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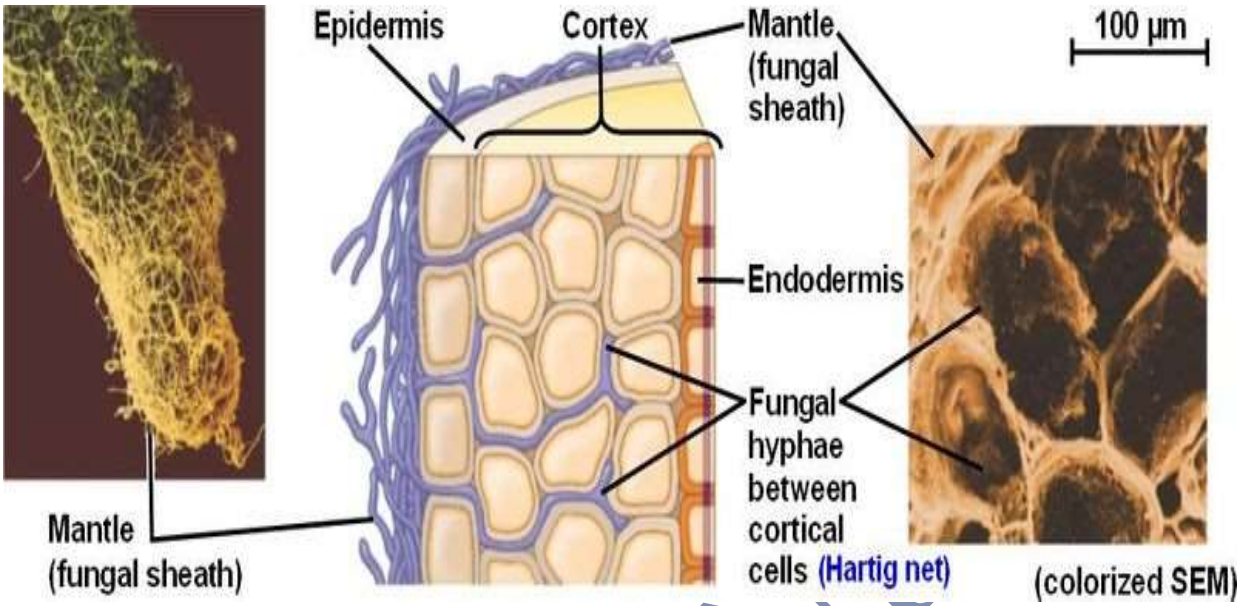
Mycorrhizae

- A **mycorrhiza** is a mutualistic relationship between a **fungus** and a **plant root.**
- The fungus functions like a root by growing into the soil and absorbing nutrients for the plant.
- The plant provides the fungus with products of photosynthesis (sugar).
- The **roots of about 90%** of all plant families have species that are involved in mutualistic symbiotic relationships with certain kinds of fungi.
- The fungi in mycorrhizal associations function as extensions of the root system.

