

Lecture 5



Introduction to medical virology
“Viral structure and classification”

- Additional Notes
- Important
- Explanation
- Examples

We would like to thank med students 432 for giving us the permission to copy some of their work in this lecture.



OBJECTIVES:

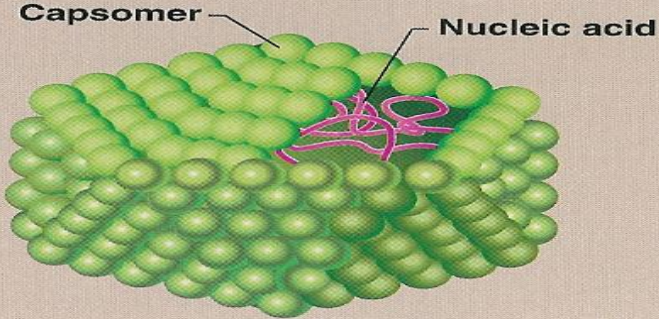
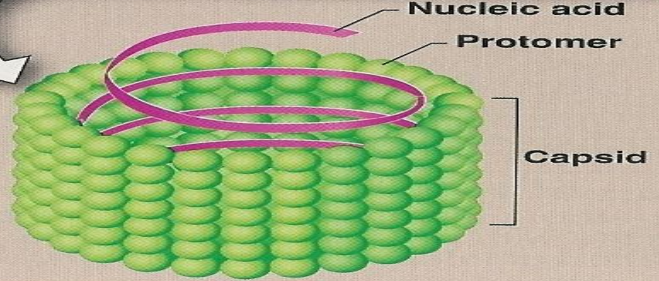
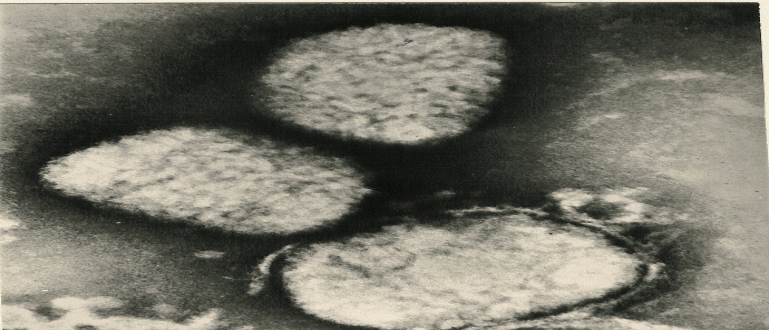
- General characteristics of viruses.
- Structure & symmetry of viruses.
- Classification of viruses.
- Steps of virus replication.
- Laboratory diagnosis of viral infections.

Properties & Characteristics of viruses:

- They are energy-less. They float around until they come in contact with an appropriate cell.
- They are basic life forms “Acellular organisms”
- composed of a protein coat, called a capsid, that surrounds genetic material.
- Viruses do not have organelles “like mitochondria” or ribosomes.
- Certain viruses are further enclosed by an external lipid bilayer membrane that surrounds the capsid and may contain glycoproteins “Called an envelope”
- The genetic material is either DNA or RNA. **Never both!!** The genetic material contains instructions to make millions of clones of the original virus.
- **Replicates in a manner diff from cells.** Replication of the genetic material occurs when the virus takes control of the host cell's synthetic machinery. = Viruses contain all of the genetic information, but not the enzymes.
- **Size: 20-300 nm.** “cannot be observed with a light microscope.”

