Viral replication

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- **Viral replication**
- Viral replication is the term used by virologists to describe the formation of biological viruses during the infection process in the target host cells.
- the purpose of viral replication is to allow production and survival of its kind. By generating abundant copies of its genome and packaging these copies into viruses, the virus is able to continue infecting new hosts. Replication between viruses is greatly varied and depends on the type of genes involved in them. Most DNA viruses assemble in the nucleus except pox virus while most RNA viruses develop in cytoplasm except influenza virus.

- **Replication cycle**
- Viral populations do not grow through cell division, because they are acellular. Instead, they use the machinery and metabolism of a host cell to produce multiple copies of themselves, and they assemble in the cell.
- **A typical virus replication cycle**

  The life cycle of viruses differs greatly between species but there are seven basic stages in the life cycle of viruses:
- The virus replication occurs in seven stages, namely;

- 1. Adsorption
- 2. Entry (Penetration)
- 3. Uncoating,
- 4. Transcription / mRNA production,
- 5. Synthesis of virus components (translation)
- 6. Virion assembly
- 7. Release (Liberation Stage).
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- **Attachment** is a specific binding between viral capsid proteins and specific receptors on the host cellular surface. This specificity determines the host range of a virus. For example, HIV infects a limited range of human leucocytes. This is because its surface protein, gp120, specifically interacts with the CD4 molecule. Attachment to the receptor can induce the viral envelope protein to undergo changes that results in the fusion of viral and cellular membranes, or changes of non-enveloped virus surface proteins that allow the virus to enter.

- **Penetration** follows attachment: Virions enter the host cell through receptor-mediated endocytosis or membrane fusion. This is often called viral entry. The infection of plant and fungal cells is different from that of animal cells. Plants have a rigid cell wall made of cellulose, and fungi one of chitin, so most viruses can get inside these cells only after trauma to the cell wall.
- Bacteria, like plants, have strong cell walls that a virus must breach to infect the cell.

- **Uncoating** is sepration of nucleic acid from its coat: This may be by degradation by viral enzymes or host enzymes or by simple dissociation; the end-result is the releasing of the viral genomic nucleic acid.

- **Replication of viruses** involves primarily multiplication of the genome. Replication involves synthesis of viral messenger RNA (mRNA) from "early" genes (with exceptions for positive sense RNA viruses), viral protein synthesis, possible assembly of viral proteins, then viral genome replication mediated by early or regulatory protein expression. This may be followed, for complex viruses with larger genomes, by one or more further rounds of mRNA synthesis: "late" gene expression is, in general, of structural or virion proteins.

- **Transcription / mRNA production**
- The mRNA is used to instruct the host cell to make virus components. The virus takes advantage of the existing cell structures to replicate itself.
- **Synthesis of virus components (translation)**
- Viral protein synthesis: virus mRNA is translated on cell ribosomes into two types of virus protein.

- **Non – structural proteins**: not found in particle, mainly enzymes for virus genome replication. Like helicase,primase ,nuclease, ligase etc.
- **Structural proteins**: the proteins which make up the virus particle are manufactured and assembled.
- Viral nucleic acid synthesis (genome replication) new virus genome are synthesized, templates are either the parental genome or with single stranded nucleic acid genomes, newly formed complementary strands.
- **Virion Assembly**
- A virion is simply an active or intact virus particle. In this stage, newly synthesized genome (nucleic acid), and proteins are assembled to form new virus particles.
- This may take place in the cell's nucleus, cytoplasm, or at plasma membrane for most developed viruses.

- **Release (Liberation Stage)**
- The viruses, now being mature are released by either sudden rupture of the cell, or gradual (budding) of enveloped viruses through the cell membrane.
- The new viruses may invade or attack other cells, or remain dormant in the cell.
- • Following the structure-mediated self-assembly of the virus particles, some modification of the proteins often occurs.

Viruses can be released from the host cell by lysis, a process that kills the cell by bursting its membrane and cell wall if present: This is a feature of many bacterial and some animal viruses.

