

Introduction to medical virology

“Viral structure and Classification”

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OBJECTIVES

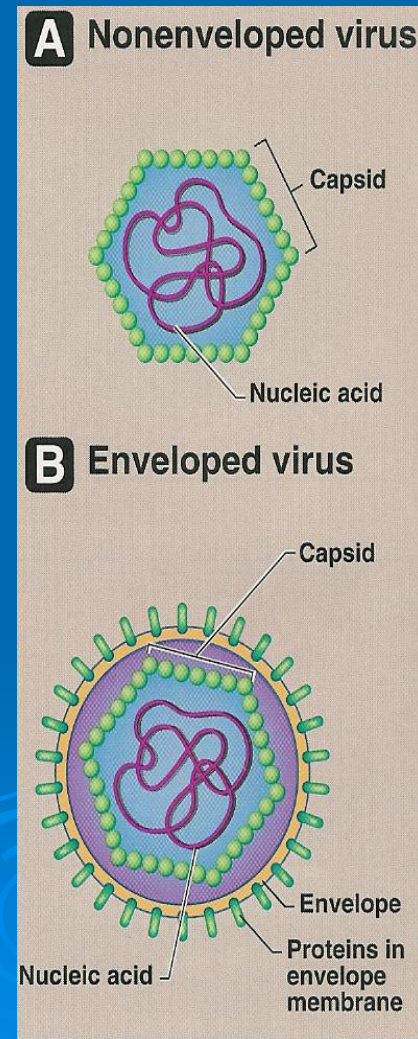
- *General characteristics of viruses.*
- *Structure & symmetry of viruses.*
- *Classification of viruses.*
- *Steps of virus replication.*
- *Laboratory diagnosis of viral infections.*

Properties of Microorganisms

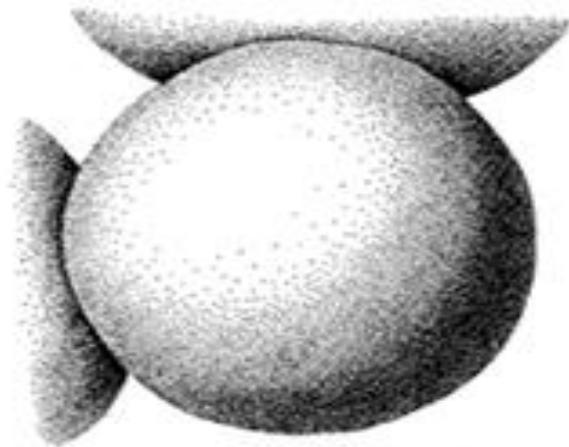
<i>characteristic</i>	<i>Parasite</i>	<i>Fungi</i>	<i>Bacteria</i>	<i>Virus</i>
<i>Cell</i>	Yes	Yes	Yes	No
<i>Type of nucleus</i>	Eukaryotic	Eukaryotic	Prokaryotic	-----
<i>Nucleic acid</i>	Both DNA & RNA	Both DNA & RNA	Both DNA & RNA	DNA or RNA
<i>Ribosomes</i>	Present	Present	Present	Absent
<i>Mitochondria</i>	Present	Present	Absent	Absent
<i>Replication</i>	Mitosis	Budding or mitosis	Binary fission	Special

Characteristics of viruses

- Acellular organisms
- Tiny particles
 - Internal core
 - Protein coat
 - Some Vs have lipoprotein mb (envelope)
- Obligate intracellular organisms
- Replicate in a manner diff from cells
(1V → many Vs)



Size ; 20-300 nm



STAPHYLOCOCCUS



HERPES VIRUS



CHLAMYDIA
ELEMENTARY
BODY



INFLUENZA VIRUS

0.2 μm



POX VIRUS



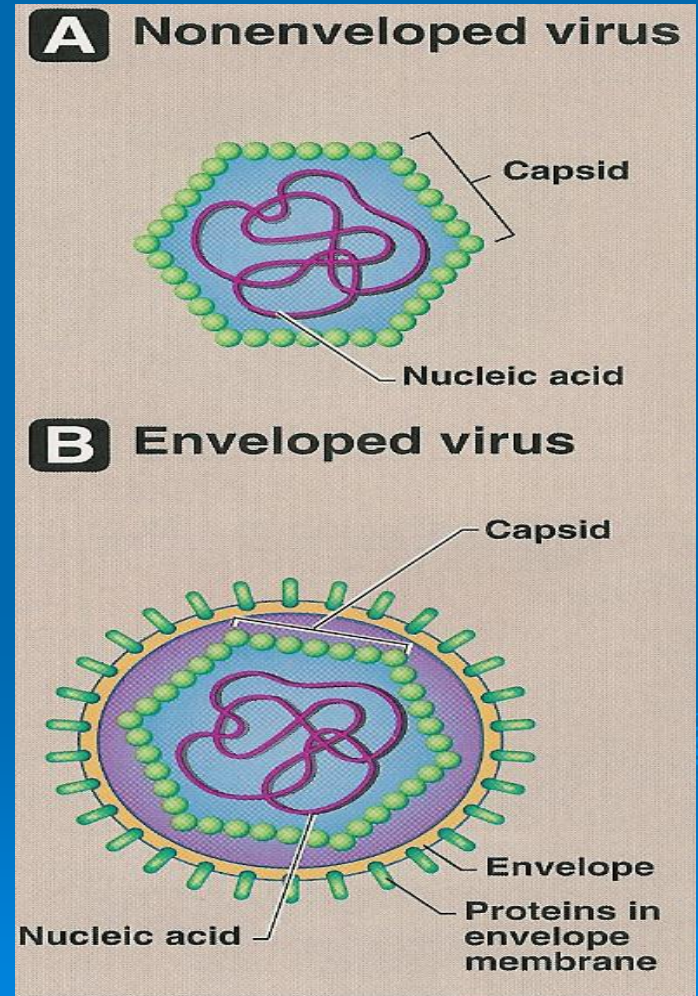
POLIO VIRUS

Viral Structure

1- Viral genome

2- Capsid

3- Envelope



Viral Structure

1-Viral genome

DNA

(Deoxyribonucleic acid)

- All DNA Vs have ds except Parvoviruses
- Single molecule

or

RNA

(Ribonucleic acid)

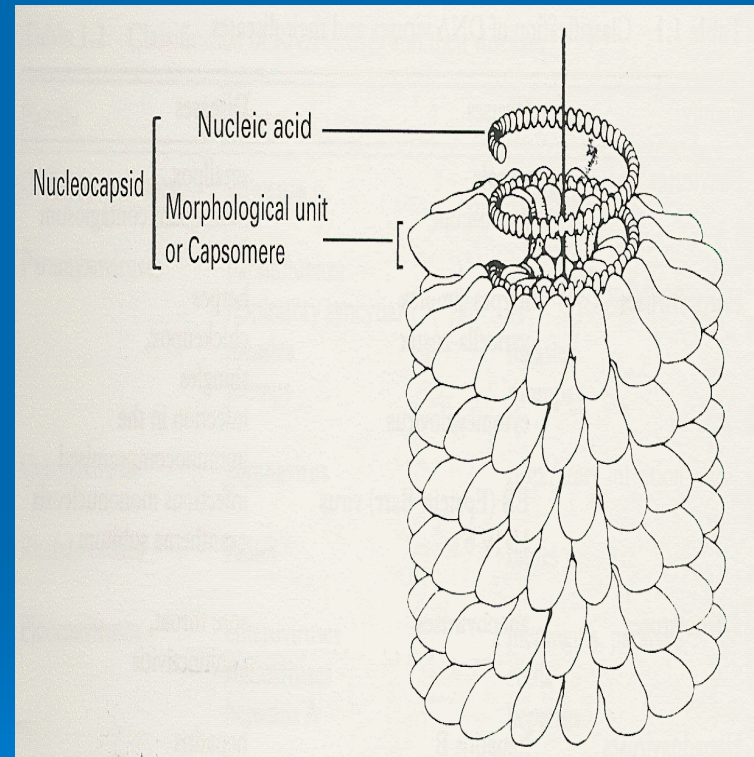
- All RNA Vs have ss except Reoviruses
- Single / double
- (+) polarity
- (-) polarity

All Vs are haploid, except retroviruses are diploid

Viral structure

2-Capsid

- a protein coat
- Subunits (capsomeres)
- Genome (NA) + capsid = nucleocapsid
- Function;
 - Protects NA
 - Facilitates its entry into cell