Structure	Components	More info.
Viral genome	DNA: -Single molecule -All have Double Strand DNA, except Parvoviruses. RNA: -Single / double - (+) or (-) Polarity. - have Single Strand except Reoviruses.	RNAs Polarity: + : Viral genome Directly Produce Protein. - : Viral Genome Indirectly Produce Protein. <u>All Vs are haploid</u> ,except retroviruses are diploid
Capsid	<ul style="list-style-type: none"> - A protein coat. - Subunits(capsomere). - Genome (NA) + capsid= nucleocapsid. 	-Function: -Protects NA. -Facilitates its entry into cell.
Envelope	<ul style="list-style-type: none"> - Lipoprotein mb (host lipid, virus specific protein). 	<ul style="list-style-type: none"> - During viral budding: -Envelope is derived from cell mb except herpesviruses from nuclear mb. -Enveloped Vs are more sensitive to heat, dry & other factors than nonenveloped Vs. -Glycoprotein attaches to host cell receptor.

Symmetry (Shape of the Virus), based on arrangement of capsomeres.

Shape	Example	Pic
Cubic symmetry (Icosahederal)	<ul style="list-style-type: none"> - Adenovirus - Herpes virus 	
Helical symmetry	<ul style="list-style-type: none"> - Elongated (filoviruses) - Pleomorphic (influenza v.) 	<p>Several rows of protomers have been removed to reveal nucleic acid surrounded by a hollow protein cylinder.</p> 
Complex symmetry	poxviruses	

Viral proteins

The outer viral proteins:

- Mediate attachment to specific Rs.
- Induce neutralizing Abs.
- Target of Abs.

The internal viral proteins:

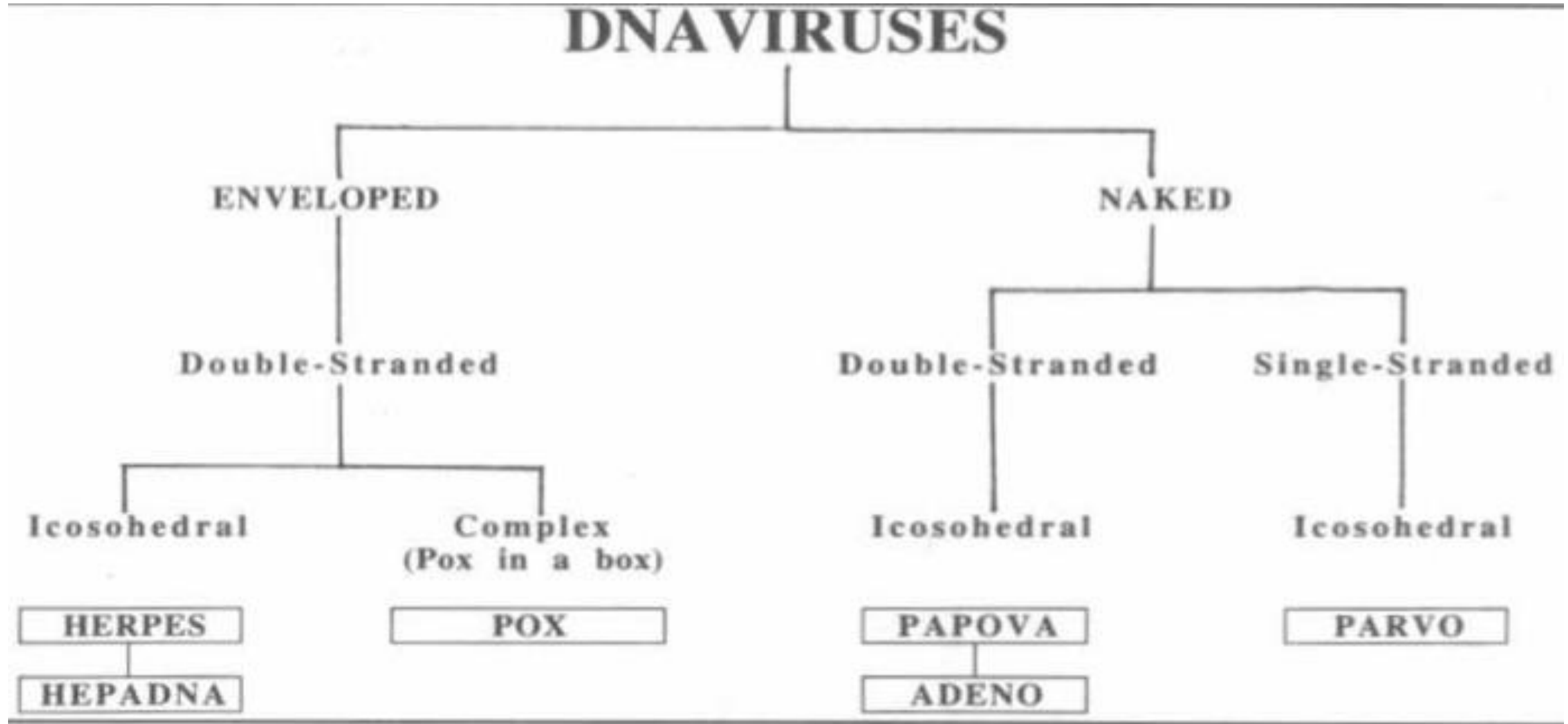
- Structural proteins (capsid proteins of enveloped Vs).
- Nonstructural proteins (enzymes):
 - ✓ All ssRNA Vs (-) polarity have **transcriptase** (RNA dependent RNA polymerase) inside virions.
 - ✓ RetroVs & HBV **contain reverse transcriptase.**

