

# ***Introduction to medical virology***

**“Viral structure and Classification”**

**Dr. Abdulkarim Alhethel**

**Assistant Professor in Microbiology Unit**

**College of Medicine & KKUH**

# *OBJECTIVES*

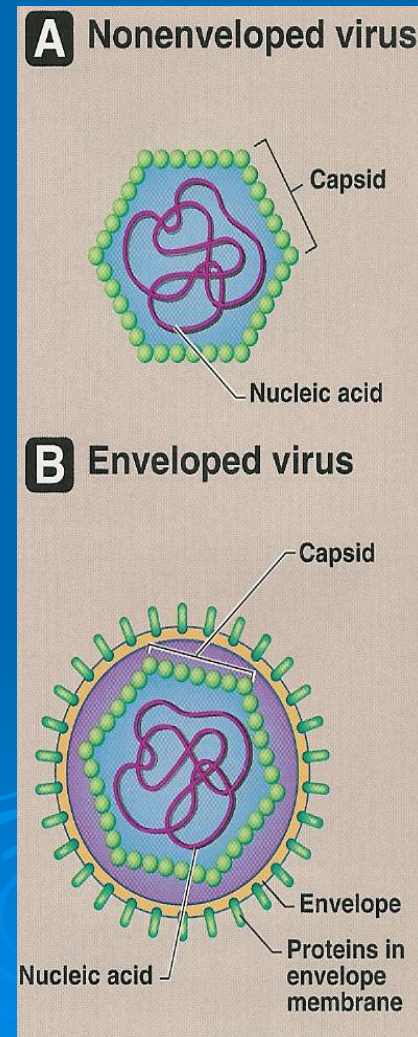
- *General characteristics of viruses.*
- *Structure & symmetry of viruses.*
- *Classification of viruses.*
- *Steps of virus replication.*
- *Laboratory diagnosis of viral infections.*

# 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

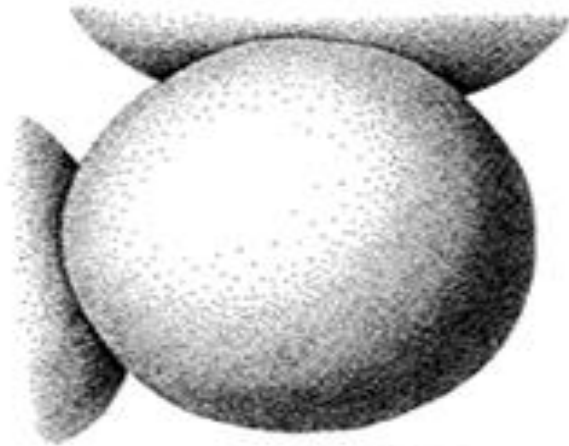
# Characteristics of viruses

- 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  $\mu\text{m}$



POX VIRUS



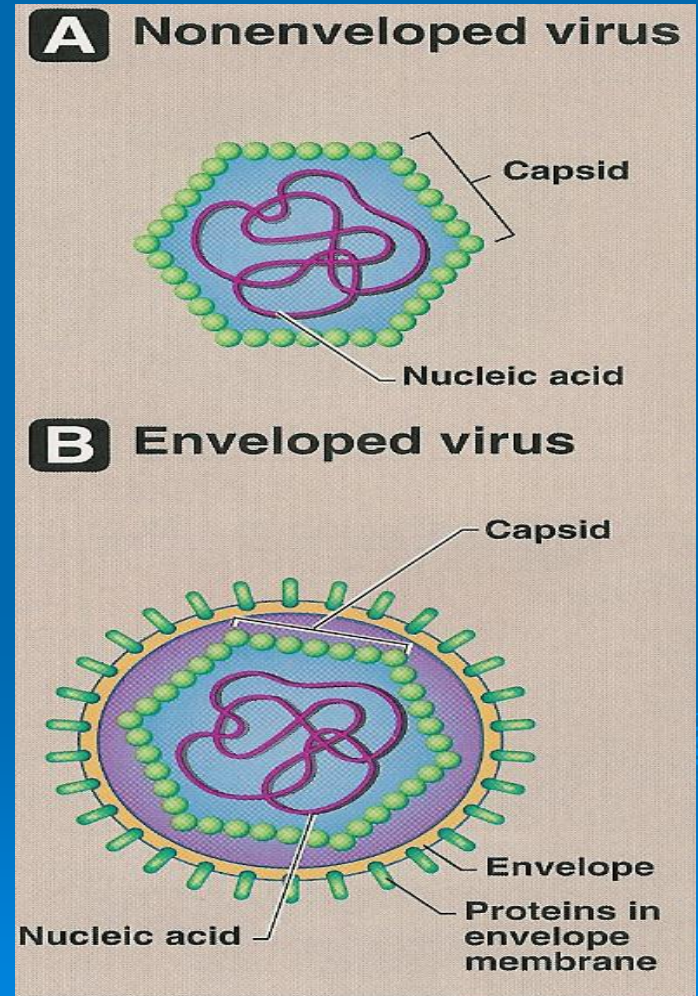
POLIO VIRUS

# 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)

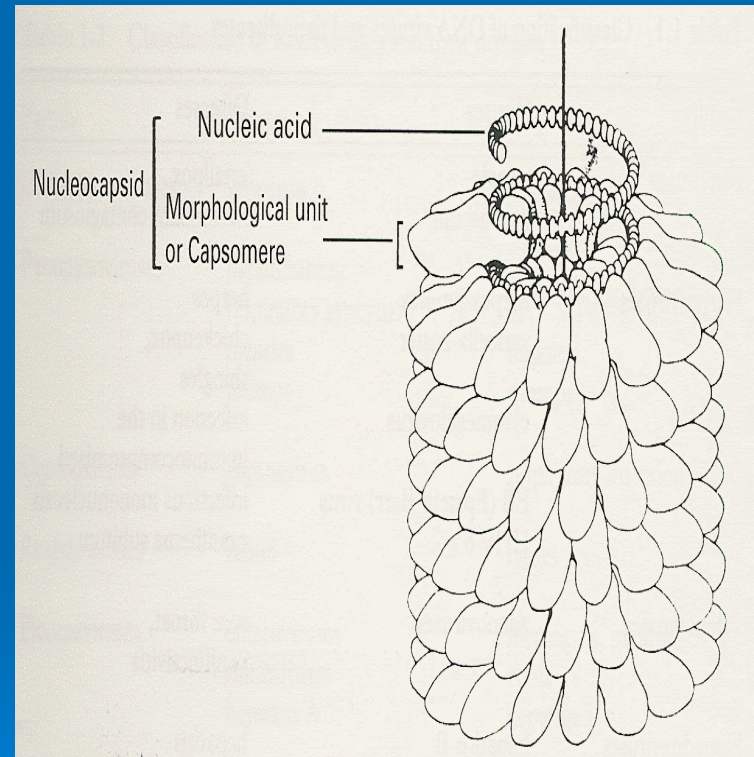
- All RNA Vs have ss except Reoviruses
- Single / double
- (+) polarity
- (-) polarity

*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*

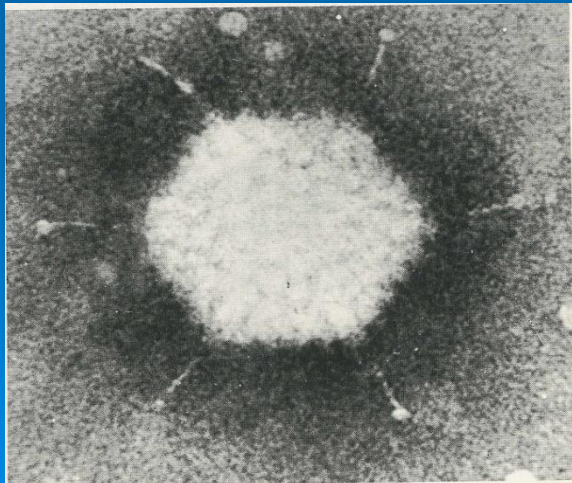
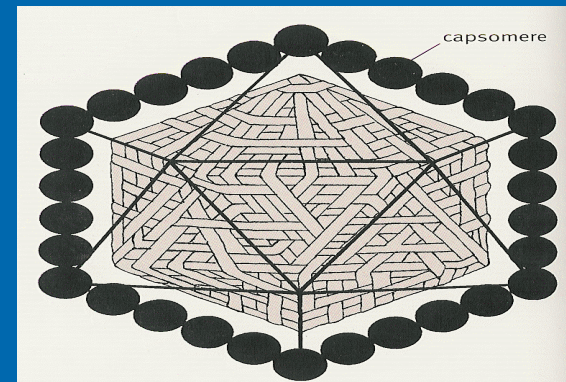
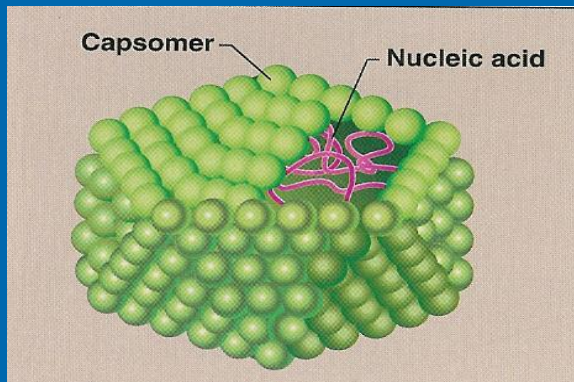
- *Cubic symmetry  
( Icosahederal )*
- *Helical symmetry*
- *Complex symmetry*