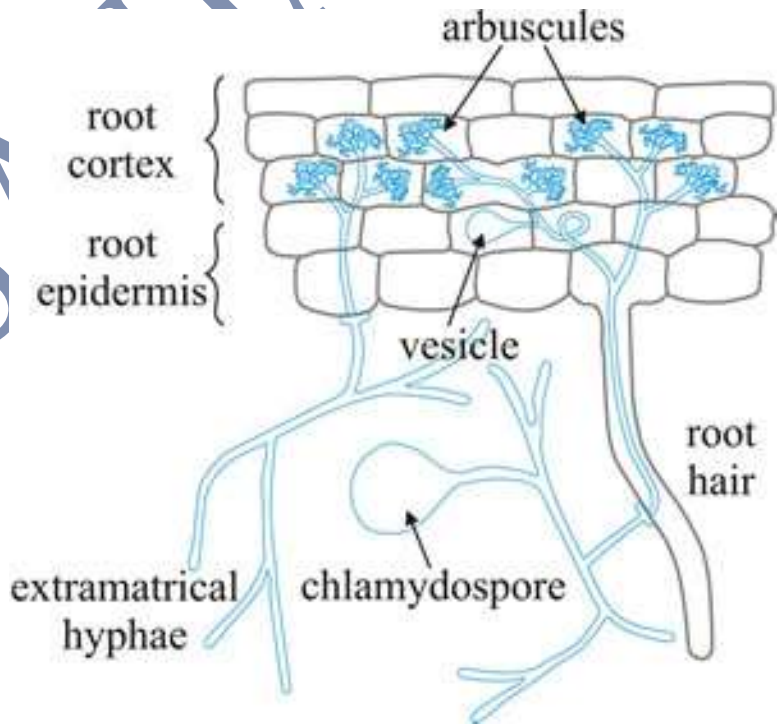
Ectomycorrhizal Fungi

- Ectomycorrhizal fungi form a dense network of hyphae around plant roots.
- The hyphae may penetrate the root, but they do not penetrate the root cells.
- The fungal components in most ectomycorrhizae are basidiomycetes
- They are characterised by hyphal mantle and hartig net



Arbuscular Vesicular Mycorrhiza

- Involving roughly **70% of all plant species** .
- The fungal component in them are **Zygomycetes**
- Hyphae penetrate the plant root cells.
- Portion of hyphae within the plant cell forms a highly-branched structure called an **arbuscule** or **vesicle** which aids in the transfer of nutrients between the two species Common in grasslands and tropical ecosystems.
- Plant benefits by more-efficient mineral (especially **phosphorus**) uptake.

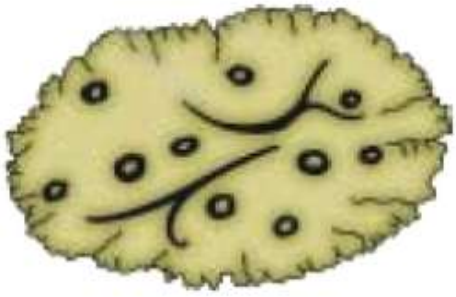


Lichens

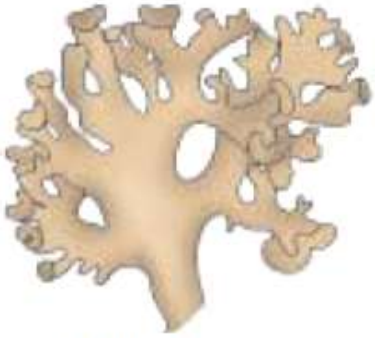
- Lichens are structures made up of two different species: - **A fungus** and a **cyanobacterium or a green algae**.
- The body of lichen is a **thallus**
- Thallus contains two main components, a fungus **mycobiont** and a photosynthetic organism, the **photobiont.**
- Mycobiant is dominant partner and mostly belongs to **Ascomycetes**
- Phycobiant is mostly green alga *e.g.* ***Chlorella, Trebouxia, Protococcus*** etc.
- Extremely slow growing and very long lived.
- **Soredia** are made up of groups of algal (photobiont) cells loosely entangled with fungal hyphae. (asexual reproduction)

On the Basis of the Type of thallus :

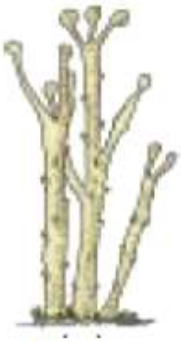
- **Crustose :** These are encrusting lichens with thin, flat, inconspicuous thalluse
- **Foliose or Foliaceous :** Foliose lichens are leafy lichens
- **Fructicose or Filamentous :** These are shrubby lichens



Crustose



Foliose



Fruticose

Economic importance of Lichens :

- **Pioneers of vegetation :** The lichens are considered **as pioneers** in initiating a xerarch plant succession on the rocks.
- **Food and fodder :** Reindeer moss (*Cladonia*), Iceland moss (*Cetraria*)
- **In - Tanning Dyeing Cosmetics Perfumes Medicine**
- **Indicators of air pollution :** Lichens are **very sensitive to SO_2** and die at higher levels of SO_2 i.e. they indicate SO_2 pollution.