Classification of viruses

is based on chemical and physical properties of virions:

- Type of NA. “DNA or RNA”
- The no. of strand. “Double- vs. single-stranded”
- The polarity of viral genome. “Positive (+) or negative (-) stranded RNA”
- The presence or absence of envelope
- Type of symmetry

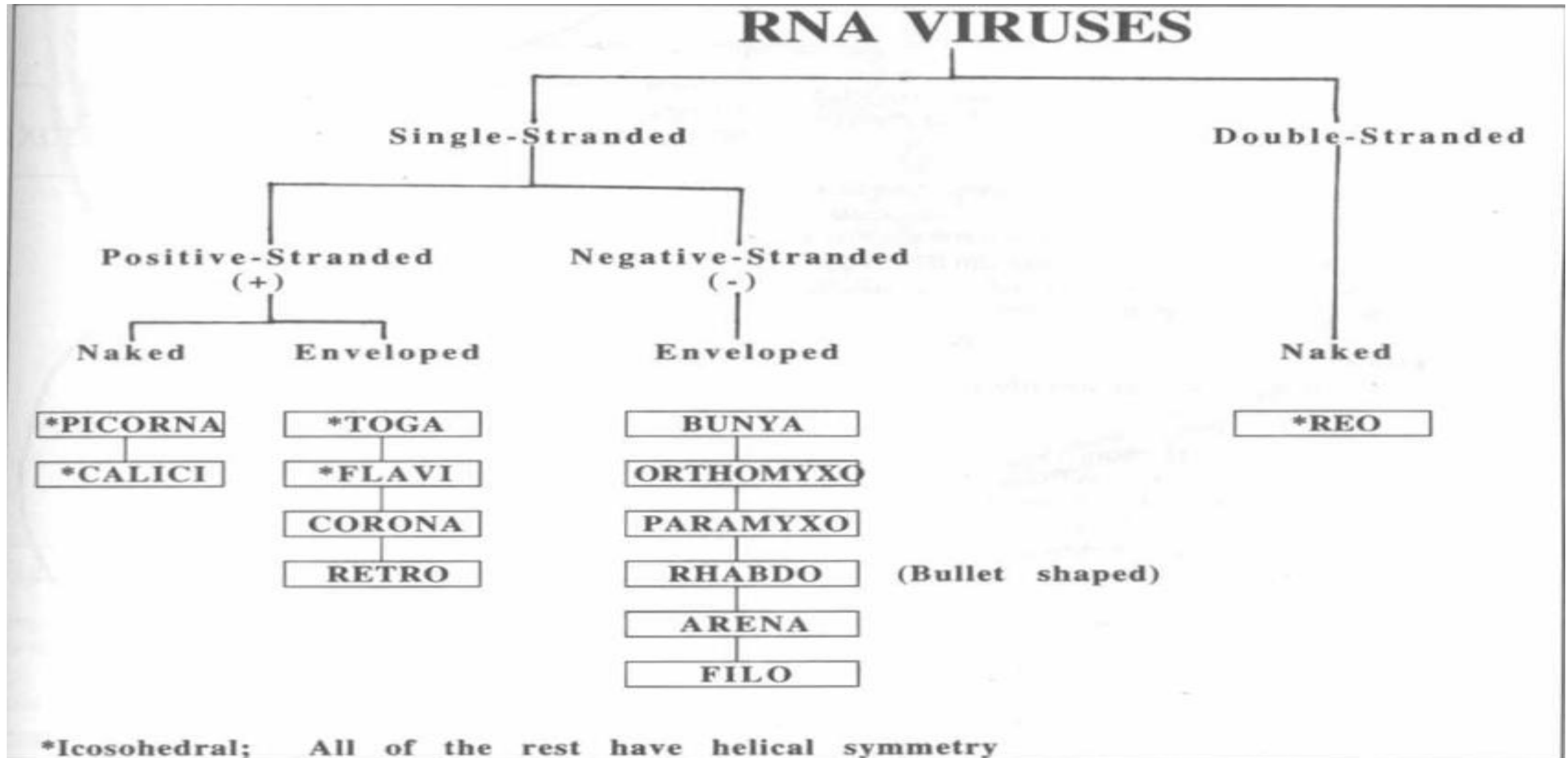
Medically Important Viruses



Not in the exam, good to know!

Source: Clinical Microbiology Made Ridiculously Simple.

Medically Important Viruses



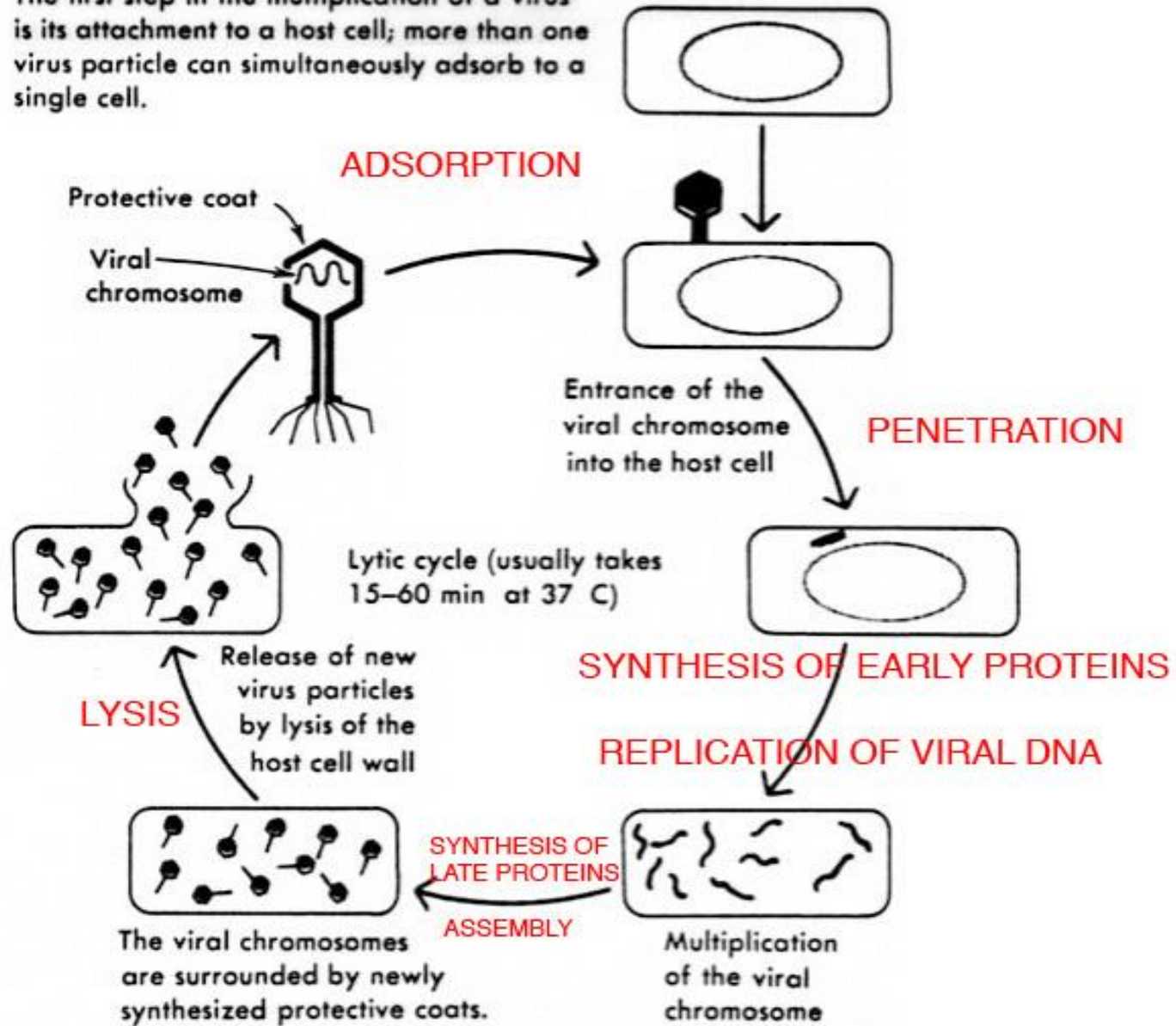
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Replication of Viruses