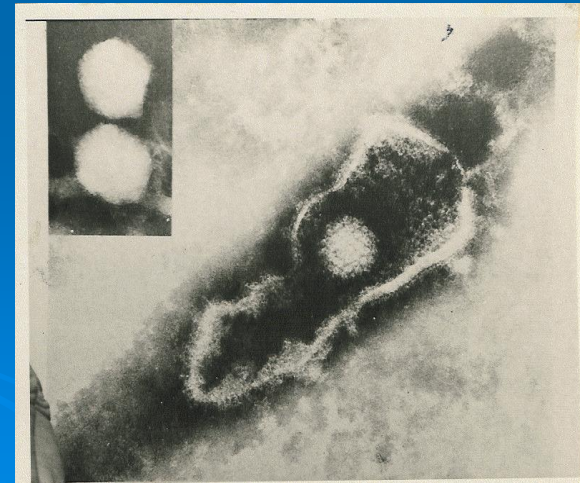
# Symmetry

based on arrangement of capsomeres

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



Adenovirus



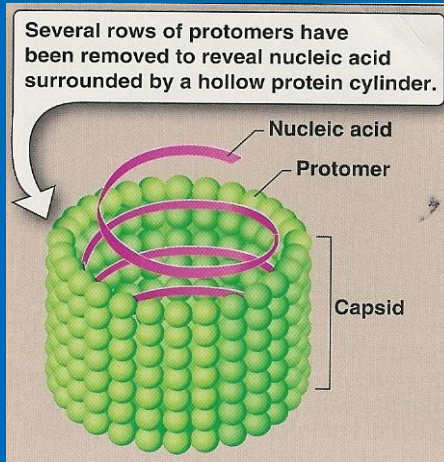
Herpes virus



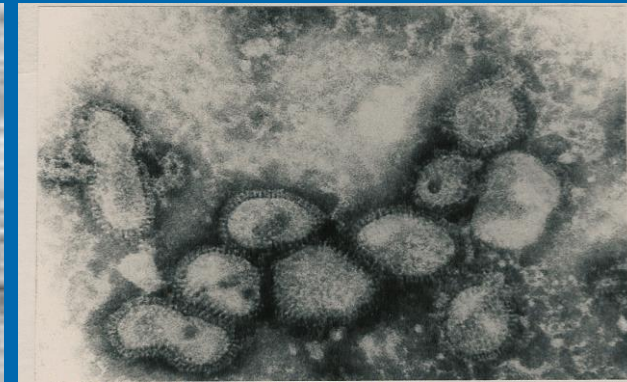
# Symmetry

based on arrangement of capsomeres

## ➤ 2- Helical symmetry



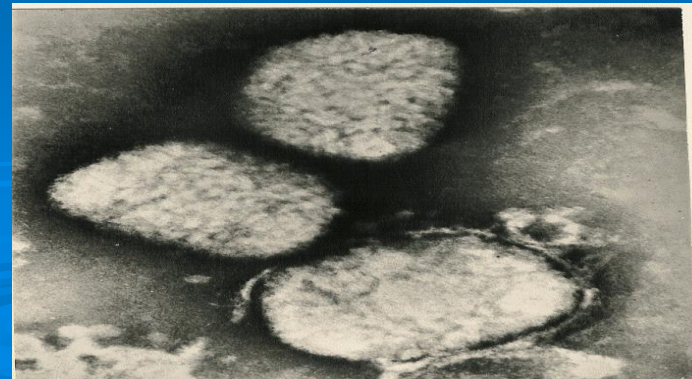
*Elongated  
(filoviruses)*



*Pleomorphic  
(influenza v.)*

## ➤ 3- Complex symmetry

poxviruses



# Viral structure

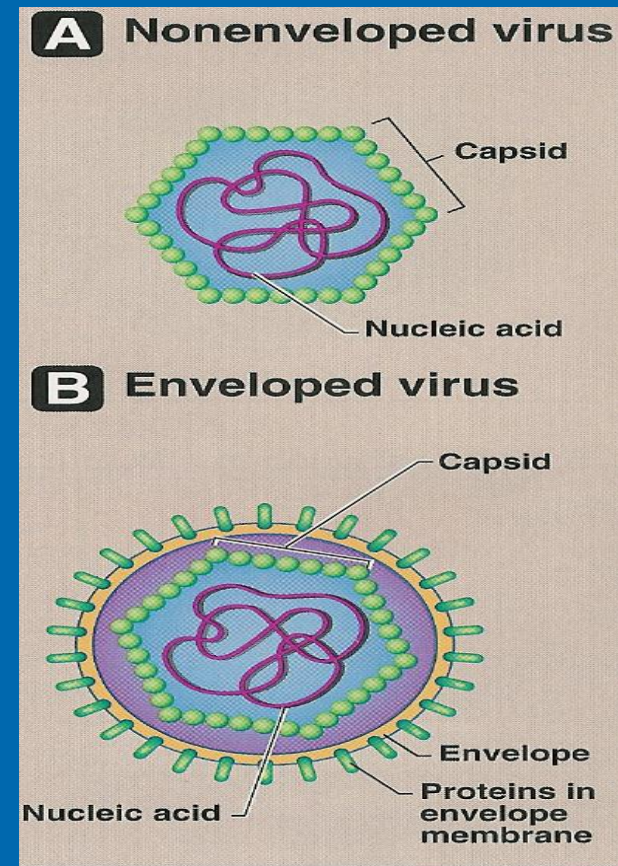