Symmetry

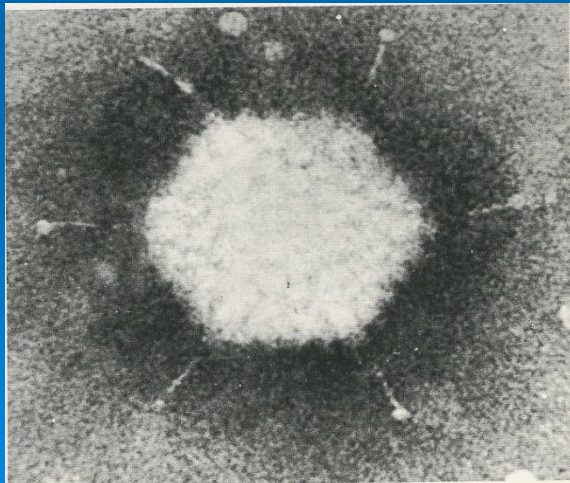
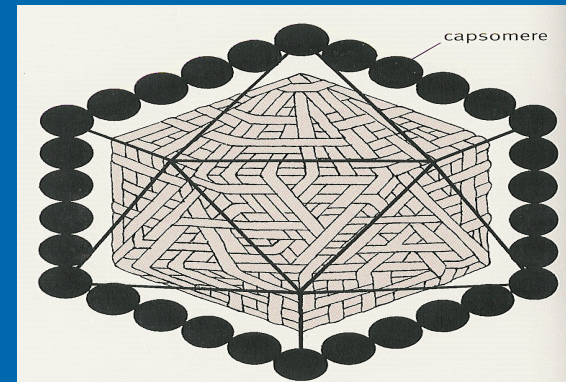
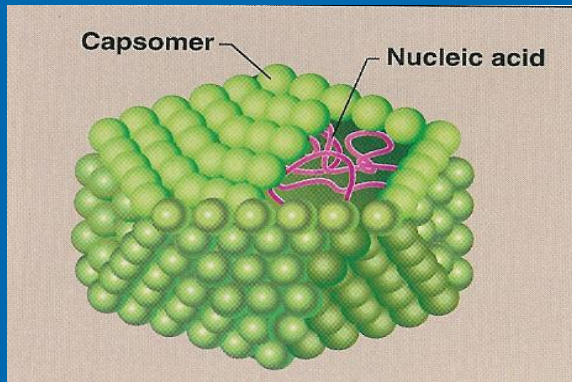
based on arrangement of capsomeres

- ***Cubic symmetry***
(Icosahederal)
- ***Helical symmetry***
- ***Complex symmetry***

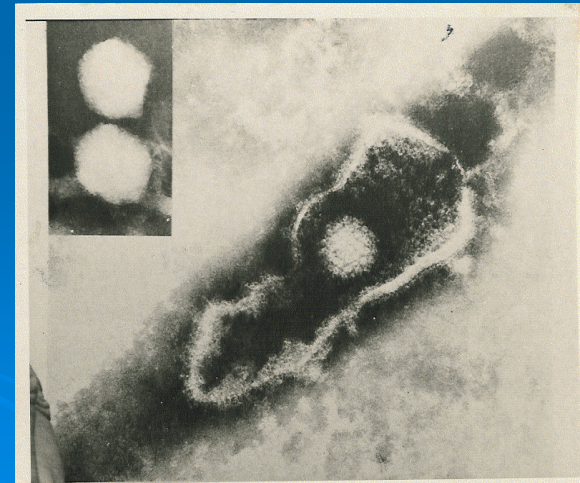
Symmetry

based on arrangement of capsomeres

- **1-Cubic symmetry**
(Icosahedral)



Adenovirus

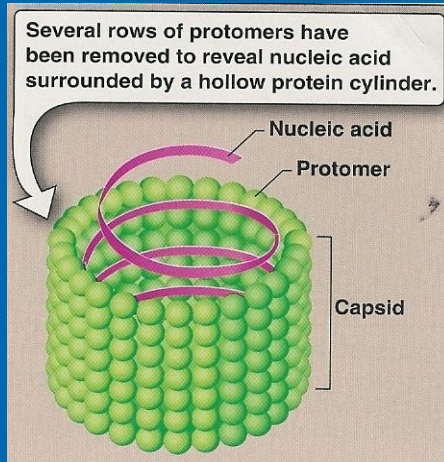


Herpes virus

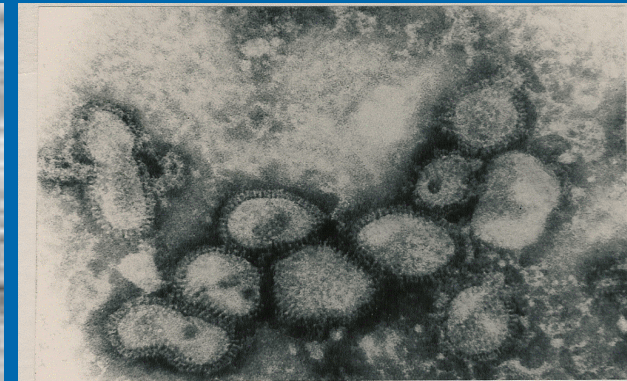
Symmetry

based on arrangement of capsomeres

➤ 2- Helical symmetry



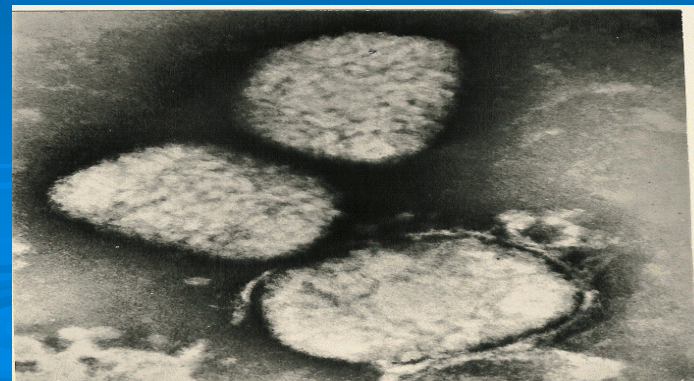
*Elongated
(filoviruses)*



*Pleomorphic
(influenza v.)*

➤ 3- Complex symmetry

poxviruses



Viral structure

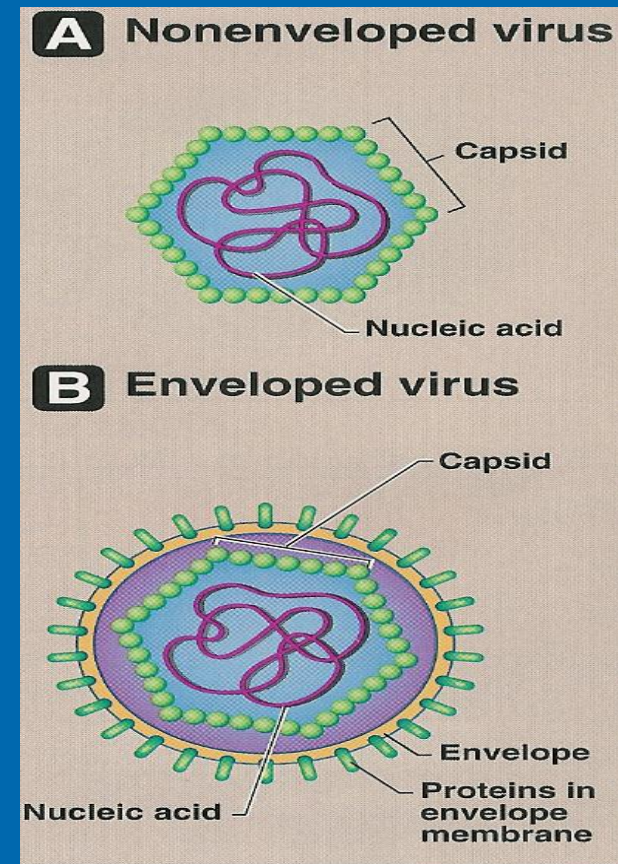
3-Envelope

Lipoprotein mb

(host lipid, virus specific protein)