<p>Adsorption (Attachment)</p>	<p>Glycoprotein help the Virus to Attach</p>
<p>Penetration</p>	<ul style="list-style-type: none"> • Fusion: Virus have a membrane and they will fuse and the Virus will Enter. • Endocytosis: Virus is consumed by the Cell. Cell wraps around the Virus.
<p>Uncoating</p>	<p>Release of Viral Genome to Cytoplasm in Direct Synthesize of Protein or to Nucleus in indirect Synthesize of protein.</p>
<p>Synthesis of viral components</p>	<p>mRNA: This Step for (-) RNAs Viruses, it will use the genome to produce mRNA, and that's why it is <u>indirect</u>.</p> <p>Viral proteins: This Step for (+) RNAs, they have mRNA, it will begin the synthesize by the Ribosomes <u>Directly</u>.</p> <p>Replication of viral genome: The mechanism will continue for the replication, As we said, one virus will produce in one cell millions of viruses.</p>
<p>Assembly</p>	<p>NA + V. proteins = Virions]Virus particles[</p>
<p>Release</p>	<p>Enveloped Viruses: Virus leaves the Cell and create his Envelope from the cell membrane by the help of GlycoProtein ex: herpes Vs.</p> <p>nonEnveloped Viruses: Cell lysis or rupture</p>

The first step in the multiplication of a virus is its attachment to a host cell; more than one virus particle can simultaneously adsorb to a single cell.



NOT required, just for explanation.

laboratory diagnosis of viral infections:

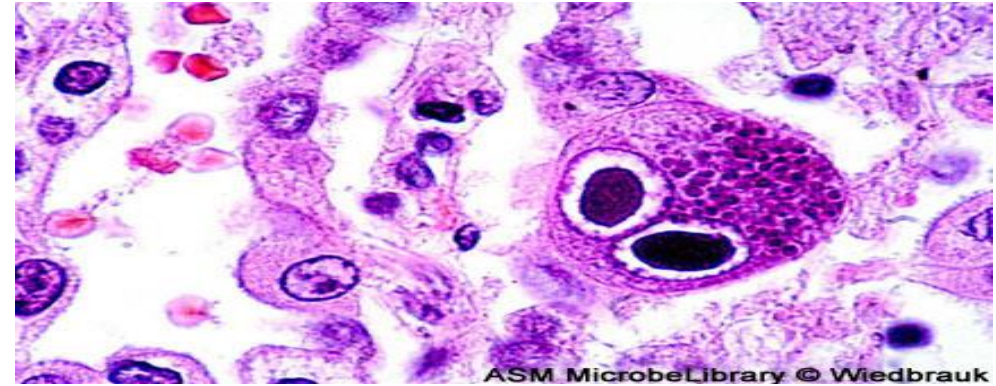
- Microscopic examination.
- Cell culture.
- Serological tests .
- Detection of viral Ag.
- Molecular method .

Microscopic examination:

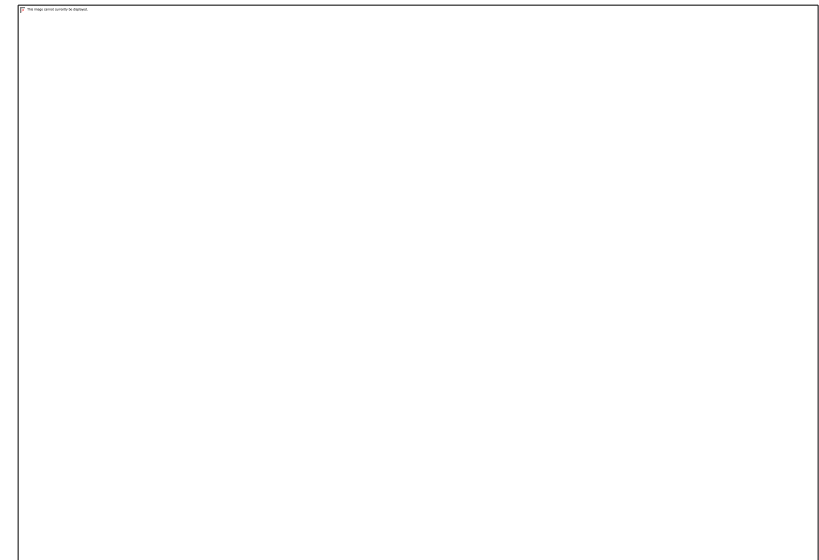
- Light microscopy:
Histological appearance. “to see what the virus has done to the cell, without seeing the virus itself”

Ex. Inclusion bodies

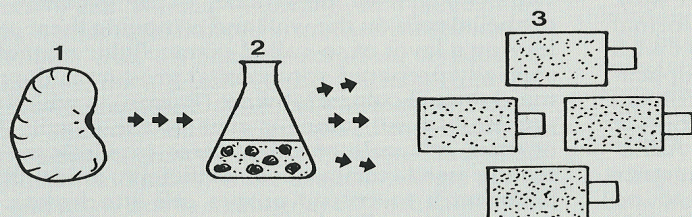
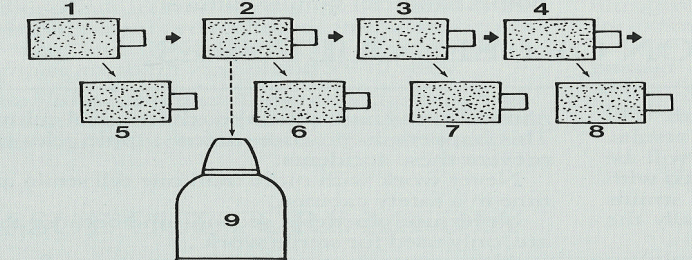
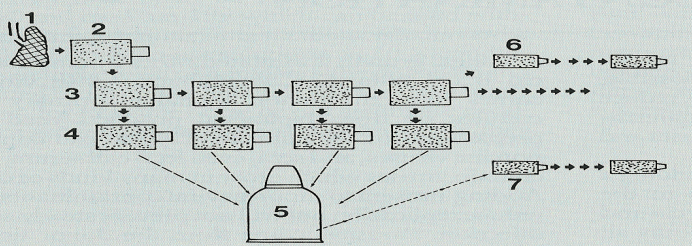
- Electron microscopy:
Morphology & size of virions“ .to see the virus particle itself”
Ex. Diagnosis of viral GE such as rota, adenoviruses.
Diagnosis of skin lesion caused by herpes, or poxviruses.
It is replaced by Ag detection & molecular tests