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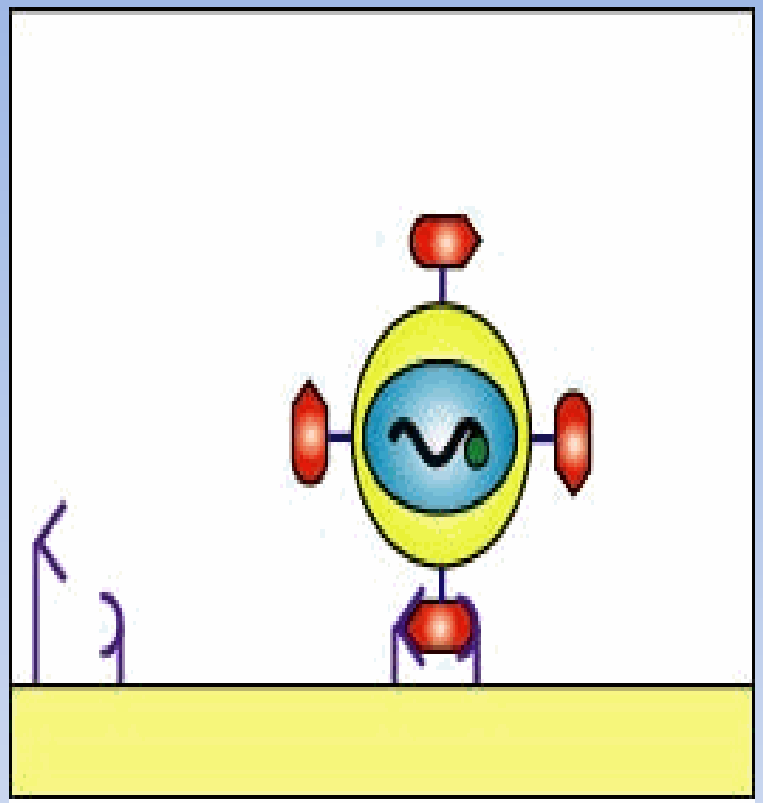
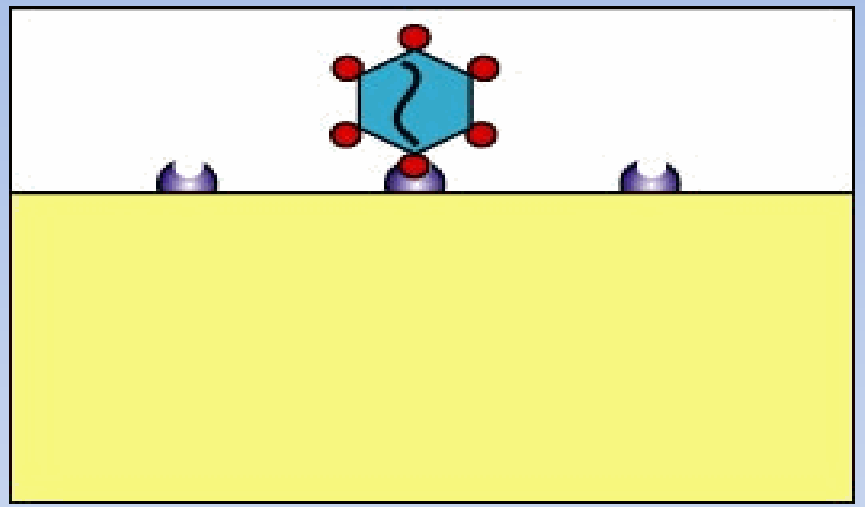
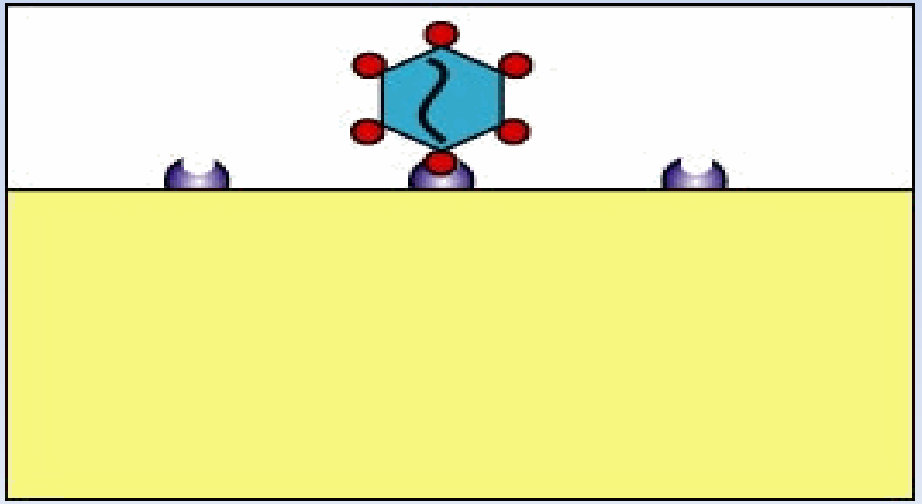
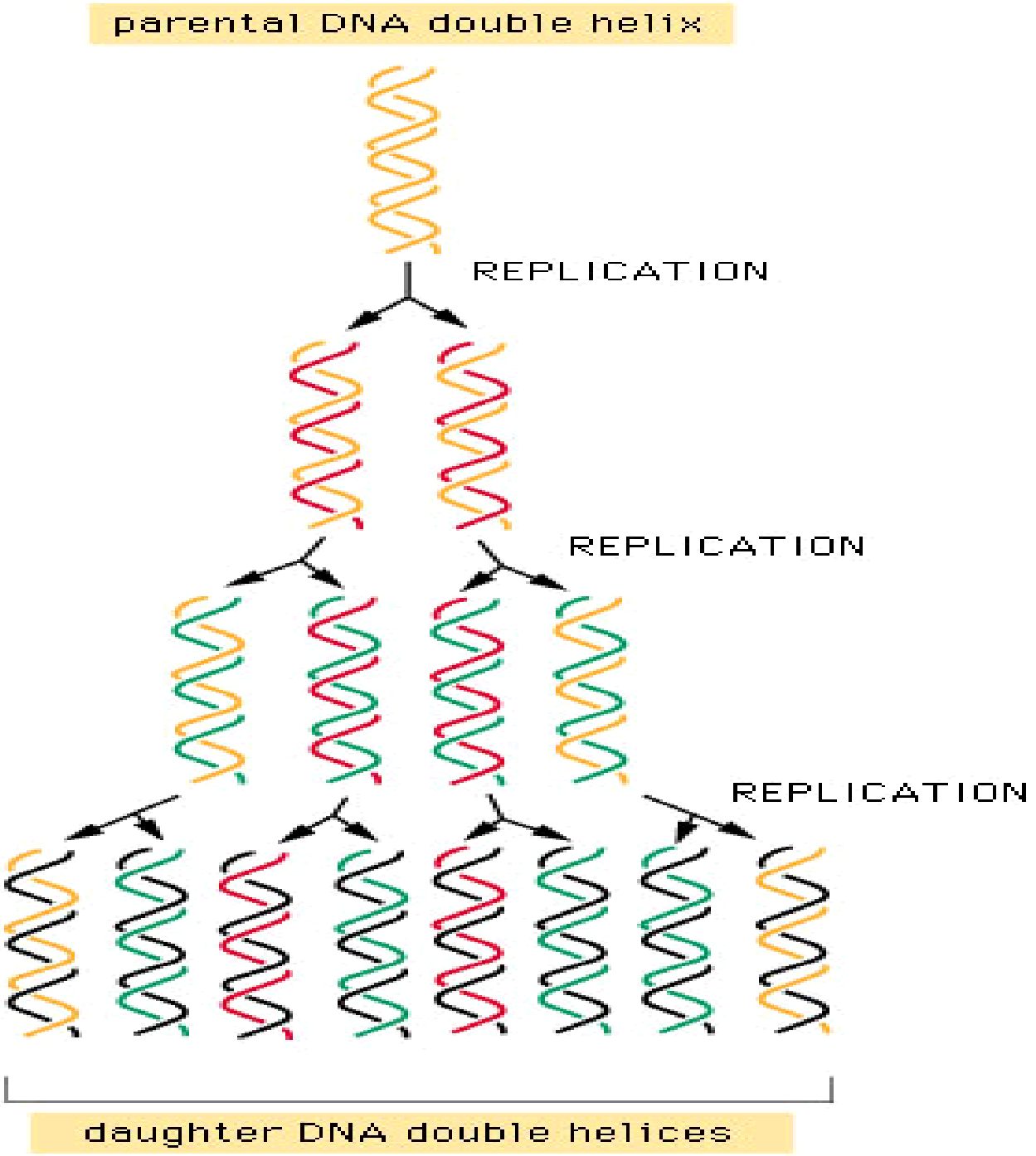
- **Effects on the host cell**
- The range of structural and biochemical effects that viruses have on the host cell is extensive. These are called cytopathic effects. Most virus infections eventually result in the death of the host cell. The causes of death include cell lysis, alterations to the cell's surface membrane and apoptosis.