➤ *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



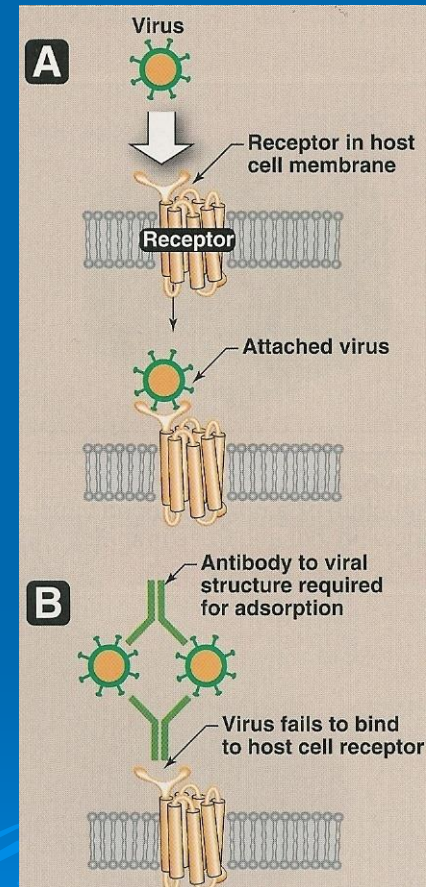
Viral proteins

❖ *The outer viral ps*

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

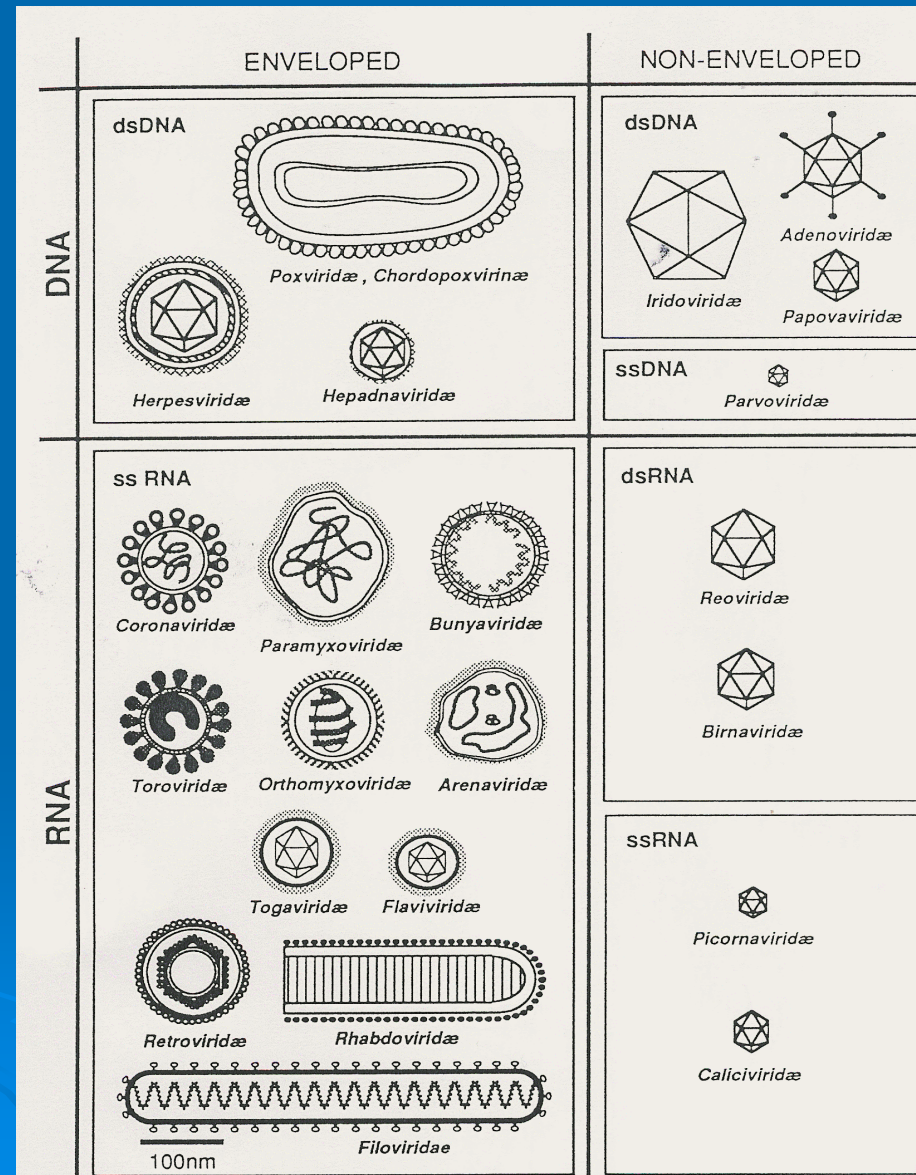
❖ *The internal viral ps*

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



Classification of viruses

- Type of NA
- The no. of strand
- The polarity of viral genome
- The presence or absence of envelope
- Type of symmetry



Medically Important Viruses

DNA

RNA

Single-stranded

double-stranded

Nonenveloped

Enveloped

Nonenveloped

Icosahedral

Parvoviridae

Complex

Poxviridae

Icosahedral

Herpesviridae

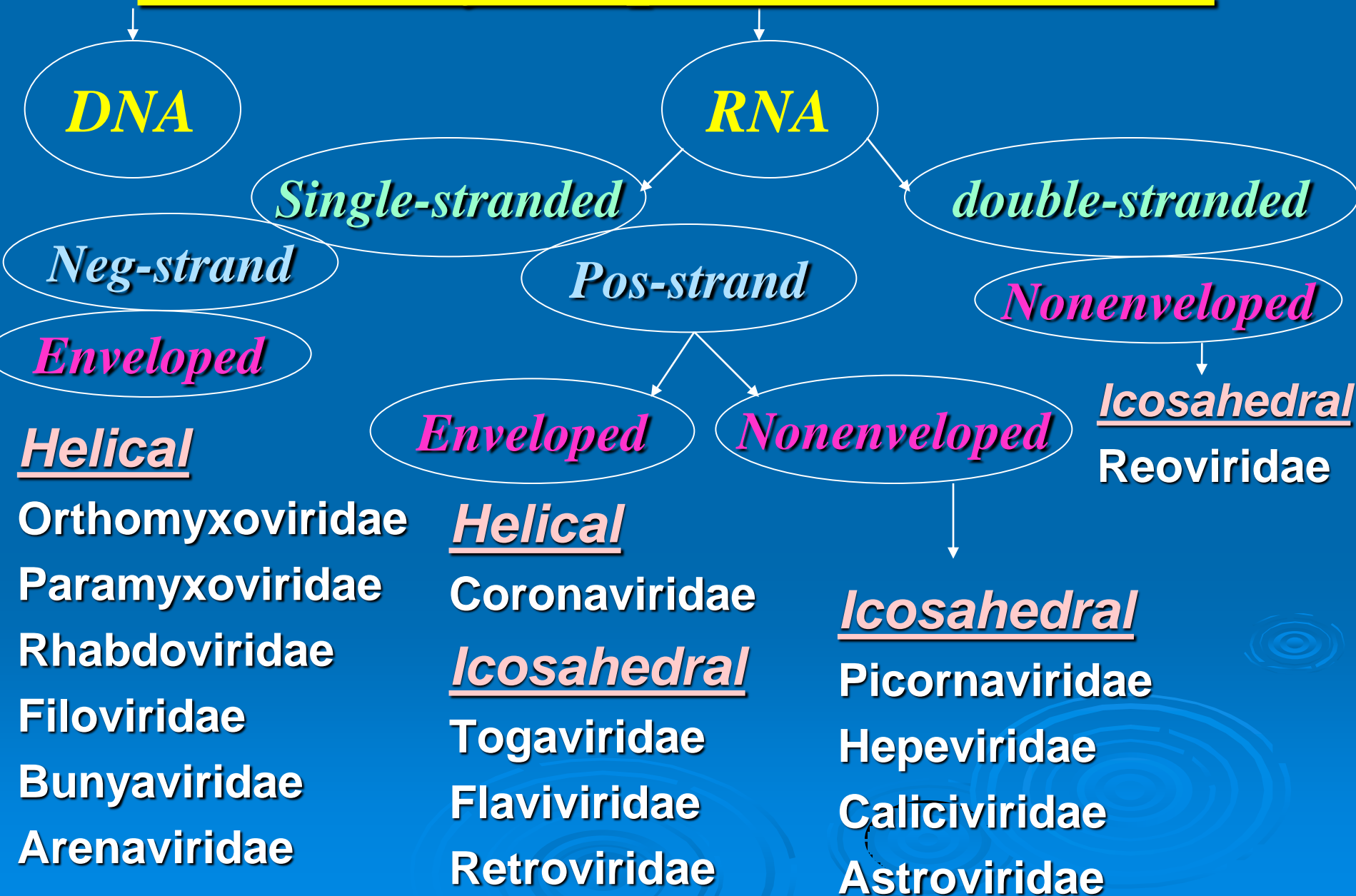
Hepadnaviridae

Icosahedral

Adenoviridae

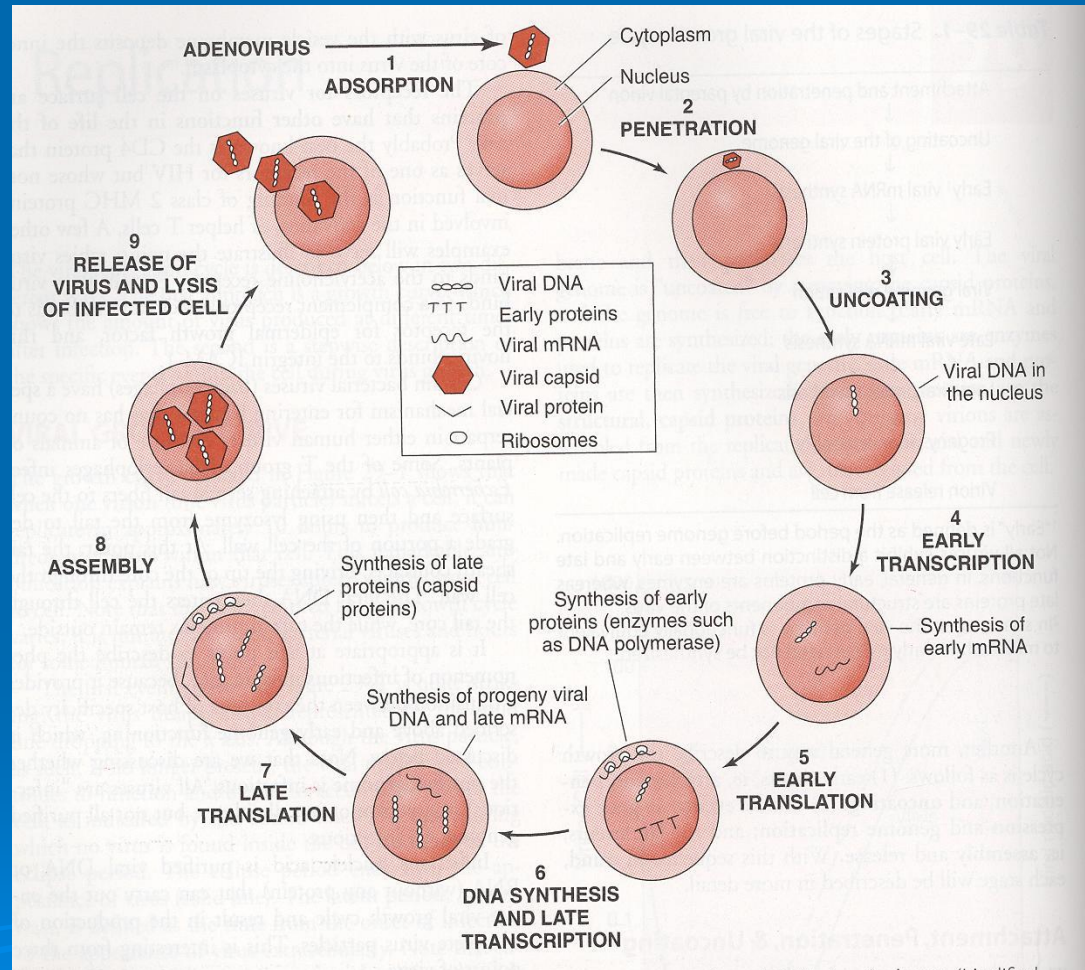
Papovaviridae

Medically Important Viruses



Replication

- Adsorption (Attachment)
- Penetration
- Uncoating
- Synthesis of viral components
 - mRNA
 - Viral proteins
 - NA
- Assembly
- Release