ASM MicrobeLibrary © Wiedbrauk



Cell culture:

Cell Culture	No of sub passages (the number of times the cells have been subcultured)	illustrating Pictures
Primary c/c	1 to 2	 A diagram illustrating primary cell culture. It starts with a single cell (1) which is placed in a flask (2) containing a medium. The cells then proliferate and are shown as a confluent monolayer in a flask (3).
Diploid c/c	20 to 50	 A diagram illustrating diploid cell culture. It shows a sequence of rectangular cell culture flasks numbered 1 through 8, connected by arrows indicating the flow of cells from one flask to the next. A larger flask (9) is shown below, with dashed lines indicating that cells from the sequence are being collected or used in this larger flask.
Continuous cell line	Indefinite	 A diagram illustrating a continuous cell line. It shows a sequence of rectangular cell culture flasks numbered 1 through 7, connected by arrows indicating the flow of cells from one flask to the next. A larger flask (5) is shown below, with dashed lines indicating that cells from the sequence are being collected or used in this larger flask. The sequence continues indefinitely, as indicated by the ellipses following flask 7.

Cell culture:

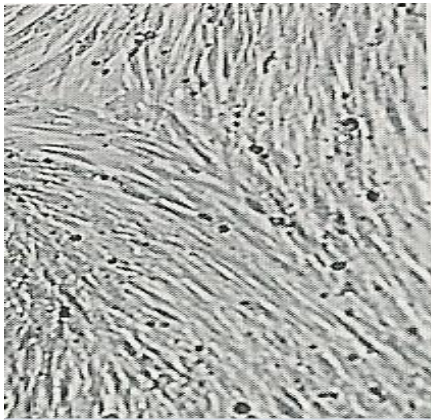
- Detection of viral growth:
Cytopathic effects.

“Rounding, shrinkage, aggregation, and lose of adherence.

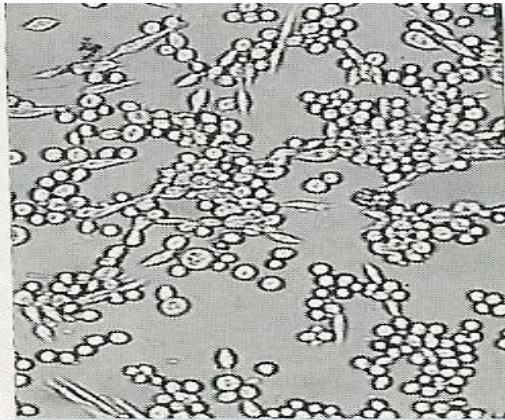
Giant Cell formation.

Inclusion bodies formation: The site of viral replication and protein synthesis.”

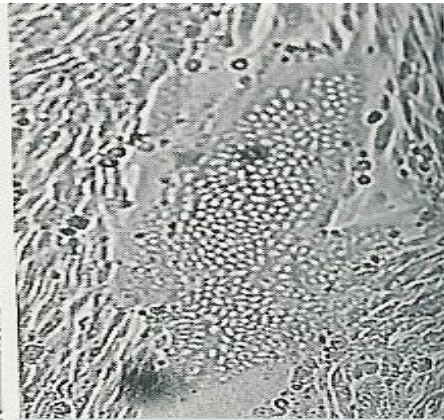
- Other effects.