Virus

- **Obligate intracellular parasite**
- Mainly the size ranges from **100-2000** millimicron.
- The genetic material is **either DNA or RNA**
- A single virus particle is known as **virion**
- They lack their own enzyme system.
- They can't be cultured on artificial culture media.
- They are highly infectious and spread disease very quickly.
- They show special kind of pathogenecity
- They can be crystallized.
- Not possessing any cellular organization
- They show mutation.
- They behave as inert chemicals outside the host cell.
- They do not show functional autonomy.
- Connecting ling between living and non living -

- Not included in the five kingdoms of life
- Smallest infectious agents

Viruses cause diseases like

- **mumps small pox herpes influenza**

In plants, the symptoms can be

- mosaic formation
- leaf rolling and curling
- yellowing
- vein clearing
- dwarfing
- stunted growth

Structure of virus

Capsid /Coat

- Protein Covering
- Protective -
- Made of Capsomeres
- Shape and arrangement of capsomeres Determine shape of virus
- Determine host specificity

Nucleic Acid (DNA or RNA) - Determine infectivity

dsDNA	ssDNA	dsRNA s	ssRNA
CaMV (**Cauliflower mosaic** virus) Lambda virus T phages Adenovirus Smallpox Hepatitis –B Cyanophage	$\phi \times 174$,	Mycophage	Polio, Influenza, TMV, Cold Measles Mumps, Yellow fever, HIV, Dengue, Rabies H1N1, Chikungunya Ebola Bird flu Swine flu Nipah Coronavirus **SARS (** severe acute respiratory syndrome)

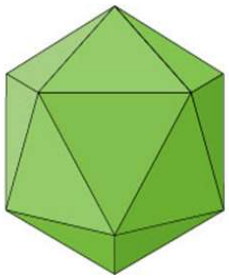
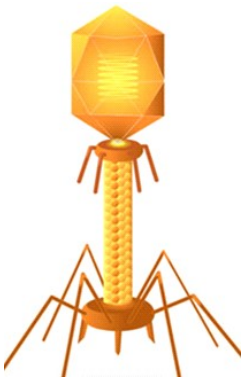
Enzyme in some viruses :

- Neuraminidase in H1N1
- Lysozyme in T phage,
- Reverse Transcriptase in HIV

Envelope -

- Some viruses have additional covering called peplos or envelope which is made of carbohydrates proteins and lipids .
- Envelope may be derived from plasma membrane or internal cell membranes
- **Examples -** Mumps, HIV , Rabies , Herpes, Coronovirus

Symmetry / Shape

Helical / Rod shaped	Polyhedral/Spherical	Complex/ Binal
Mumps, Measles **Tobacco mosaic virus**	Adenovirus Herpes, Poliovirus 	T phages Cyanophages 

TMV (Tobacco Mosaic Virus)

- Tobacco mosaic is a serious disease of tobacco and tomato
- TMV was the first virus that was crystallized by Stanley in 1935 from USA.
- The general symptom are chlorosis, curling, mottling, dwarfing, distortion and
- Virus reduces the yield as well as quality of products

Mayer (1886) showed that the juice from the infected plants of tobacco could reproduce the disease if applied to healthy plants.

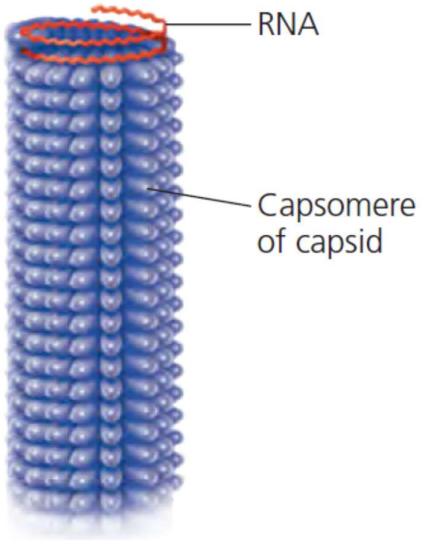
The Russian botanist **Dimitri Ivanowski** (1892), demonstrated that the causal organism of tobacco mosaic could even pass through the finest porcelain filter that withholds bacteria. Ivanowski also showed that this filterate was capable of transmitting the disease to

healthy susceptible plants. He also indicated that these causal organism were even smaller than bacteria.

Beijerinck (1898) a Dutch microbiologist, showed that the causal agent or tobacco mosaic could diffuse through an agar membrane and was therefore liquid in nature such a liquid causal agent of tobacco mosaic was called by Beijerinck as "***Contagium vivum fluidium***' **or** *'living infection fluid'.*

Franklin described the structure of TMV.