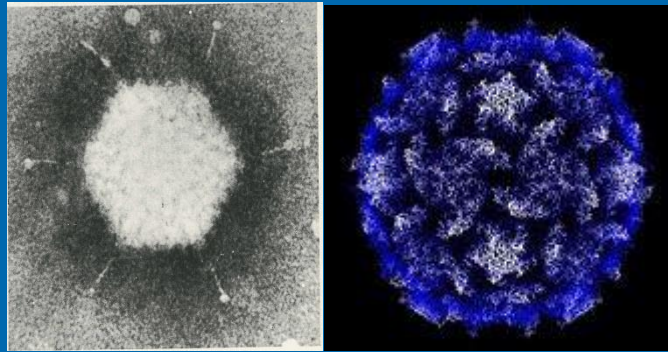


Viral growth cycle

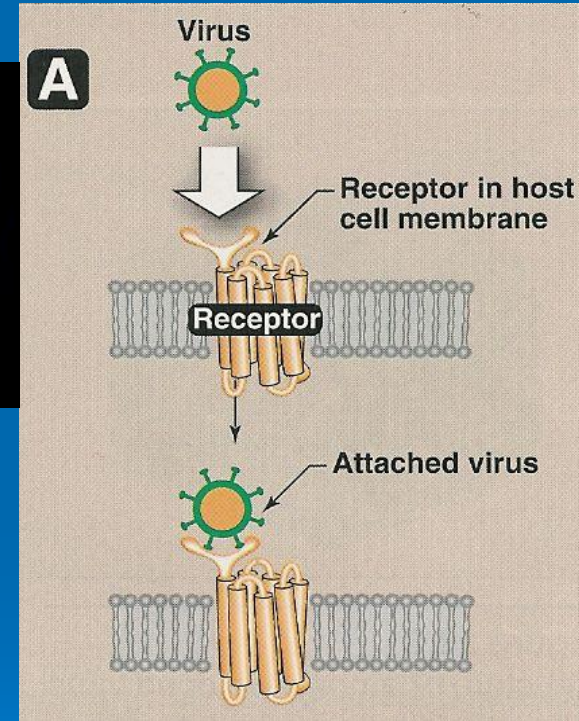
Adsorption

➤ Attachment site;

- glycoprotein

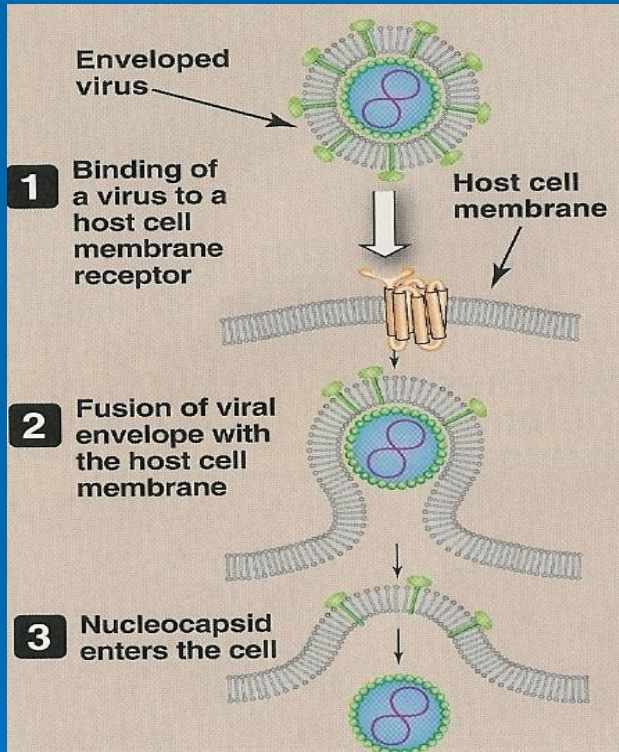


- folding in the capsid proteins.



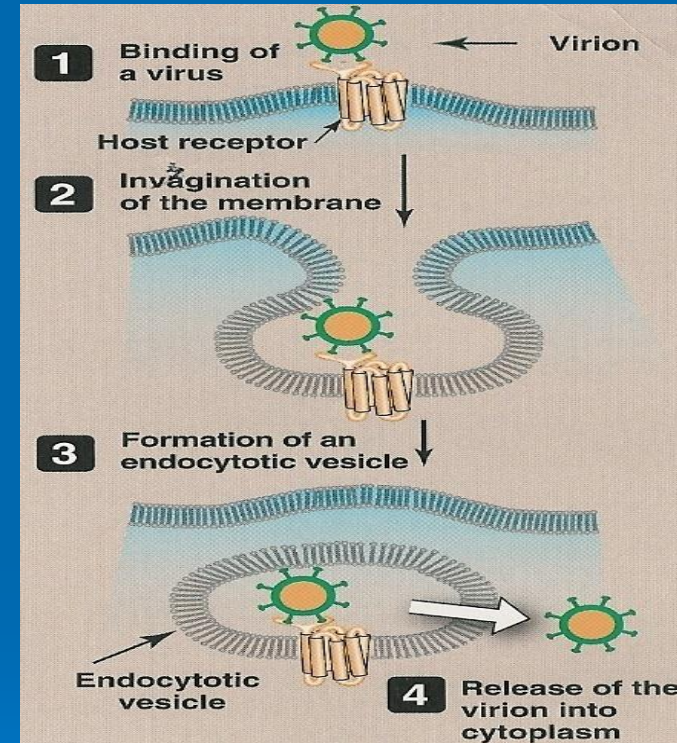
Penetration

1-Fusion



(enveloped virus)

2-Endocytosis



- Enveloped viruses fuse with endosome mb.
- Nonenveloped viruses lyse, or pore em.

Replication

- Adsorption (Attachment)
- Penetration
- **Uncoating**

Release of viral genome - cytoplasm
- nucleus

Synthesis of viral components

➤ mRNA

Viral genome $\xrightarrow[\text{+ssRNA acts directly}]{\text{transcription}}$ mRNA

➤ Viral proteins

mRNA $\xrightarrow[\text{cell ribosome}]{\text{translation}}$ viral proteins
- enzymes
- structural ps

➤ replication of viral genome

Replication

- Adsorption (attachment)
- Penetration
- Uncoating
- Synthesis of viral components
 - mRNA
 - Viral proteins
 - NA

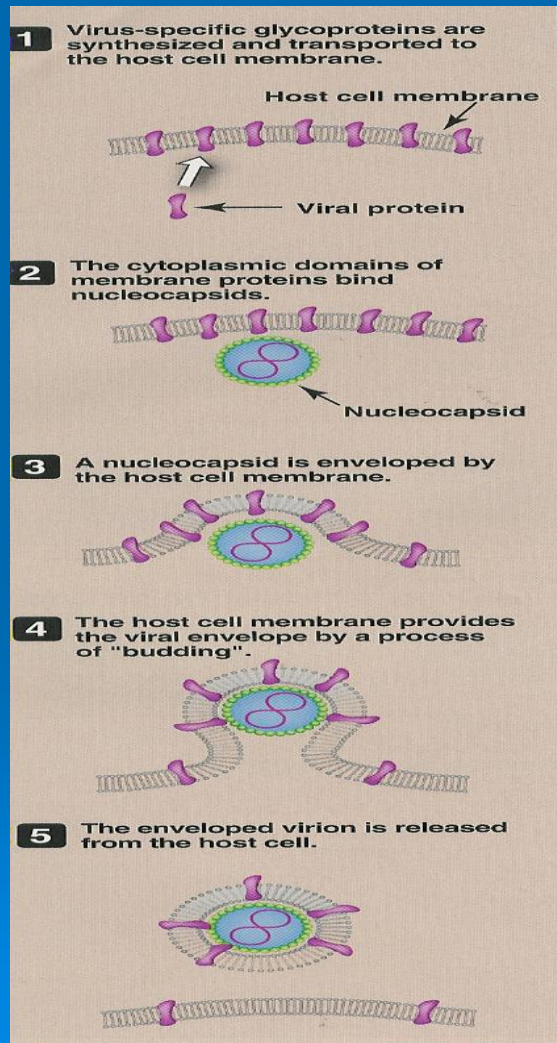
➤ *Assembly*

NA + V. proteins = Virions

- Release

Release

- 1-Budding
(enveloped Vs)
 - cell mb*
 - nuclear mb
(herpesVs)