## *3-Envelope*

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





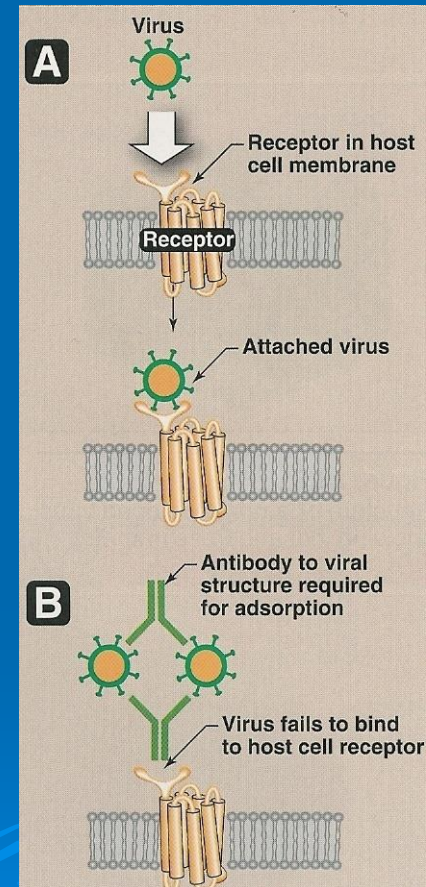
# Viral proteins

## ❖ *The outer viral ps*

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

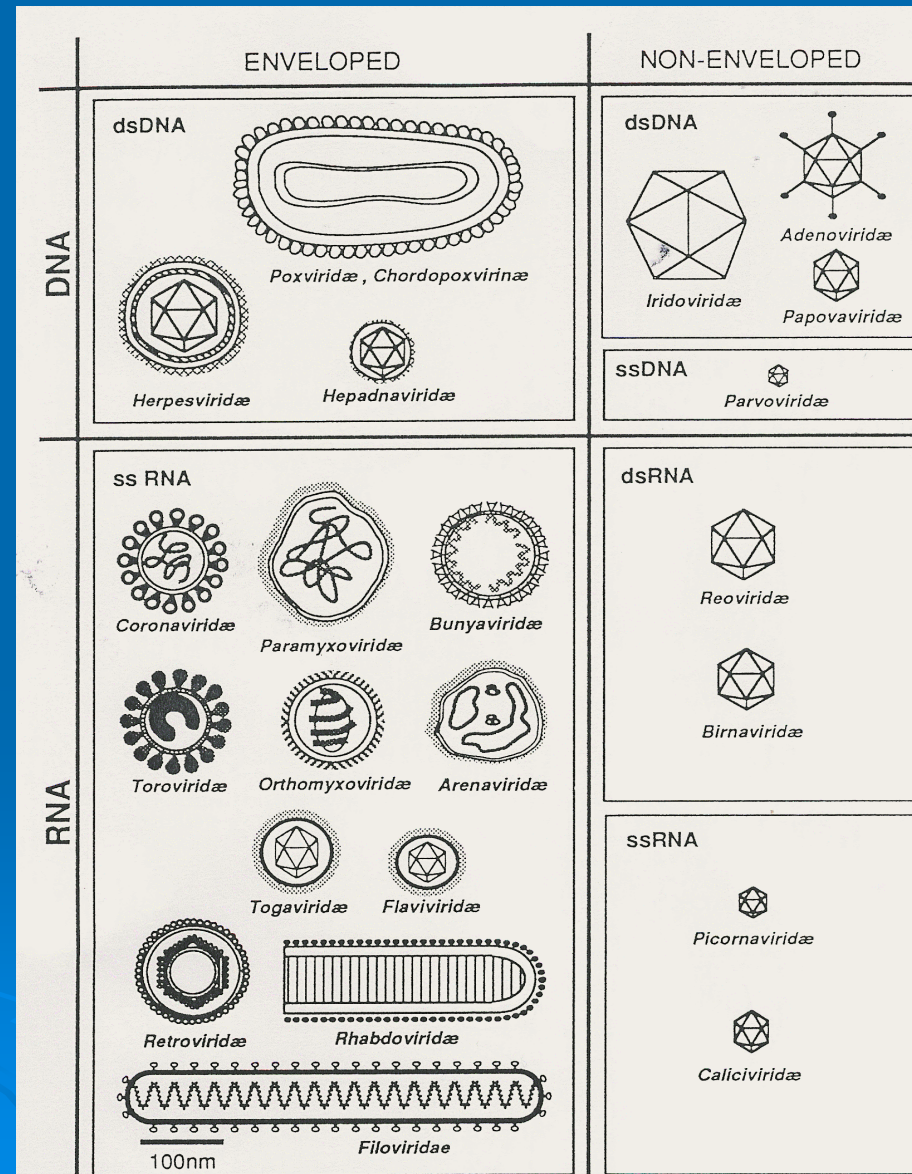
## ❖ *The internal viral ps*

- 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

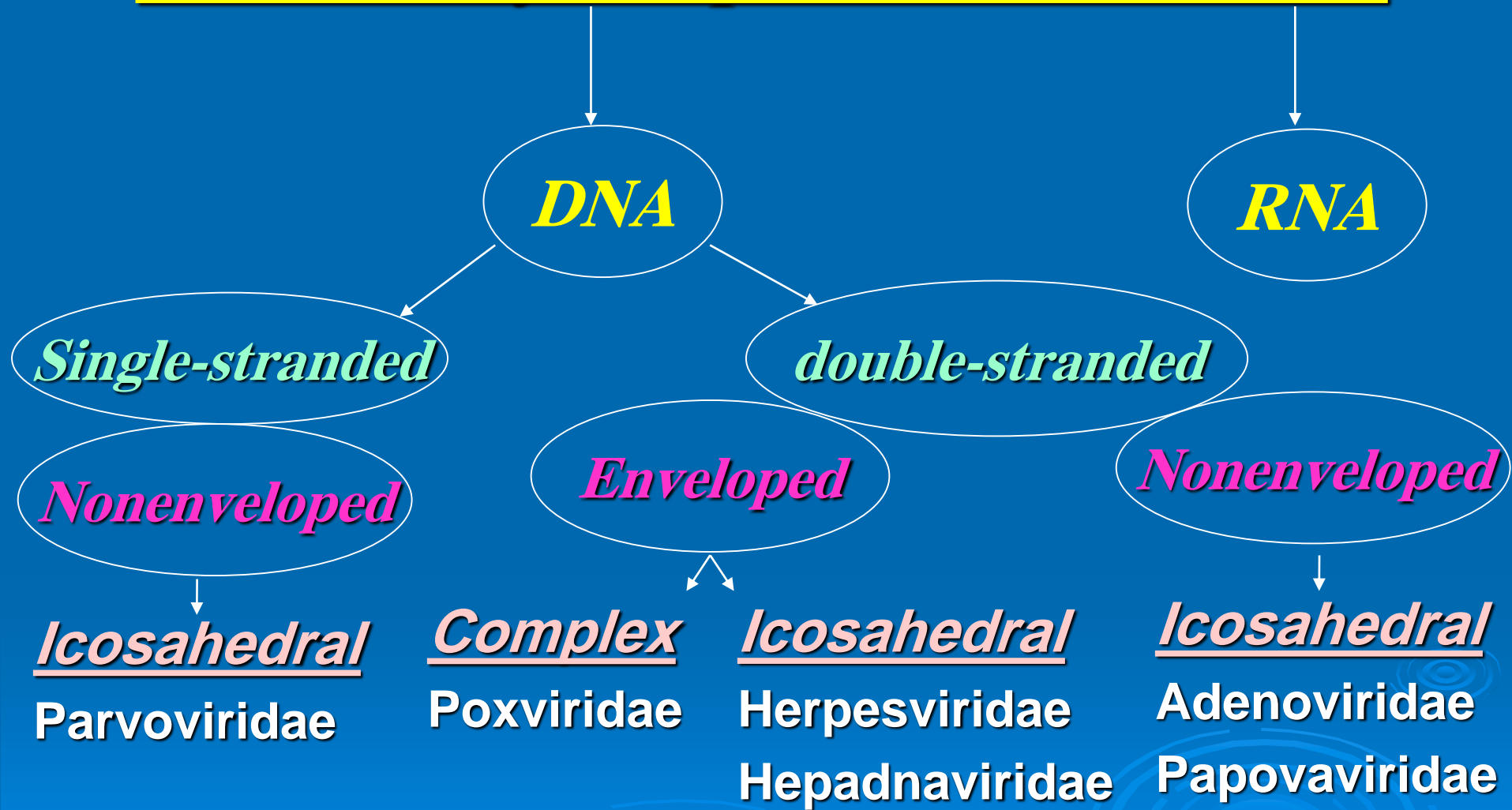


# Classification of viruses

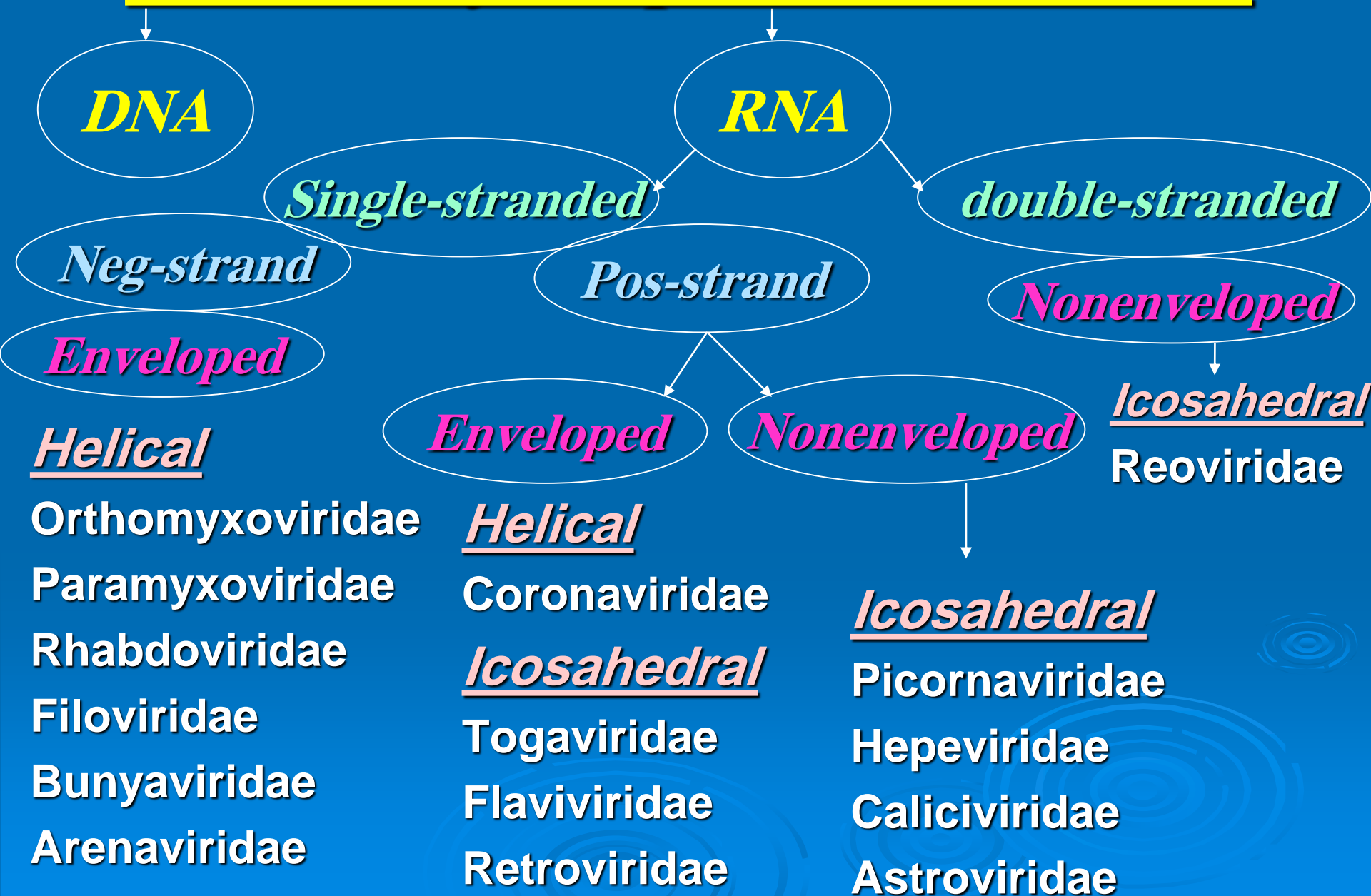
- Type of NA
- The no. of strand
- The polarity of viral genome
- The presence or absence of envelope
- Type of symmetry