- penetration








parental DNA double helix
REPLICATION
REPLICATION
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daughter DNA double helices
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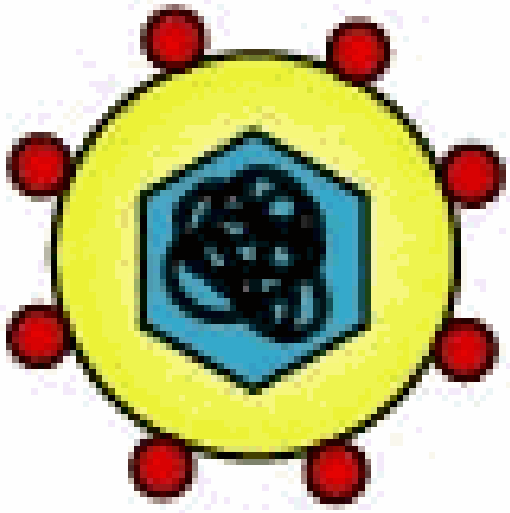
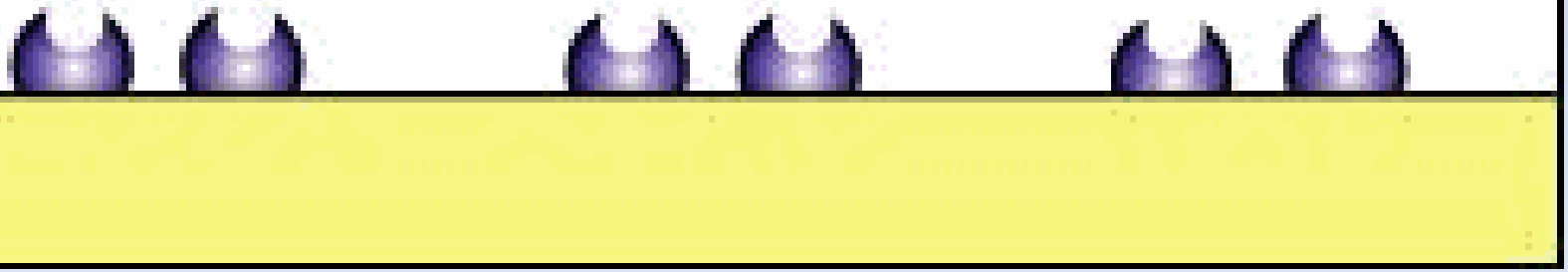
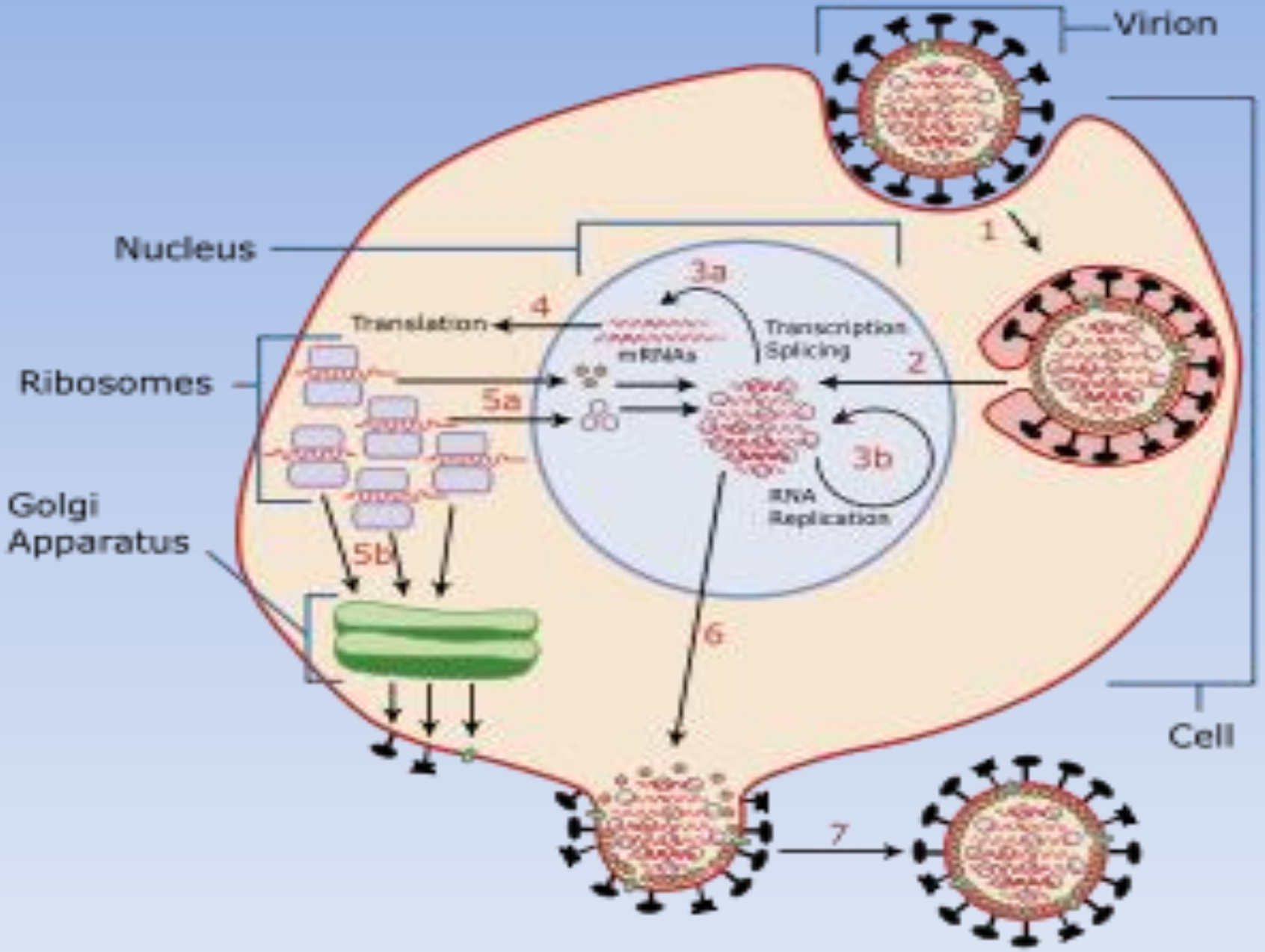
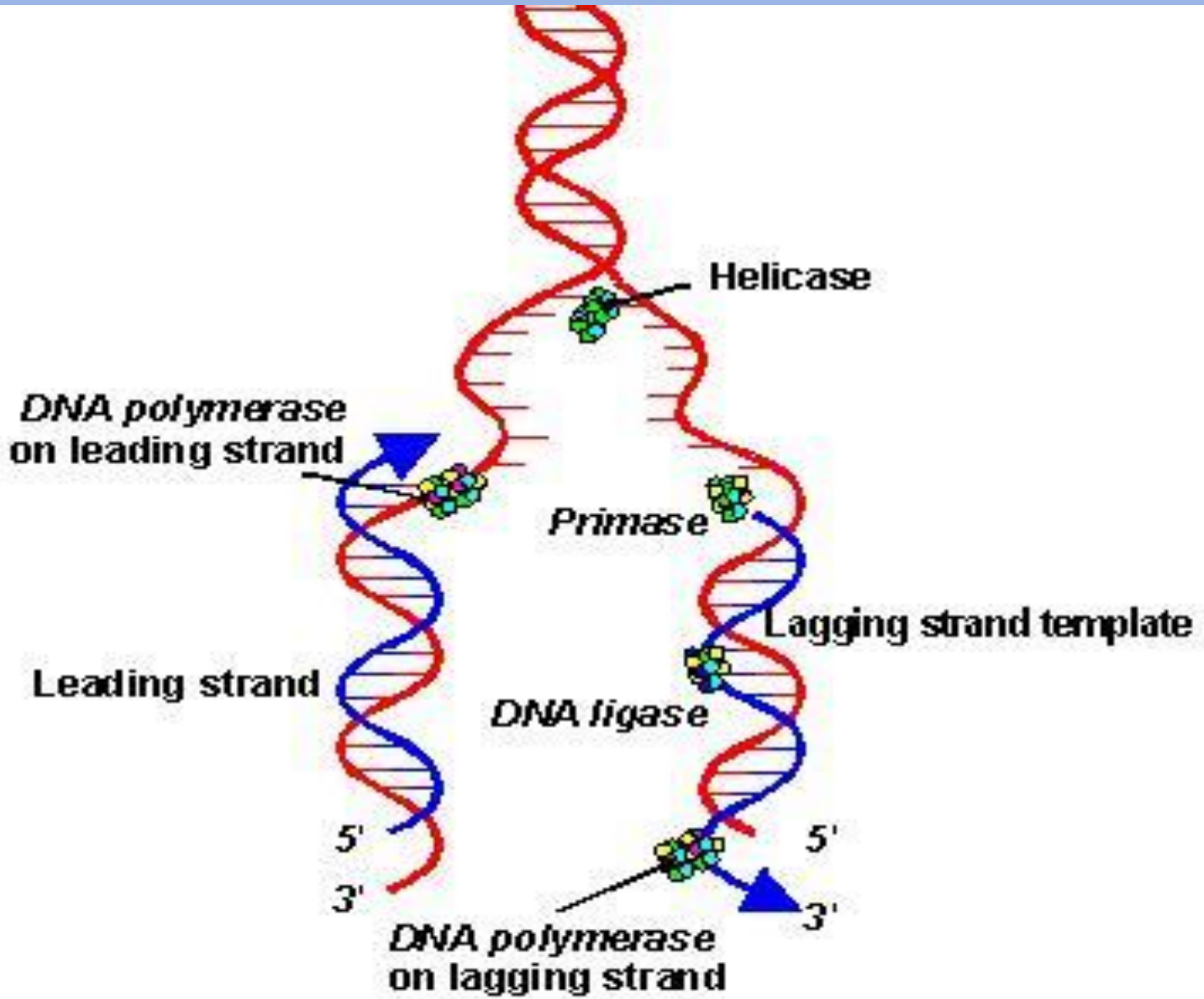
ADSORPTION






Virion
Nucleus
Ribosomes
Golgi Apparatus
Translation
mRNAs
Transcription Splicing
RNA Replication
1
2
3a
3b
4
5a
5b
6
7
Cell

- A gene is the sequence of nucleotides within a portion of DNA that codes for a peptide or a functional RNA.
- Sum of all genes = genome
- Mistakes during Replication
- Base pairing rules must be maintained
- Mistake = genome mutation, may have consequence on daughter cells
- If wrong nucleotide is included Polymerase uses its proofreading ability to cleave the phosphodiester bond of improper nucleotide
- DNA polymerase has proofreading ability but RNA polymerase is not.
- ***Eclipse period***: the period of time between infection by a virus and the appearance of the mature virus within the cell.


Helicase
DNA polymerase
on leading strand
Primase
Lagging strand template
Leading strand
DNA ligase
5'
3'
5'
3'
DNA polymerase
on lagging strand

Thank you •