- 2- Cell lysis
or rupture of the cm
(nonenveloped Vs)

laboratory diagnosis of viral infections

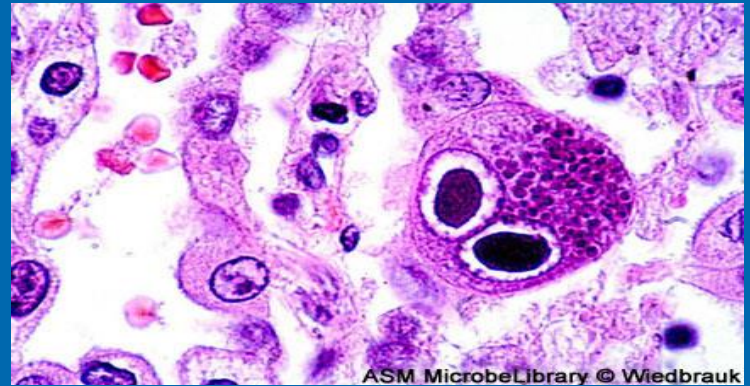
- *Microscopic examination.*
- *Cell culture.*
- *Serological tests .*
- *Detection of viral Ag.*
- *Molecular method .*

Microscopic examination

➤ *Light microscopy;*

Histological appearance

Ex. Inclusion bodies



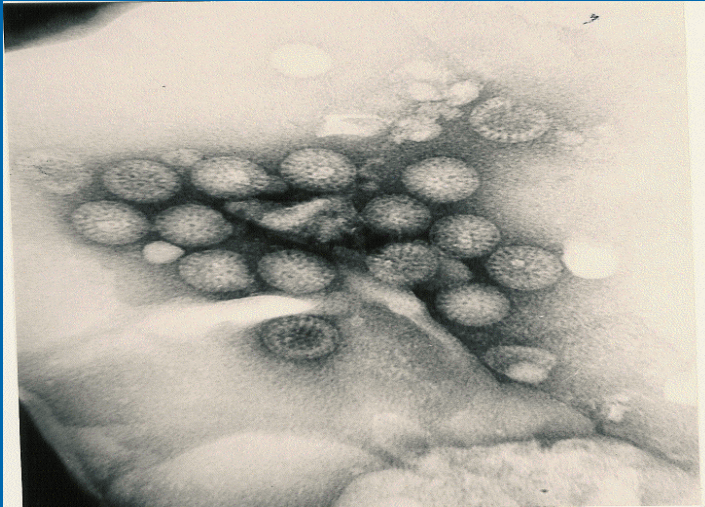
Owl's eye (CMV)

➤ *Electron microscopy;*

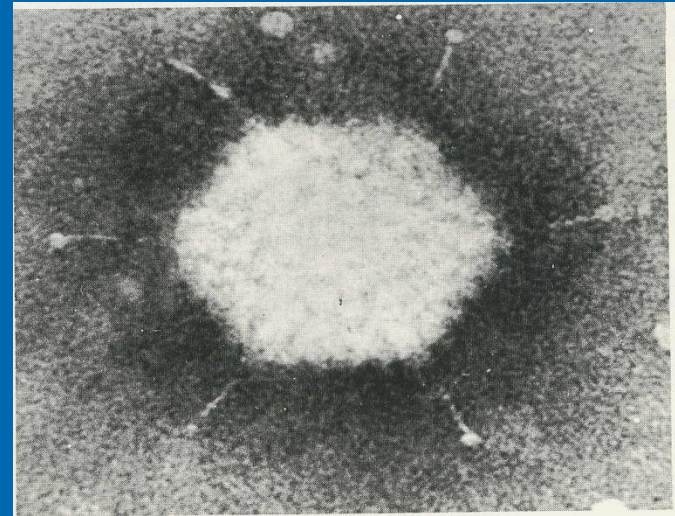
- Morphology & size of virions
- Ex. Diagnosis of viral GE such as rota, adenoviruses.
Diagnosis of skin lesion caused by herpes, or poxviruses.
- It is replaced by Ag detection & molecular tests

➤ Electron micrographs

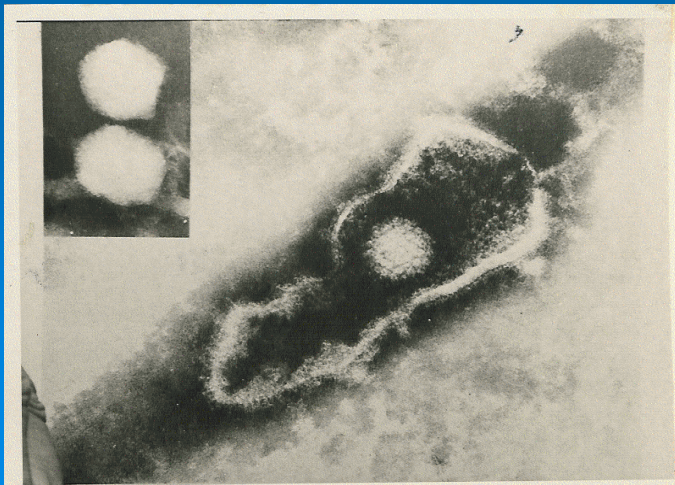
Rotavirus



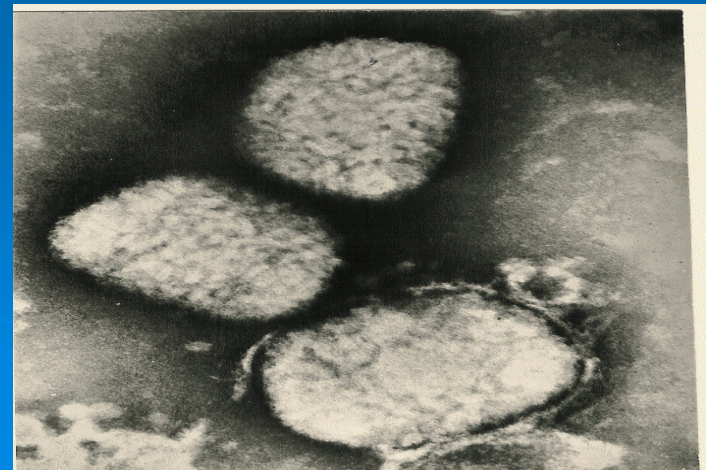
Adenovirus



Herpesvirus



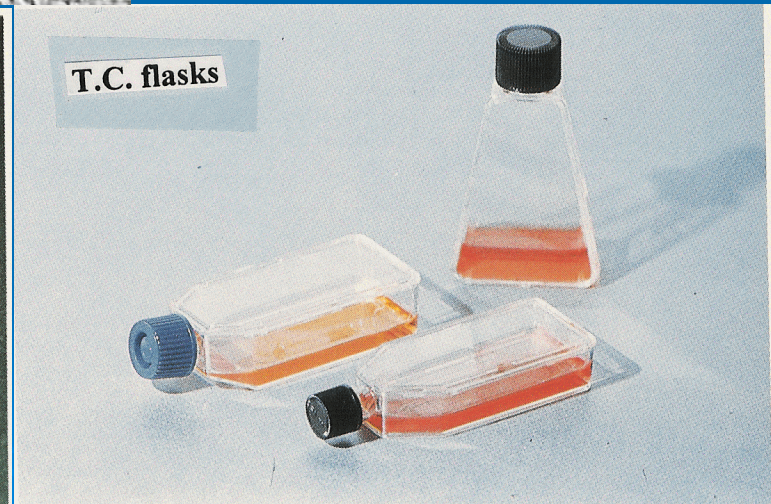
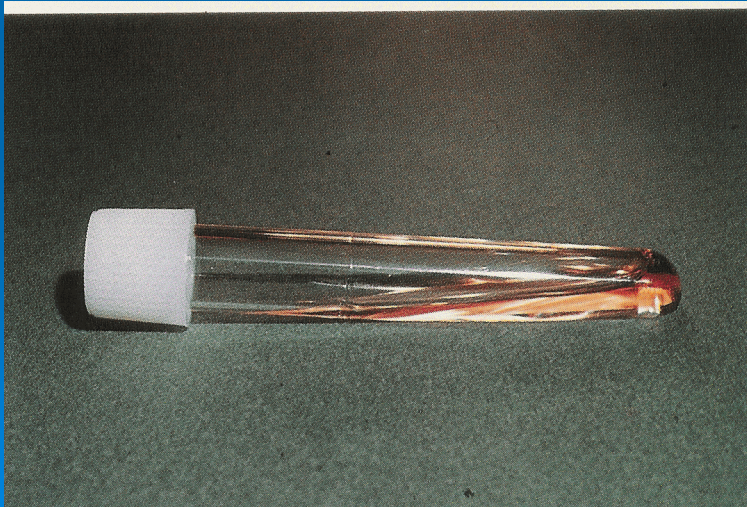
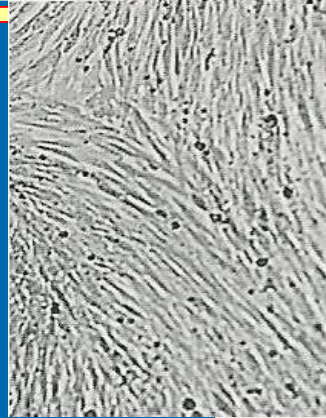
Poxvirus