# Medically Important Viruses



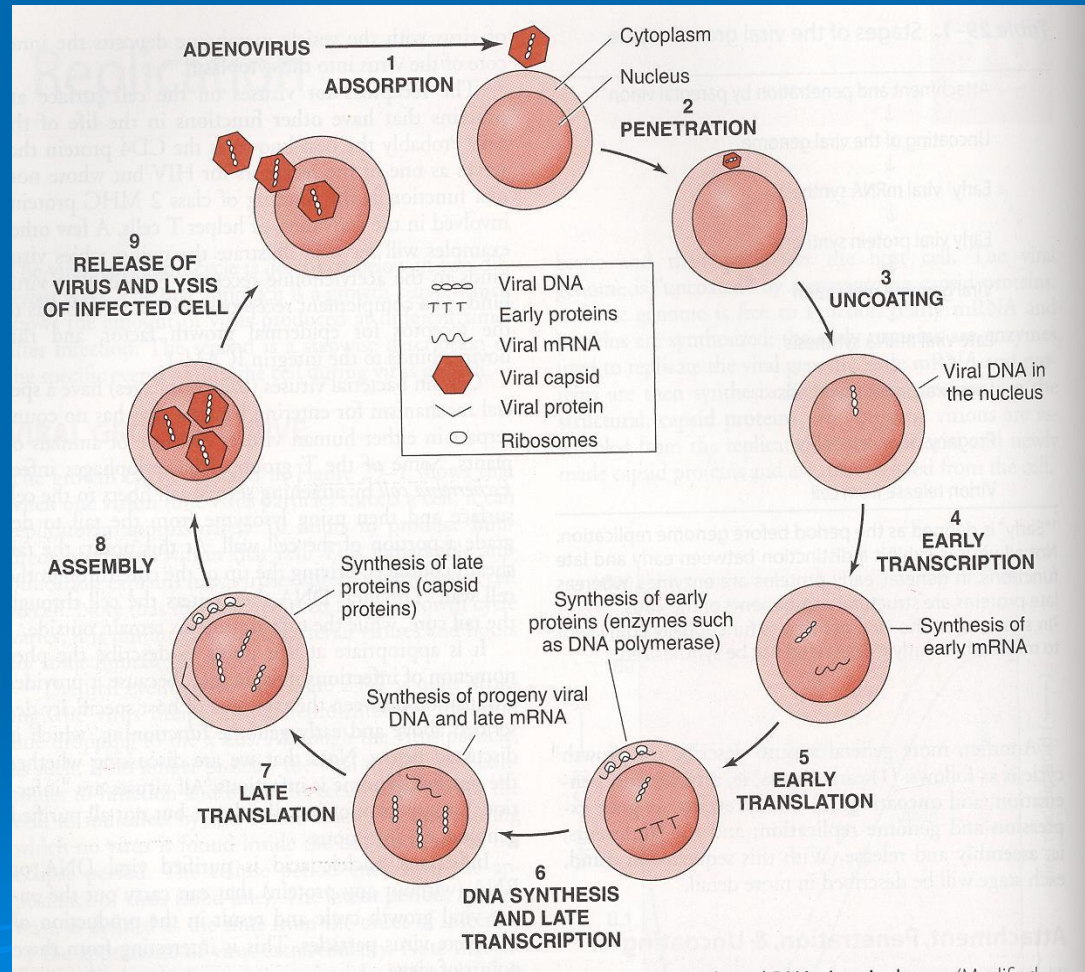
# Medically Important Viruses





# Replication

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

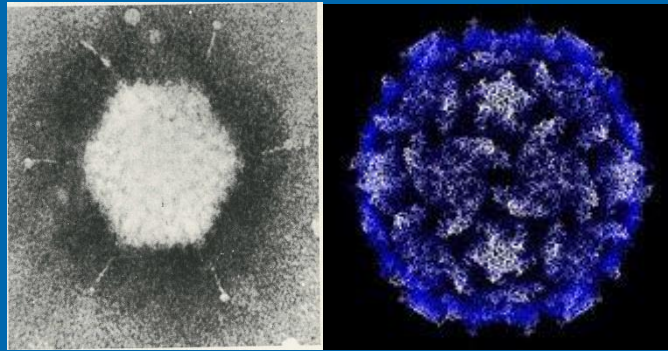


Viral growth cycle

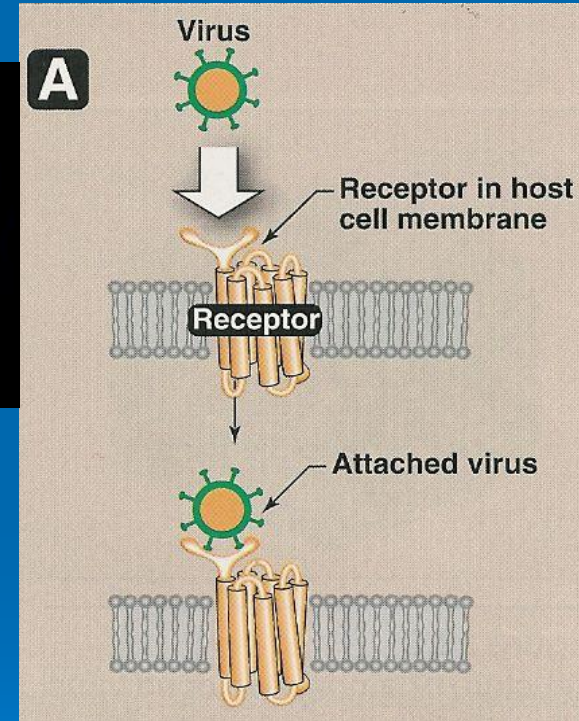
# Adsorption

## ➤ Attachment site;

- glycoprotein



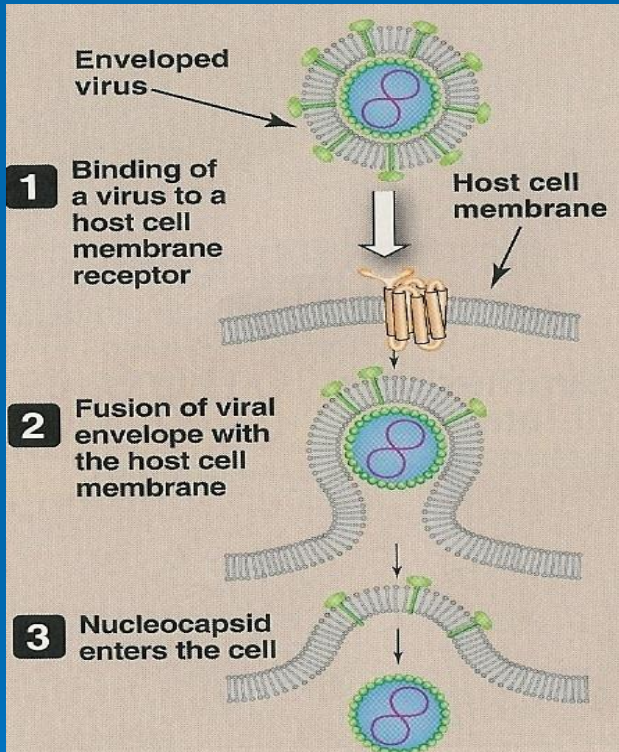
- folding in the capsid proteins.