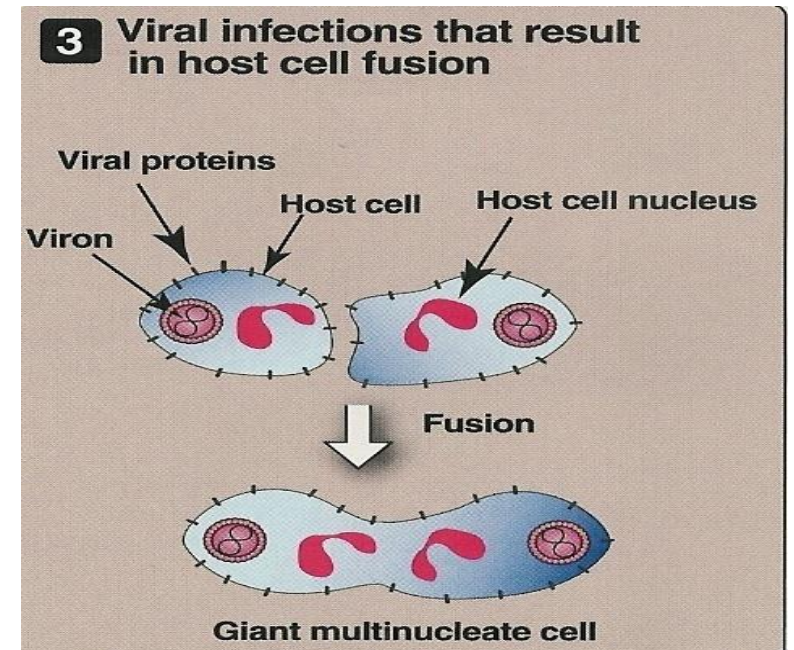
Uninfected cc



Cell rounding



Syncytium



Cell culture:

- Problems with cell culture:
 - ✓ Long incubation (up to 5 days). “Because one of the problems with cell culture is long incubation, they came up with a modified cell culture: a Rapid culture technique:
Shell vial assay (this technique detects viral antigens in cell culture, and takes 1-3 days)”.
 - ✓ Sensitivity is variable.
 - ✓ Susceptible to bacterial contamination.
 - ✓ Some viruses do not grow in cell culture e.g. HCV.

Serological tests:

Antigen detection			Antibody detection
Sample	Virus	Test	e.g. of techniques: Complement fixation test (CFT) Immunofluorescence (IF) Enzyme- linked immunosorbent assay (ELISA)
Nasopharyngeal aspirate	Influenza V	IF	
Skin scrapings	HSV	IF	
Faeces	Rotavirus	ELISA	
Blood	HBV(HBsAg)	ELISA	

Immunofluorescence (IF)	Enzyme-linked immunosorbent assay (ELISA)
<p>Direct: antigen detection by using an antigen sample.</p> <p>Indirect: antibody detection by using an antibody sample Uses florescent dye</p>	<p>Direct: antigen detection or specific IgM,IgG</p> <p>Indirect: antibody detection, Uses an enzyme that reacts with an enzymatic substrate to show colour, coloured wells indicate reactivity.</p>

Molecular test:

- Polymerase chain reaction (PCR)
 - NA amplification technique.
 - Viral genome.
- Uses of molecular test:
 - Diagnosis.
 - Monitoring response to treatment.

Quiz

1.The genetic material in viruses is:

- a) DNA only b) Either DNA or RNA c) Both DNA & RNA d) RNA only

2.Which one of the following is type of virus symmetry:

- a) Complex symmetry b) Columnar symmetry c) Simple symmetry

3.Molecular test is used for:

- a) Prognosis b) Pathogenesis c) Diagnosis

4..... is an example of a virus that doesn't grow in cell culture :

- a) HCV b) HIV c) CMV

5.Viruses have organelles such as mitochondria.

- a) T b) F