Virus cultivation

- *Laboratory animals*
- *Embryonated eggs*
- *Cell culture*

Cell culture

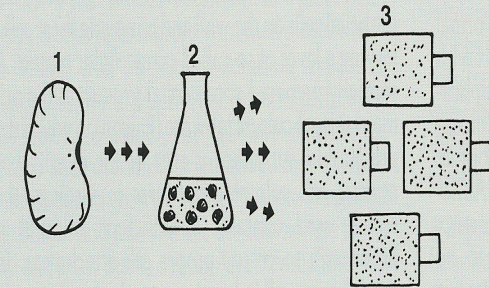


Cell culture

No of sub passages

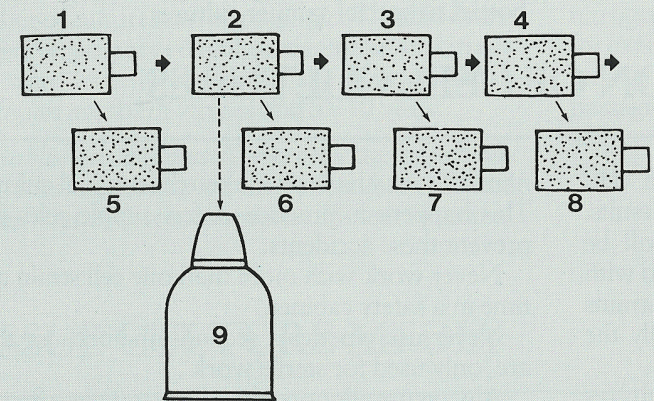
Primary C/C

1 or 2



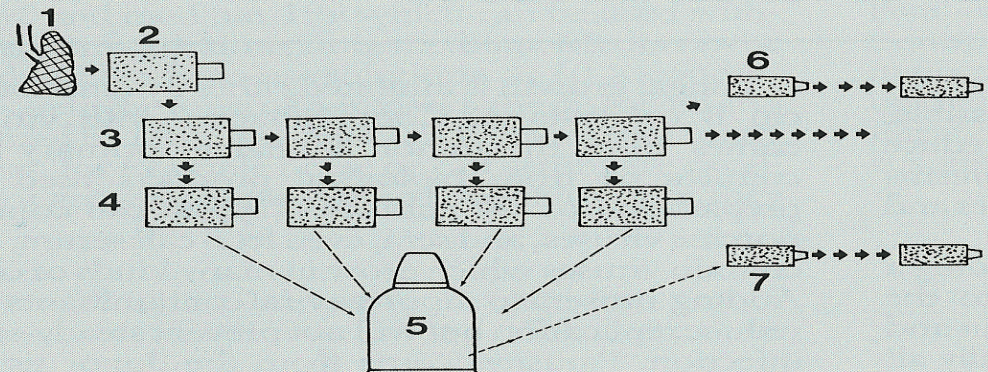
Diploid C/C
[semi continuous]

20 to 50



Continuous cell line

Indefinite



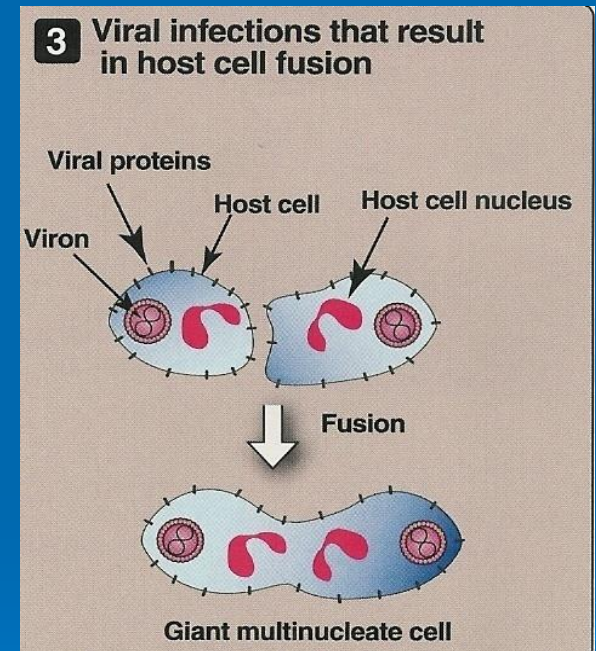
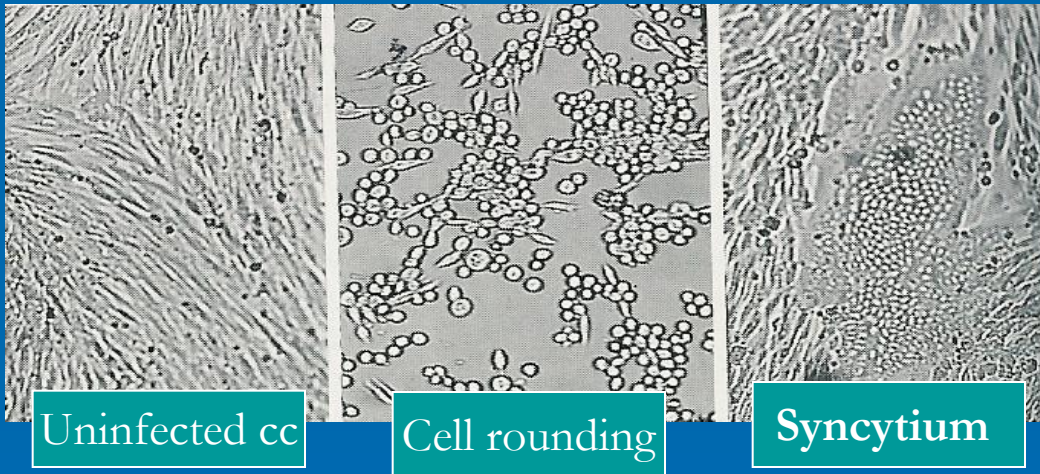
Variation in Sensitivity of cell cultures to infection by viruses commonly isolated in clinical virology laboratories

Virus	Cell culture ^a		
	PMK	HDF	HEp-2
RNA virus			
Enterovirus	+++	++	+/-
Rhinovirus	+	+++	+
Influenza virus	+++	+	-
RSV	++	+	+++
DNA virus			
Adenovirus	+	++	+++
HSV	+	++	++
VZV	+	+++	-
CMV	-	+++	-

PMK, primary MK. Degree of sensitivity: +++, highly sensitive; ++, moderately sensitive; +, low sensitivity; +/-, variable; -, not sensitive

Detection of viral growth

➤ Cytopathic effects



➤ IF

➤ Other

Problems with cell culture

- Long incubation (up to 5 days)
- Sensitivity is variable
- Susceptible to bacterial contamination
- Some viruses do not grow in cell culture
e.g. HCV

Rapid culture technique

- Shell Vial Assay
- Detect viral antigens
- 1-3 days

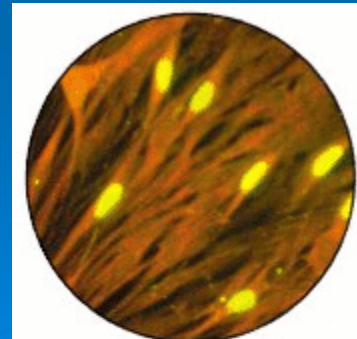
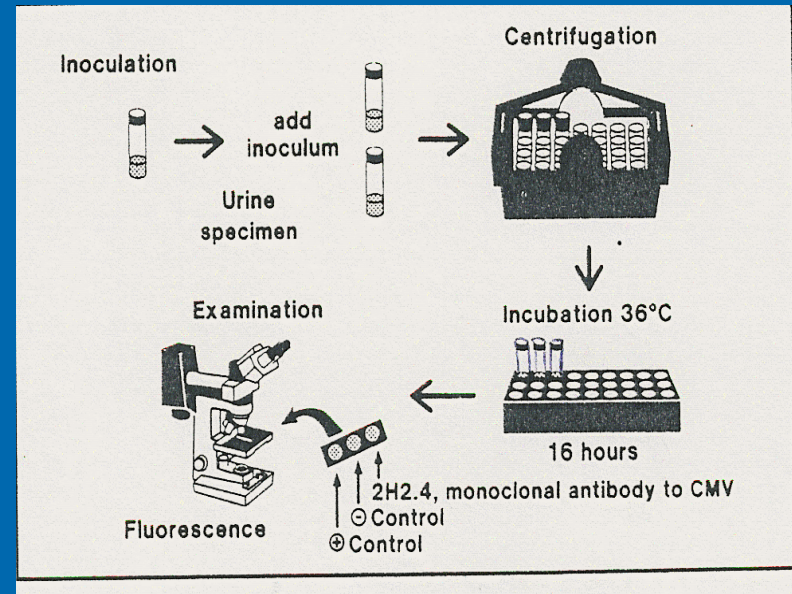


Fig. 2, CMV centrifugation culture fixed and stained 16 hrs after inoculation showing viral proteins in nuclei of infected human fibroblast cells