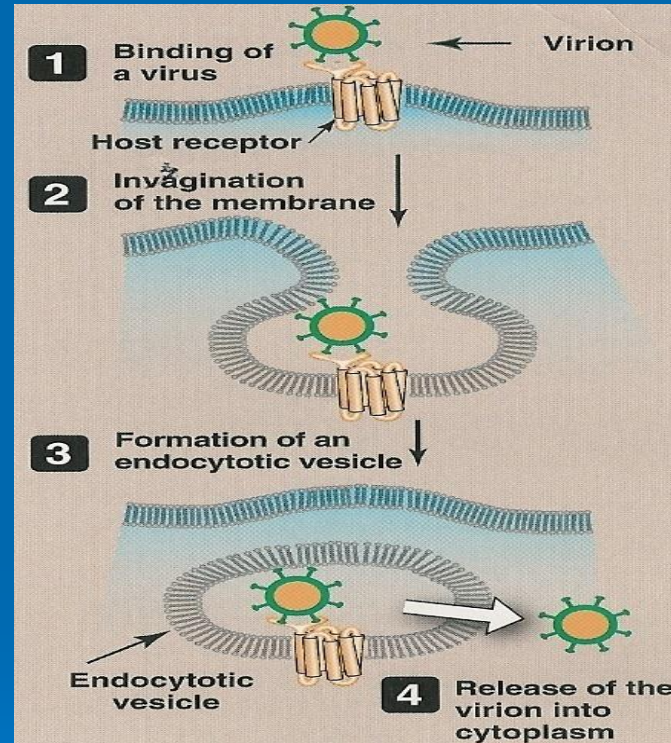
# Penetration

## 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*

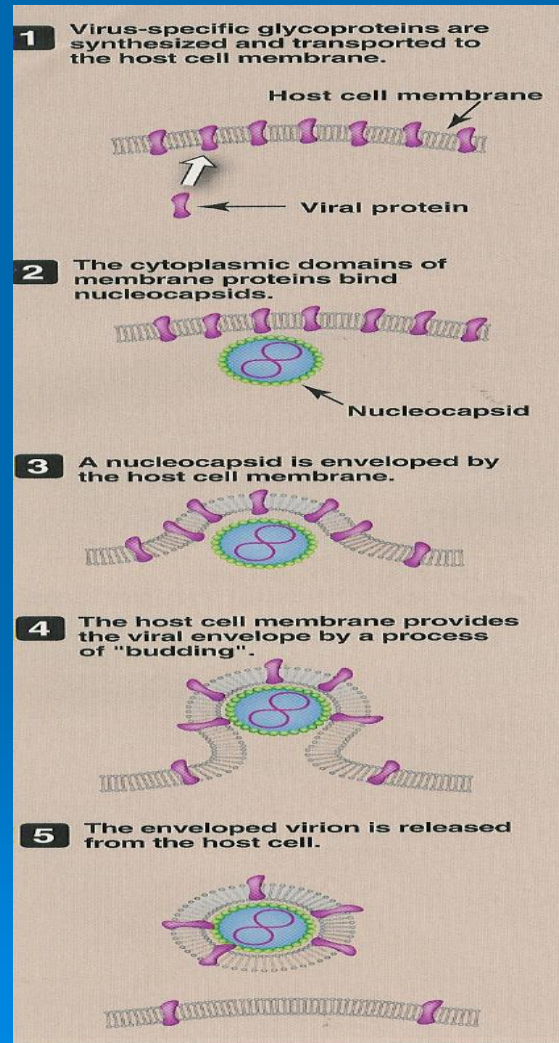
*NA + V. proteins = Virions*

- 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*

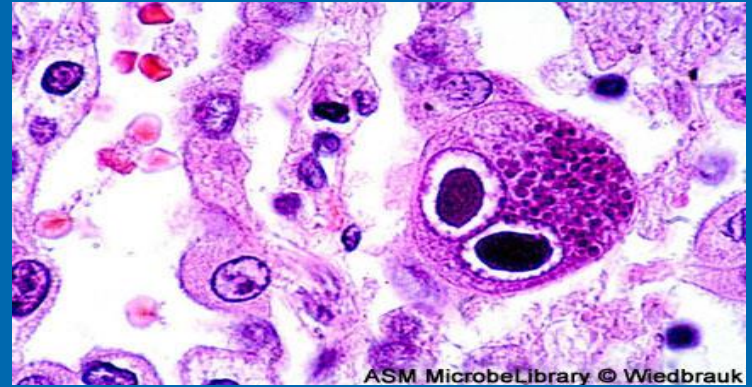
- *Microscopic examination.*
- *Cell culture.*
- *Serological tests .*
- *Detection of viral Ag.*
- *Molecular method .*

# *Microscopic examination*

## ➤ *Light microscopy;*

Histological appearance

Ex. Inclusion bodies



*Owl's eye (CMV)*

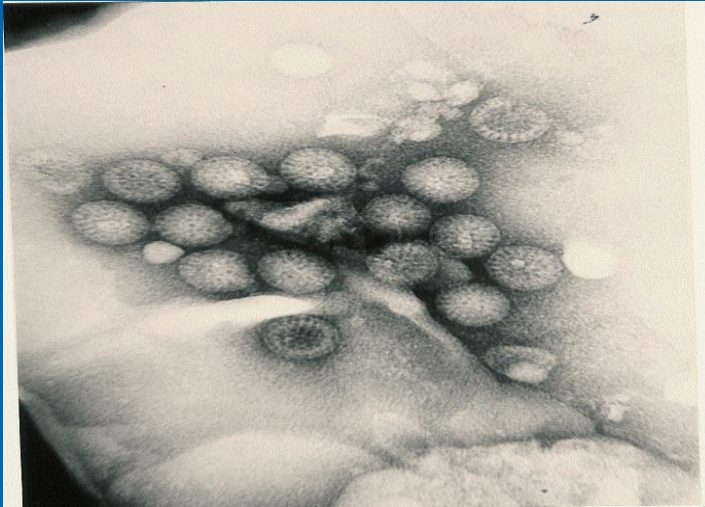
## ➤ *Electron microscopy;*

- 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

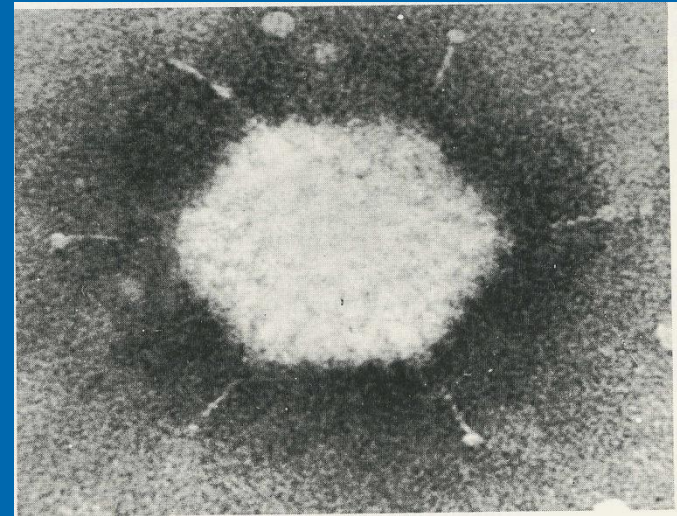


➤ Electron micrographs

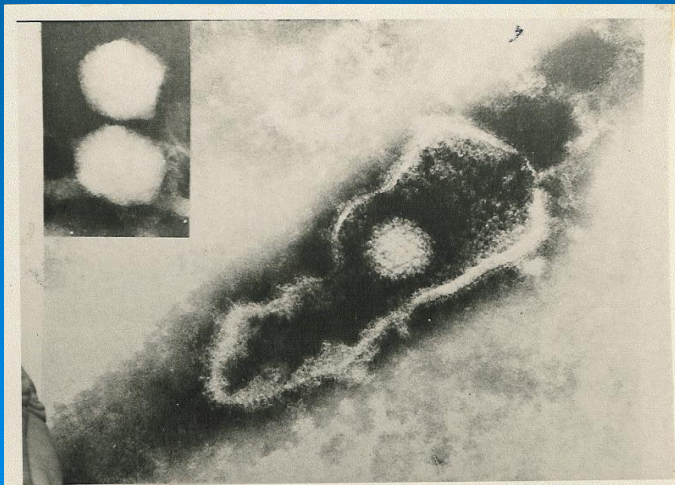
**Rotavirus**



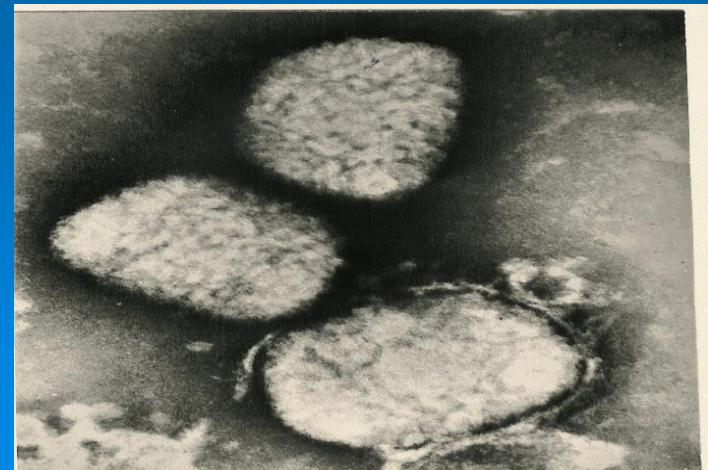
**Adenovirus**



**Herpesvirus**



**Poxvirus**

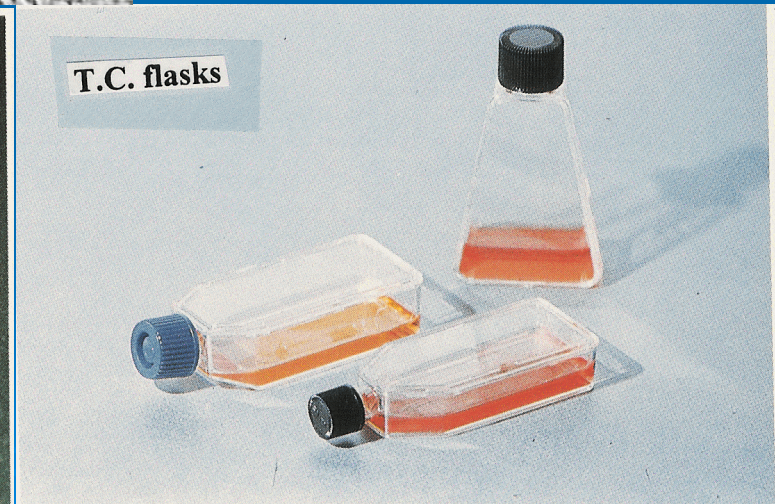
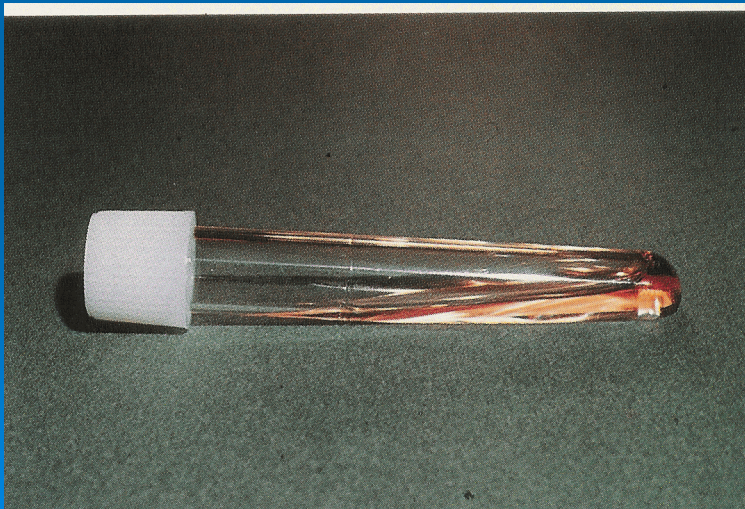
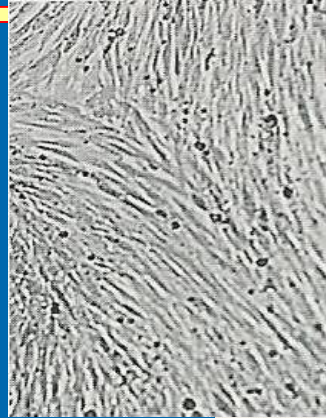