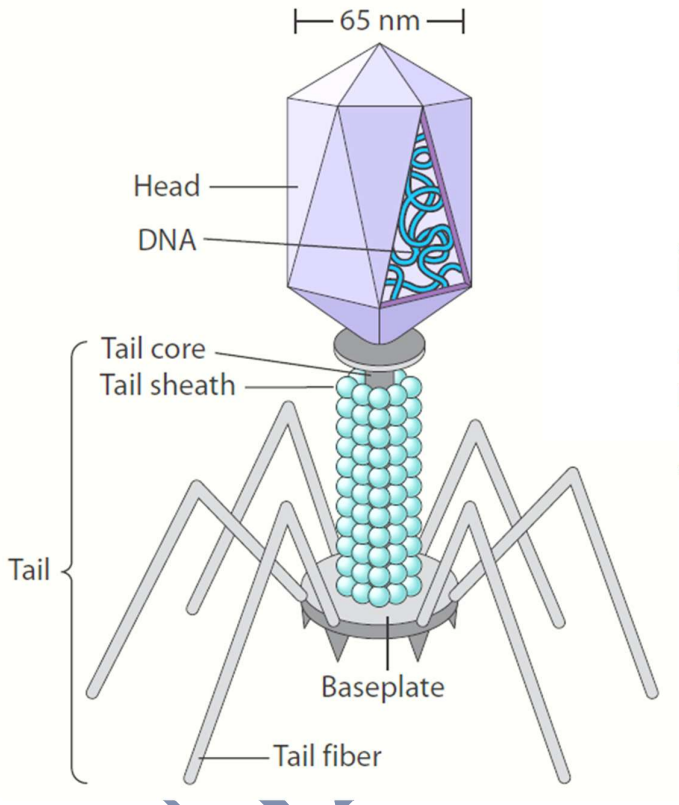
- It is rod shaped helical virus about 300 nm x 8 nm in diameter.
- The virion consist of protein coat, made up of **2,130 protein subunit** of identical size.
- The central/hole consist of **ssRNA** molecule **3300 A** long which is also spirally coiled to form helix.
- Virus is **95 % protein and 5% RNA**



T Phages

- Discovered by **Frederick Twort** and **Felix de Herelle** 1917
- Named by **Max Delbruck** 1938
- **Tadpole Shape Bacteriophage** - with head and tail regions.
- **T-even Series** (T2, T4, T6)
- Head capsid has the form of a prolate icosahedron.
- It is made up of about **2,000** similar ubunits and is packed with circular **double stranded DNA** .
- Head capsid consist of **two 10-faceted equatorial bands** with a pyramidal vertex at either end.
- The tail has helical symmetry.

- The tail consist of a core tube 80A in diameter, through which DNA passes out surrounded by a protein tail sheath.
- The **base plate is hexagonal**
- From each of the six corners is also given off a long, thin tail fibre.
- Lysozyme present at tips of tail fibres



Life cycle of viruses :

- **Lytic cycle :** shown by **T-phages**
- **Lysogenic cycle :** shown by **lambda phages**

Lytic Cycle : steps

Attachment to the host: along with tail fibres.

Adsorption:.

- phage can move attached with tips of tail fibres to cell surface
- Pinning is the irreversible process.
- tail sheath contracts and therefore, appears shorter and thicker

Penetration into the host:

- penetration of nucleic acid of the phage into the bacterial cell.
- like an injection through a syringe.
- hollow core of the phage tail to pierce through the bacterial cell wall
- contractile tail sheath functions like a muscle and It derives the energy from ATP present in the tail of the phage.
- phage DNA is injected
- lysozyme facilitate the DNA penetration by producing a hole on the bacterial wall.
- empty head and the tail of the phage remain outside called ghosts.

Replication of viral nucleic acids:

Protein synthesis:

- phage nucleic acid, once inside the bacterial cell, takes over the protein synthesis machinery of the cell.
- It suppresses the synthesis of bacterial protein and directs the metabolism of the cell to synthesize the proteins of the phage particle.