Serological test;
Antigen detection;

sample

- Nasopharyngeal aspirate
- Skin scrapings
- Faeces
- Blood

virus

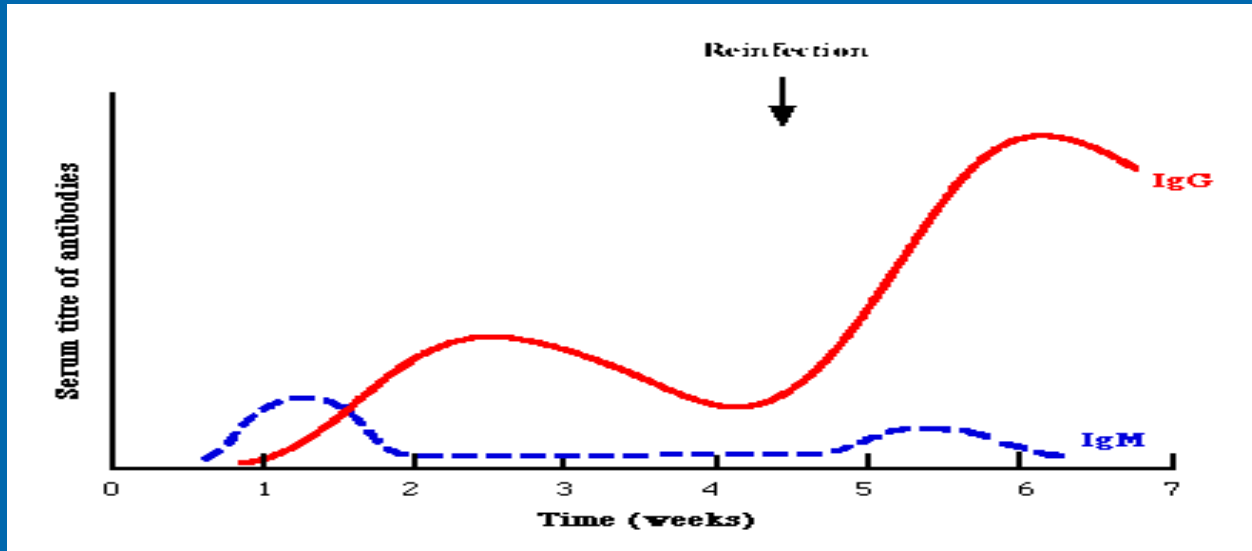
Influenza V.
HSV
Rotavirus
HBV(HBsAg)

test

IF
IF
ELISA
ELISA

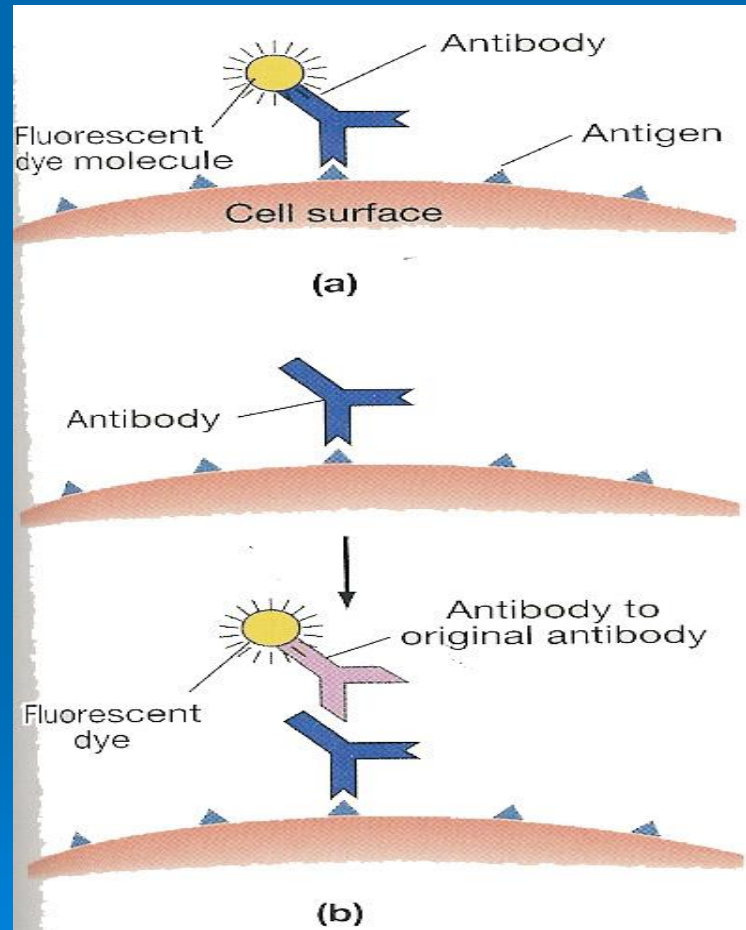
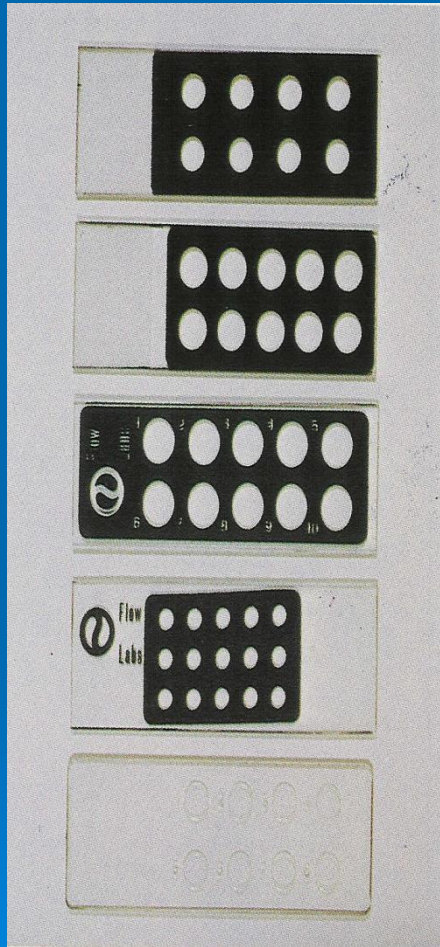
Serological test;

Antibody detection;



- e.g. of techniques
- Complement fixation test (CFT)
- Immunofluorescence (IF)
- Enzyme-linked immunosorbent assay (ELISA)

Immunofluorescence; IF



- A- Direct
Ag detection;
 - Sample (Ag)

- B- Indirect
Ab detection;
 - Sample (Ab)

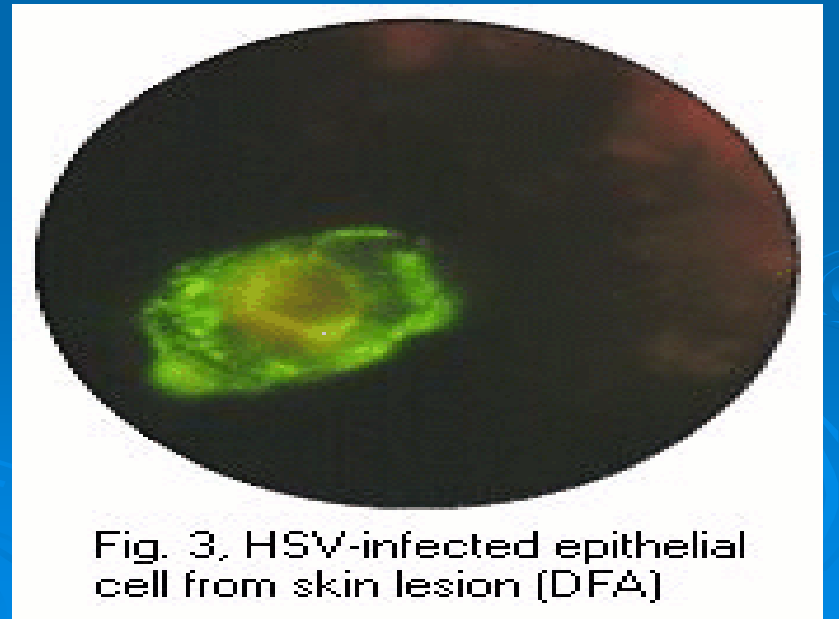
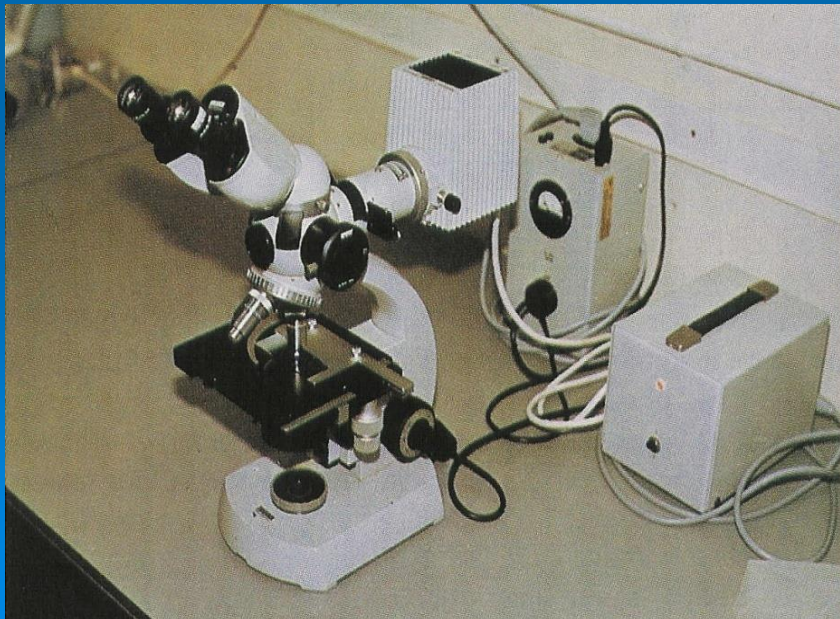
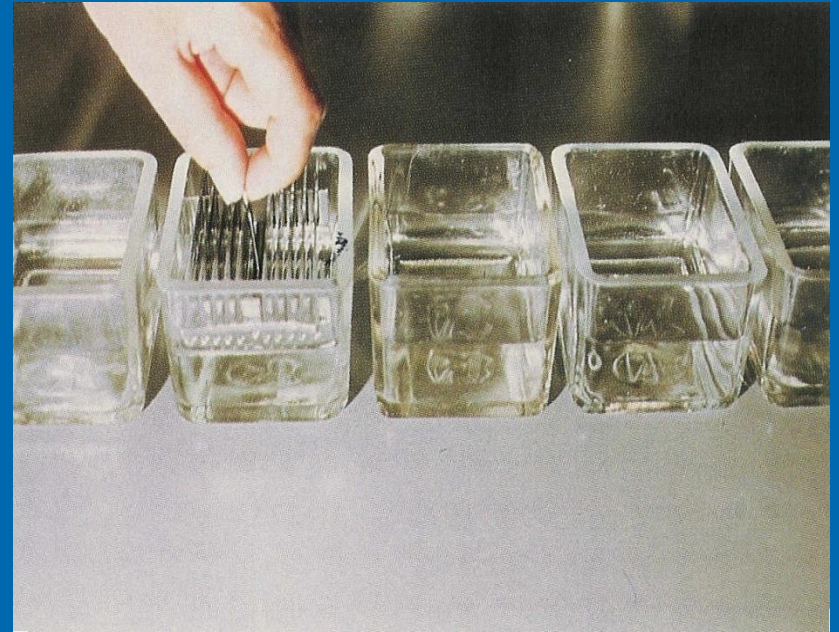
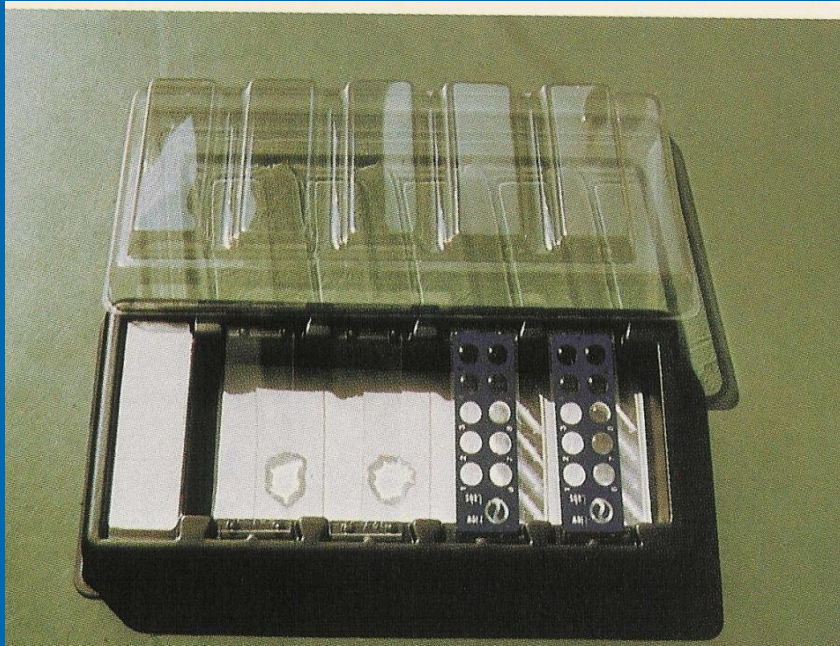
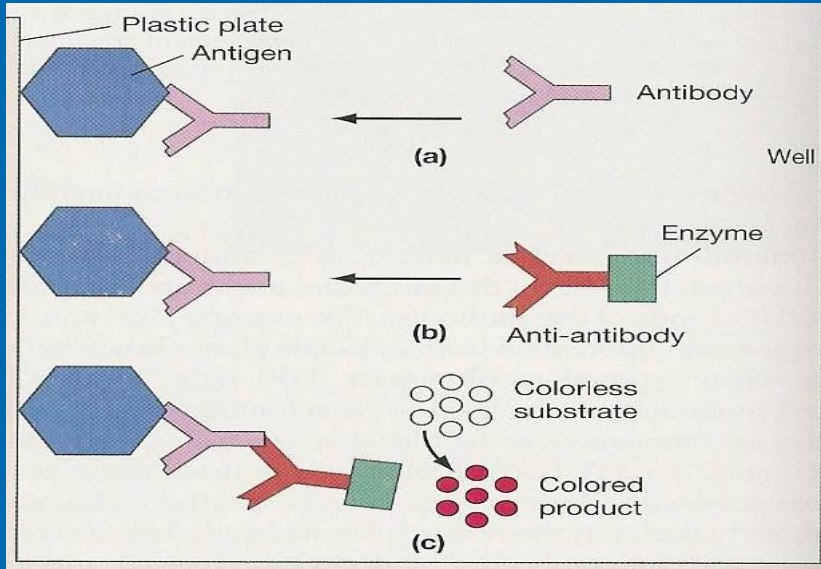