# *Virus cultivation*

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



# Cell culture



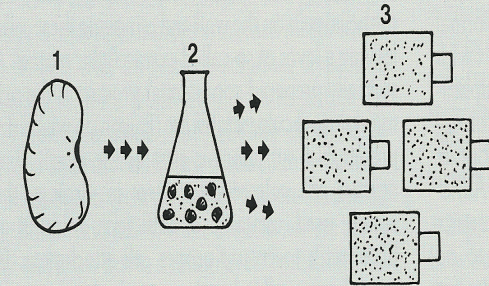


# Cell culture

# No of sub passages

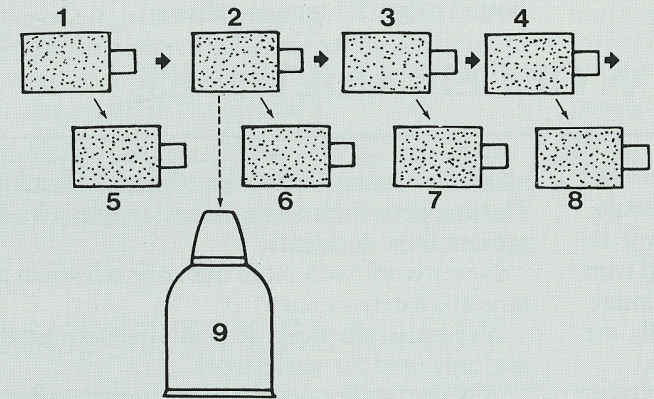
Primary C/C

1 or 2



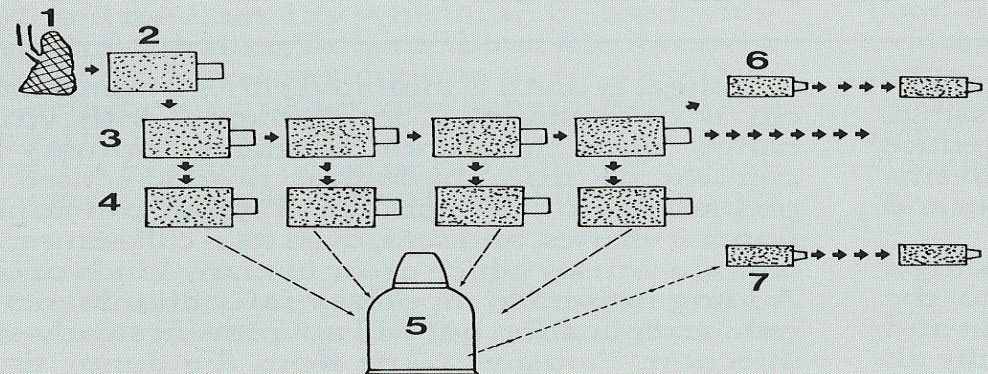
Diploid C/C  
[semi continuous]

20 to 50



Continuous cell line

Indefinite



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

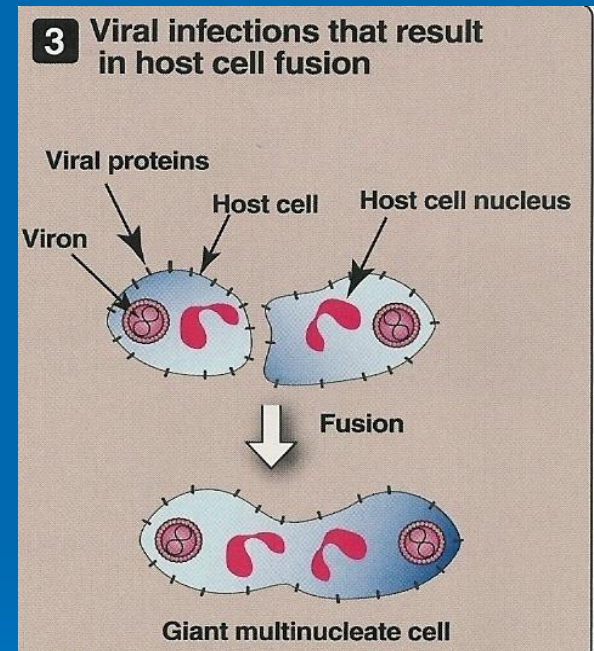
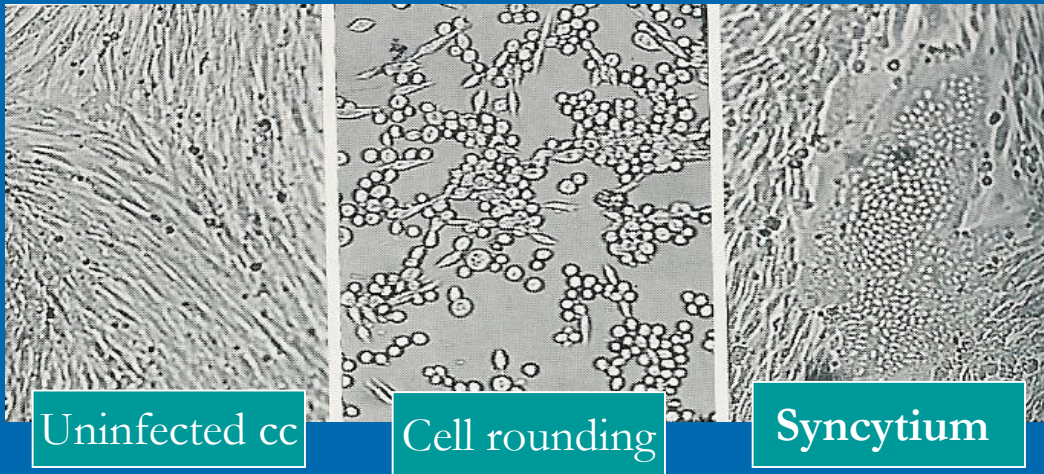
Virus	Cell culture <sup>a</sup>		
	PMK	HDF	HEp-2
RNA virus			
Enterovirus	+++	++	+/-
Rhinovirus	+	+++	+
Influenza virus	+++	+	-
RSV	++	+	+++
DNA virus			
Adenovirus	+	++	+++
HSV	+	++	++
VZV	+	+++	-
CMV	-	+++	-

*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

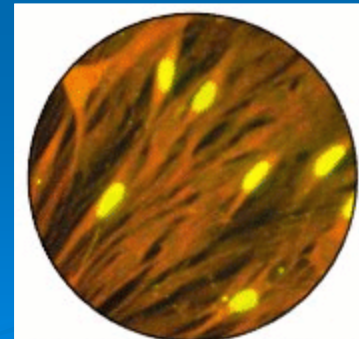
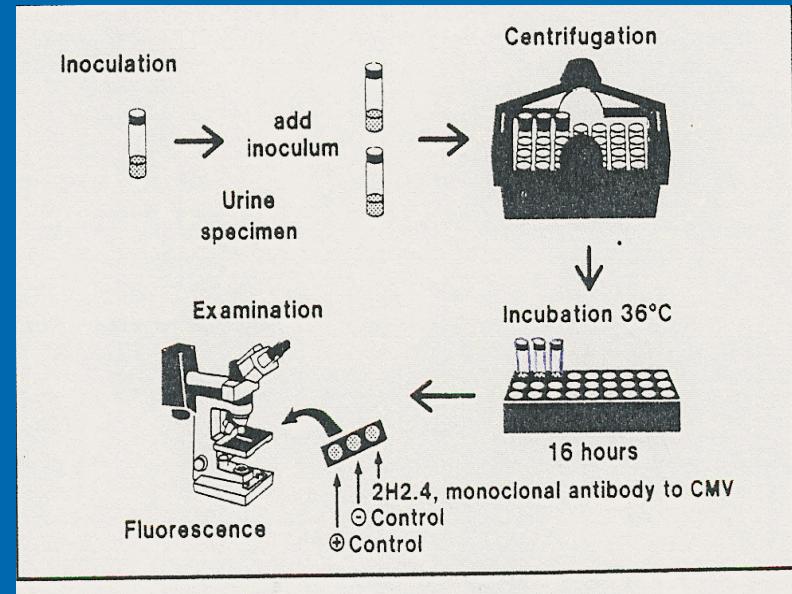


Fig. 2, CMV centrifugation culture fixed and stained 16 hrs after inoculation showing viral proteins in nuclei of infected human fibroblast cells