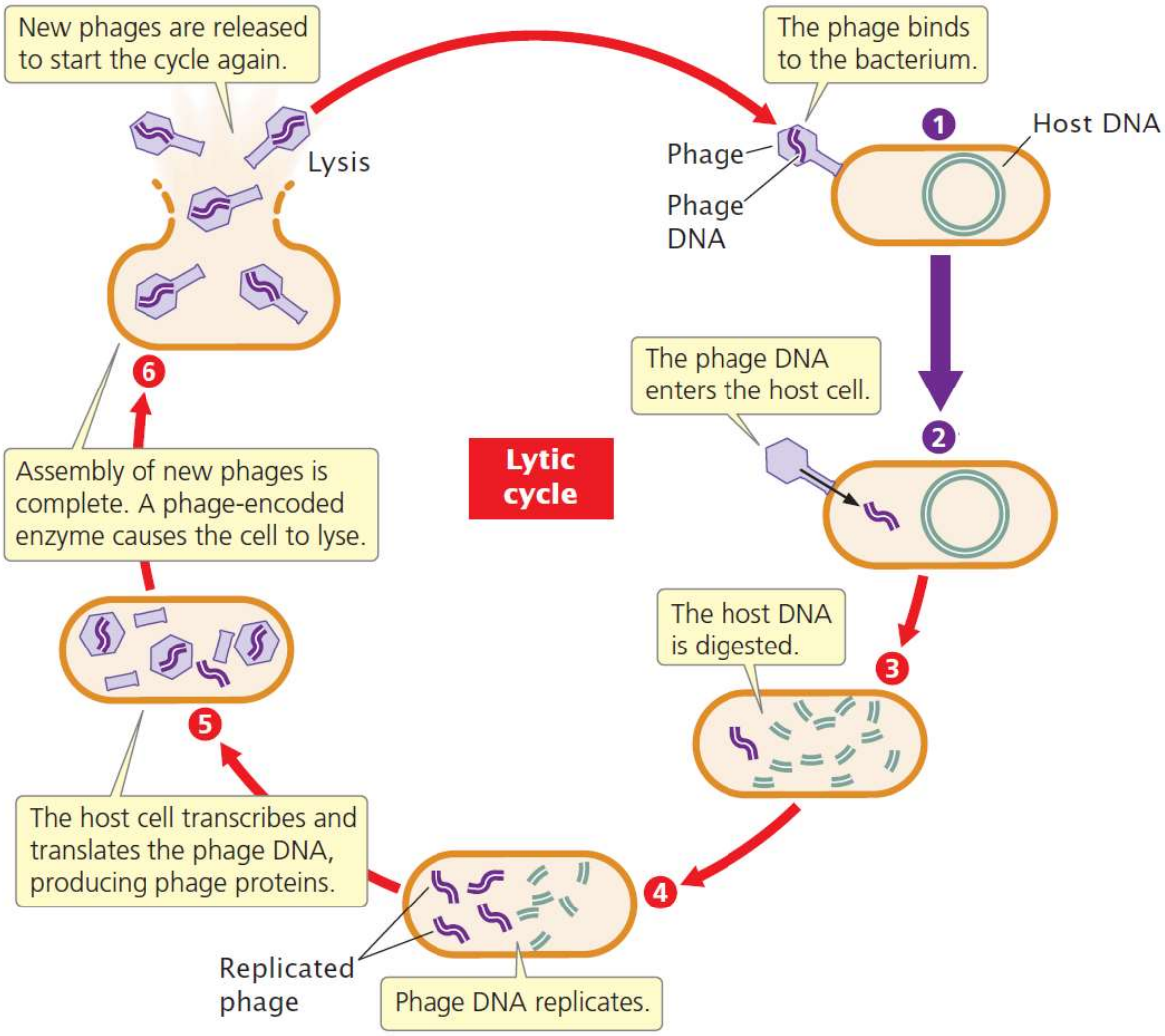
Assembly of new virions:

- DNA of phage and proteins of its head and tail are synthesize separately
- phage DNA is condensed into a compact polyhedron and packaged into the head.
- Finally the tail structures are added and thus new virion is assembled.
- **Maturation'**

Release of mature viruses:

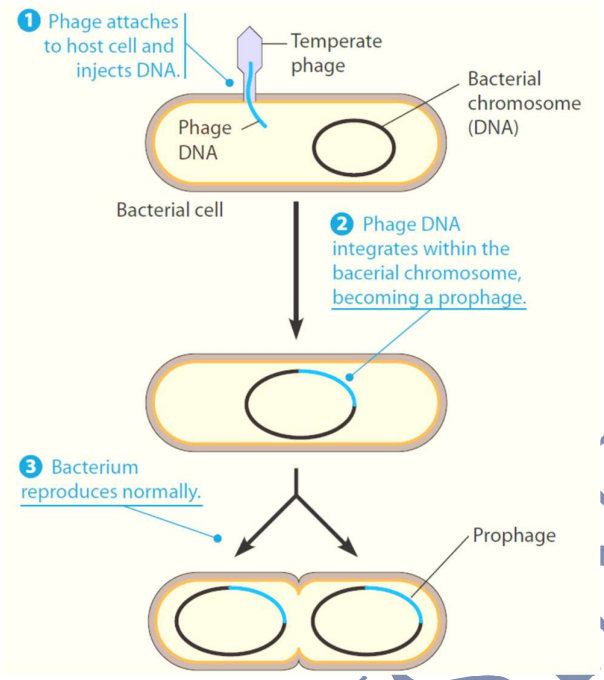
- entire cycle of phage development is completed in 25-30 min
- In an infected bacterium 7- 8 phage particles are formed/minute
- a total of about **200 phages** are formed in a bacterium.

The bacterial cell wall is weakend. It is facilitated by the enzyme lysozyme, secreted by the phage DNA in the host cell. This enzyme causes the lysis or bursting of cell wall.
The time between adsorption and the formation of new viral particles is called an **eclipse period**



Lysogenic Life cycle -

- When *E. coli* is infected with a lambda phage, two cycles may happen: **Lytic or Lysogenic.**
- The lytic cycle happens when progeny phage particles are produced. The lytic cycle is the more common life cycle that comes after most infections.
- The lysogenic cycle, in contrast, does not produce a huge number of progeny phage or break down the host cell. Instead, the **λ DNA recombines with its host's genome to produce a prophage**.
- The phage DNA then integrates with the host chromosome, producing an integrated DNA combination called the **prophage DNA.**
- The prophage DNA is replicated along each time the host bacterial cell replicates itself, producing more cells, each with a copy of the prophage DNA. When these cells are exposed to certain chemicals or to ultraviolet light, phage induction happens; the prophage DNA is then cut out of the host genome and proceeds to the lytic cycle.



Cyanophages : Algal Viruses

- Cyanophages are the **ds DNA** complex viruses
- By **Safferman & Morris** (1963) .
- The first algal virus was named as strain **LPP-I**

Viroids

- Viroids are much smaller than viruses, contain RNA only
- Discoversd by **T.O.Diener**
- It contains **single circular RNA** of low molecular weight
- **No capsids** or envelops.
- First viroid was **potato spindle tuber viroid** (PSTD)

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Prions

The **transmissible spongiform encephalopathies,** or **prion diseases,** are fatal neurodegenerative diseases characterized by spongiform changes, astrocytic gliomas, and neuronal loss resulting from the **deposition of insoluble protein aggregates in neural cells.**

- Discovered by **Stanley B Prusiner**
- **Infectious proteins**
- Prions are made up of only **2-3 molecules** of protein only.
- Prions are **100 times shorter than viruses**
- A single prion rod is made up of about **1000 prion** molecules.
- The brains of infected individuals develop numerous **small cavities as neurons die**, producing a marked spongy appearance.

Diseases

- **Kuru -** symptoms are tremors , ataxia , dementia first detected In Fore people (tribe) in Papua New Guinea
- **Scrapie** in sheep - symptoms are tremor, ataxia (failure of muscle coordination) and death
- **Creutzfeld Jakob Disease CJD** - symptoms are dementia and tremors and lack of motor co-ordination
- Bovine spongiform encephalopathy (BSE) or **"mad cow"** disease in cattle

- Every host expresses a **normal prion protein** (PrPc) in their cells.
- The disease-causing prions are the same protein, but **folded differently (PrPsc).**

- **These misfolded proteins have been shown in vitro to serve as a template for normal PrP to misfold.**

Interferon (IFN)

- Discovered by **Issacs and Lindemann**
- **Antiviral chemicals -** a glycoprotein
- inhibit synthesis of viral RNA and protein.