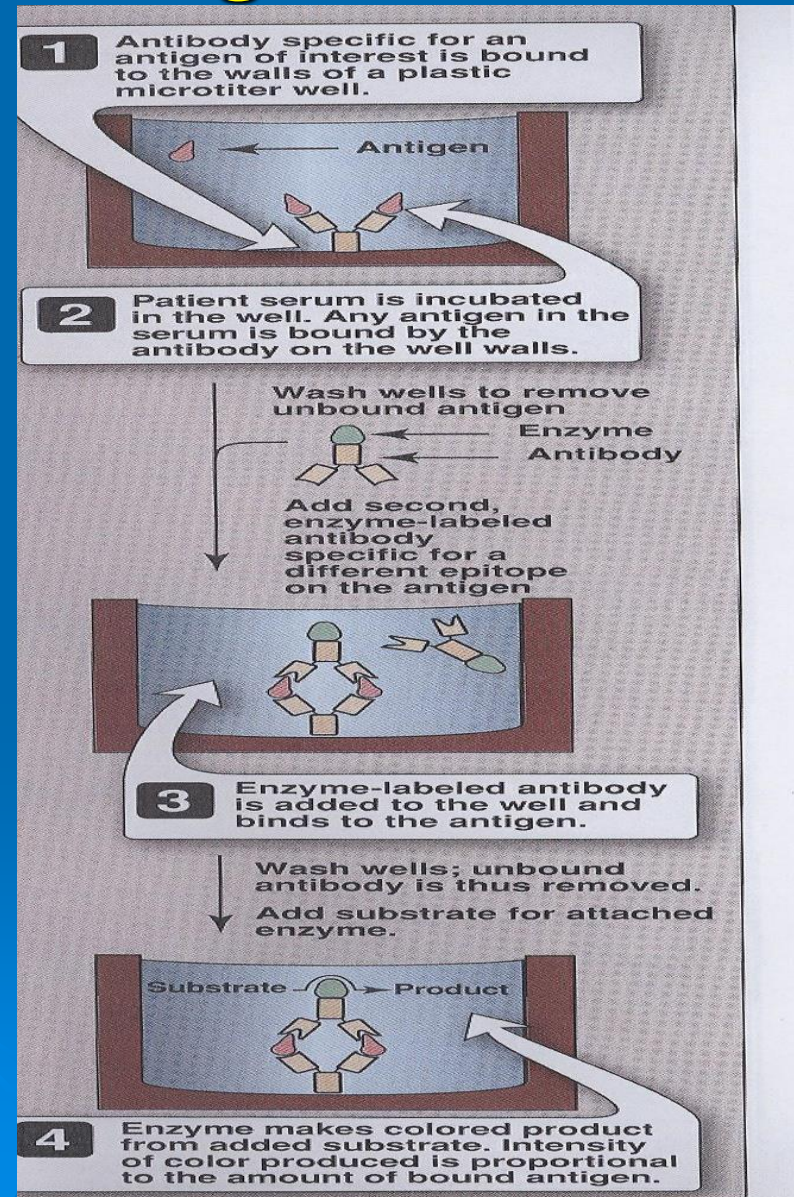
Fig. 3, HSV-infected epithelial cell from skin lesion (DFA)

ELISA

Ab detection



Ag detection



Indirect ELISA for Ab detection ;
coloured wells indicate reactivity

Molecular test;

- Polymerase chain reaction (PCR)
 - NA amplification technique.
 - Viral genome
- Uses;
 - Diagnosis
 - Monitoring response to treatment

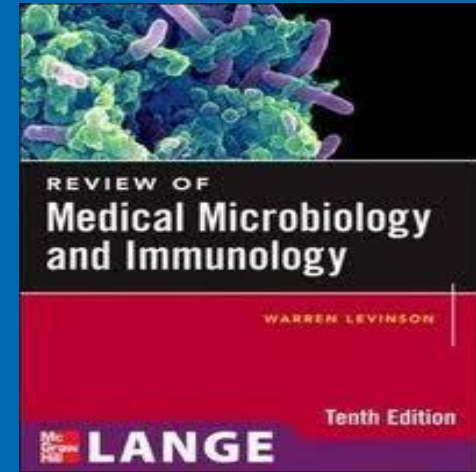
Reference book and the relevant page numbers

➤ Medical Microbiology and Immunology

By: Warren Levinson .

10th Edition, 2008.

Pages;192-195,199-207, 216-220,233-235.



➤ Lippincott's Illustrated Reviews: Microbiology

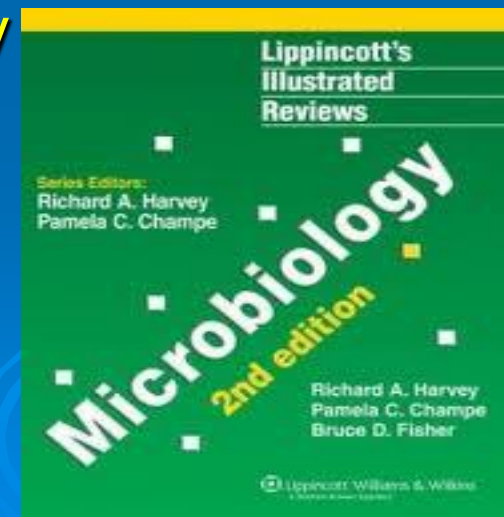
By: Richard A. Harvey ,

Pamela C Champe &

Bruce D. Fisher

2nd Edition, 2007 .

Pages;233-242



Thank you