*Serological test;*  
*Antigen detection;*

*sample*

- Nasopharyngeal aspirate
- Skin scrapings
- Faeces
- Blood

*virus*

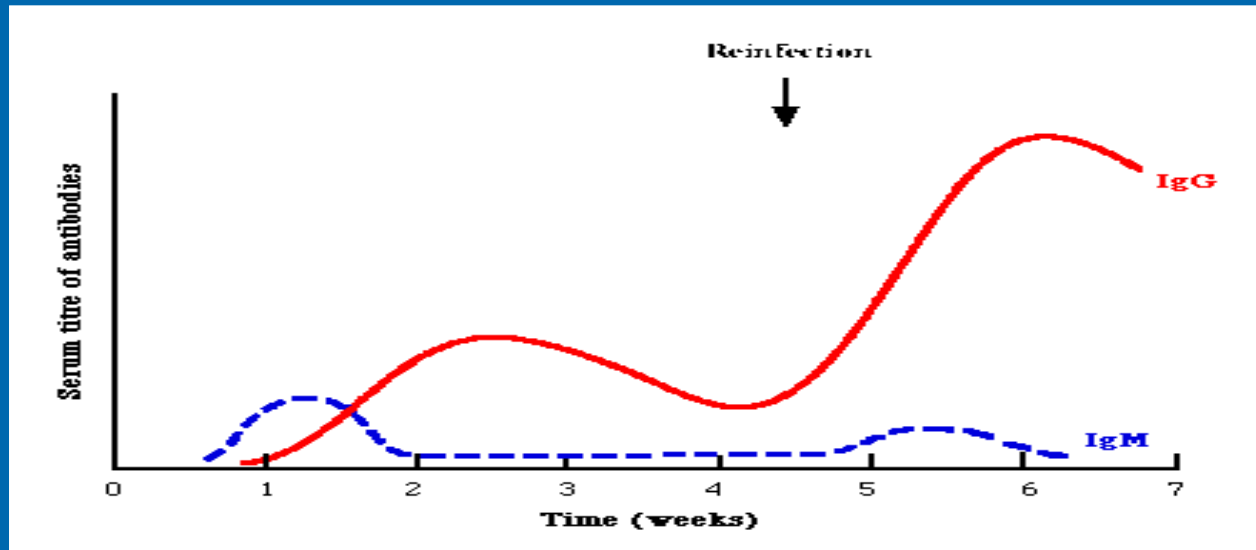
Influenza V.  
HSV  
Rotavirus  
HBV (HBsAg)

*test*

IF  
IF  
ELISA  
ELISA

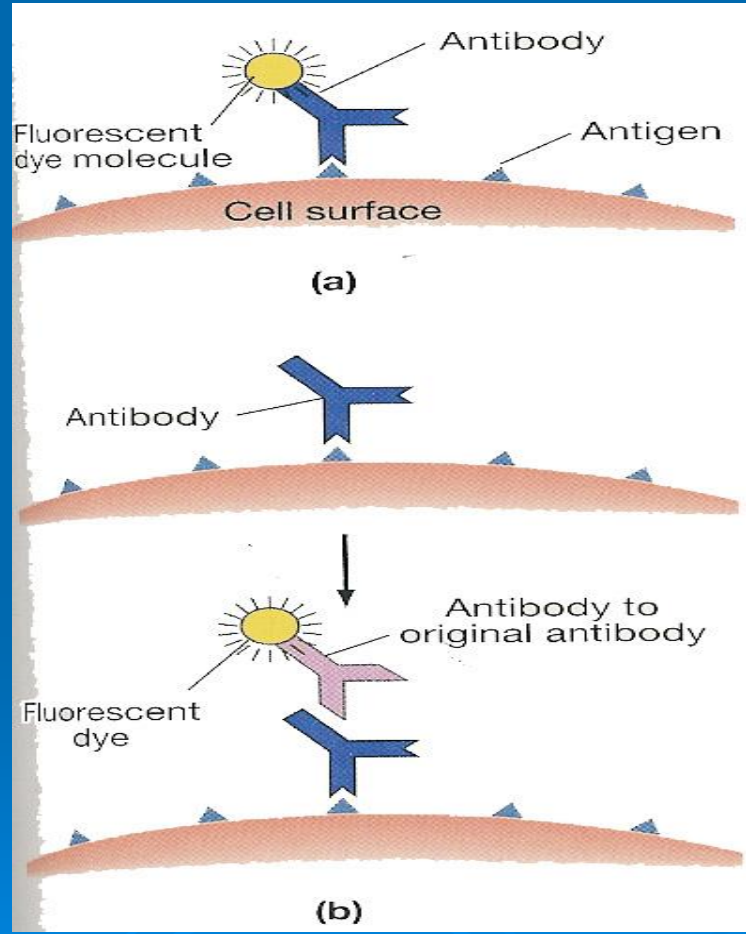
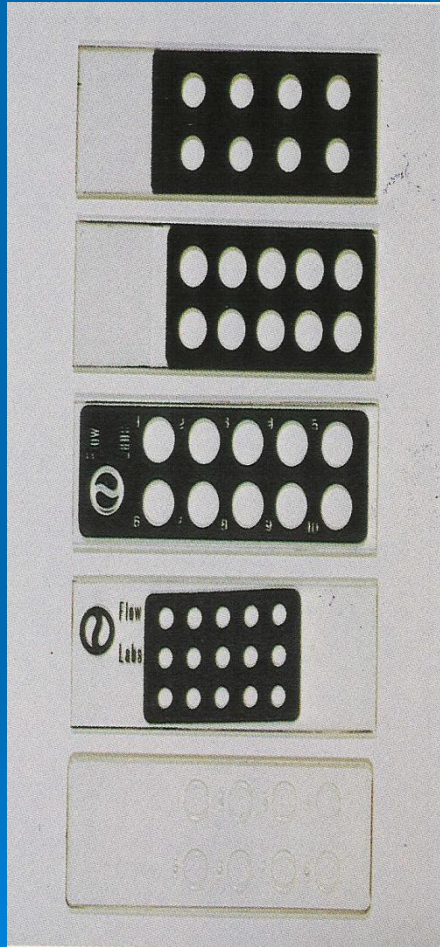
# Serological test;

## 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)



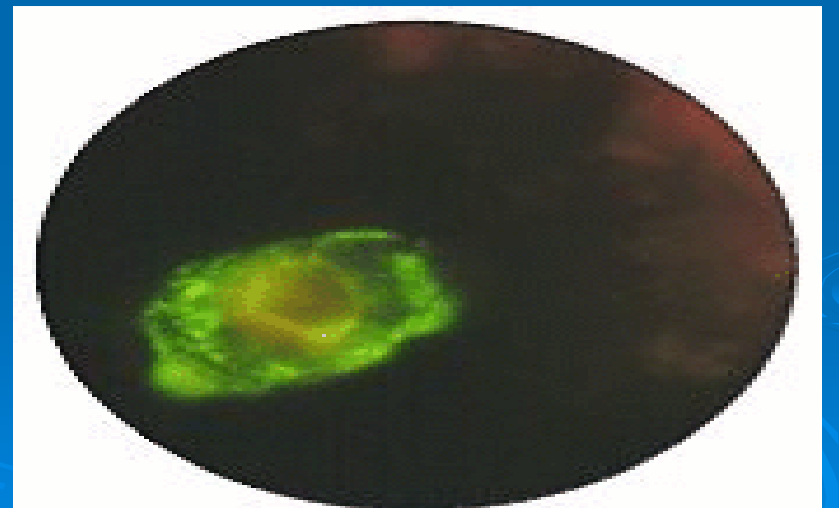
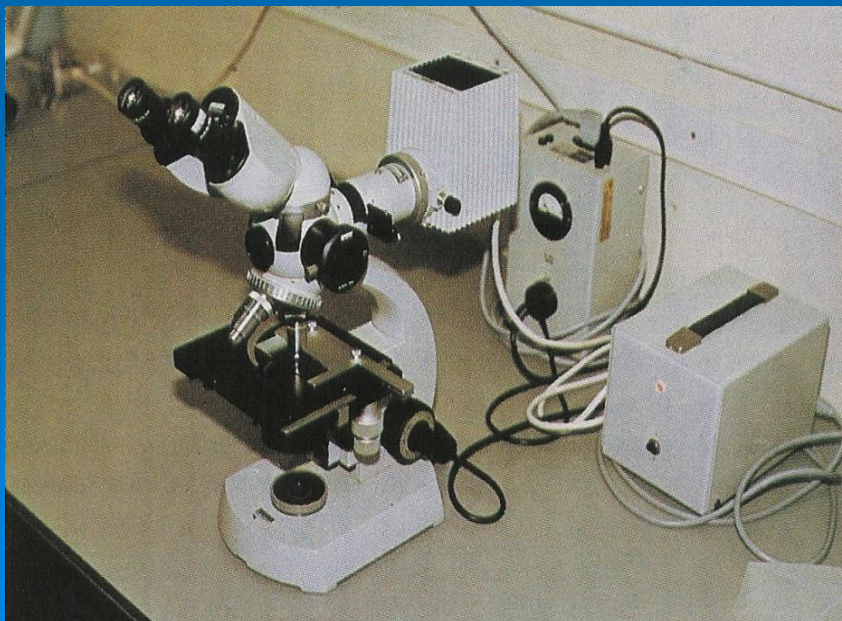
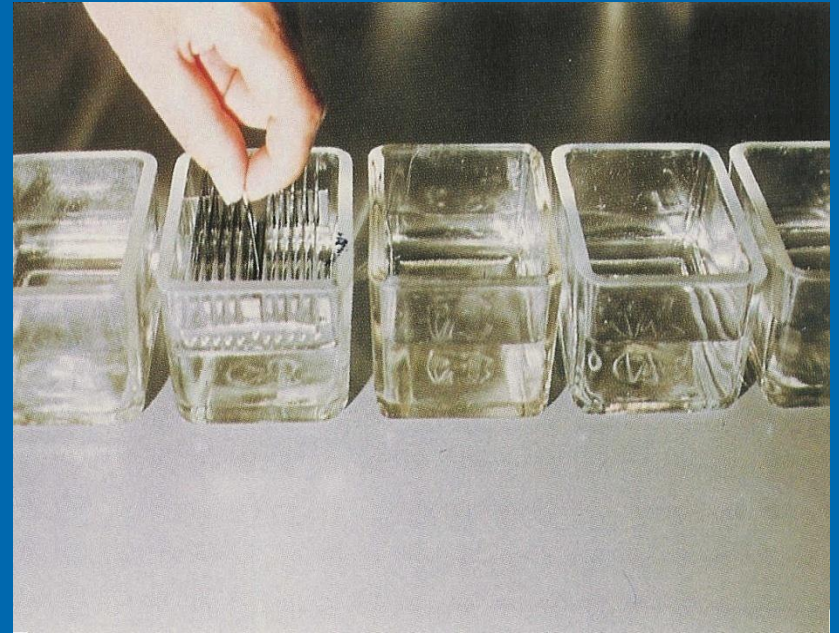
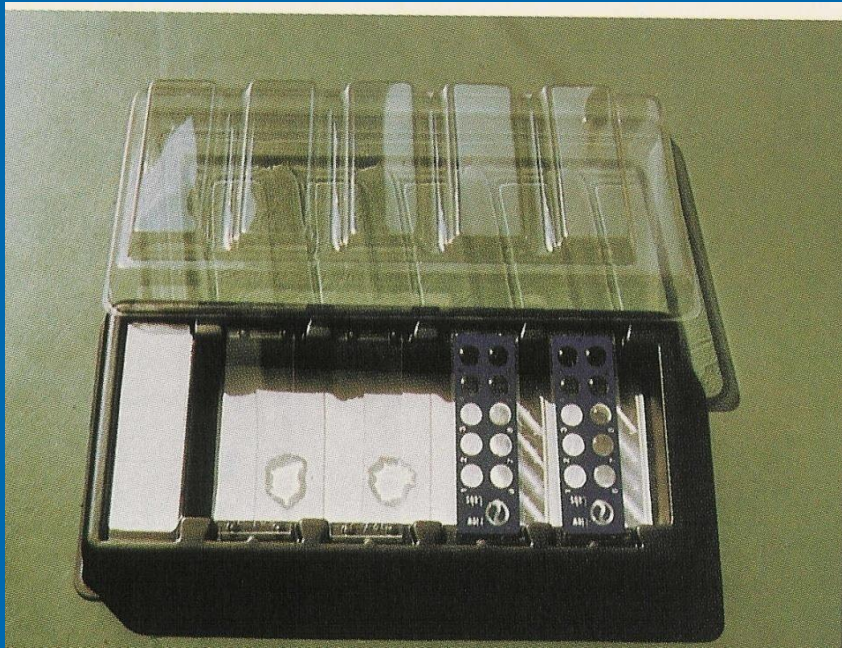
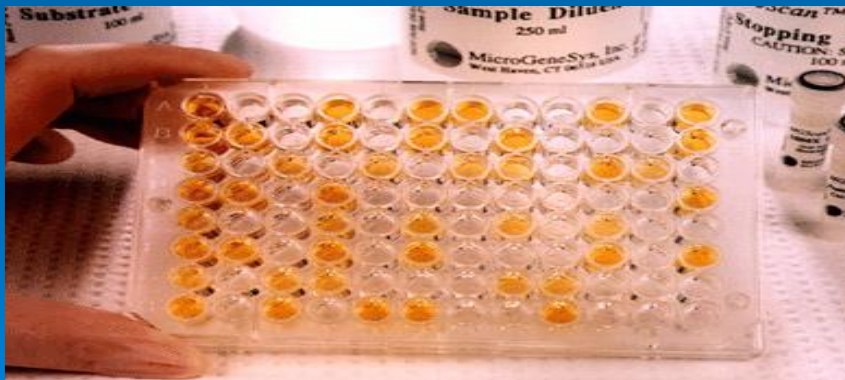
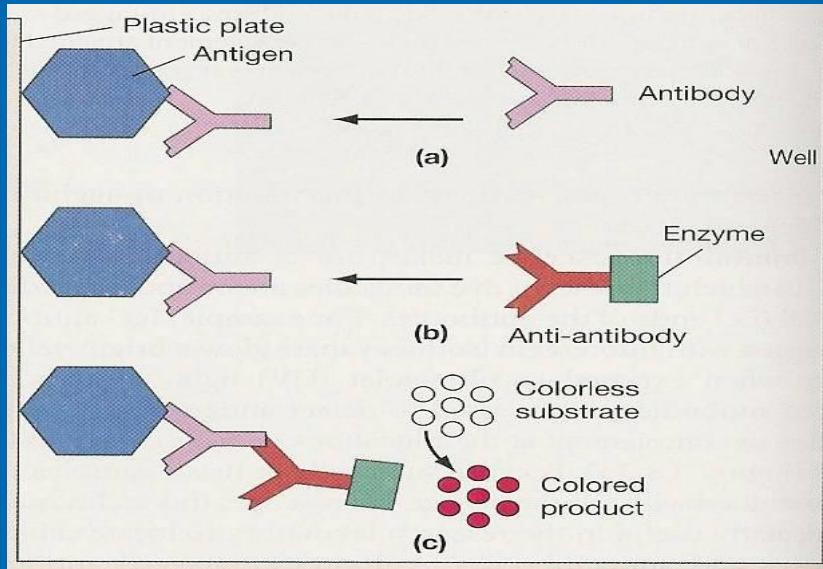


Fig. 3, HSV-infected epithelial cell from skin lesion (DFA)



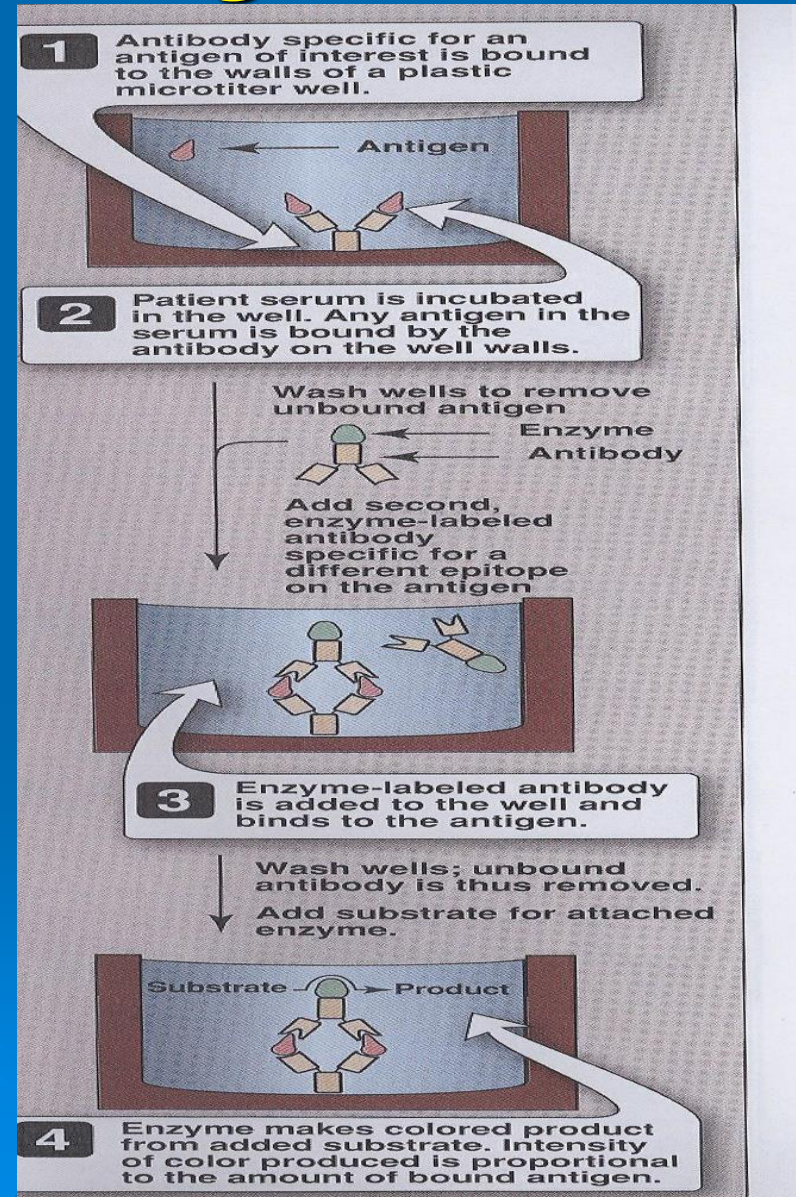
# ELISA

## Ab detection



Indirect ELISA for Ab detection ;  
coloured wells indicate reactivity

## Ag detection



# *Molecular test;*

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



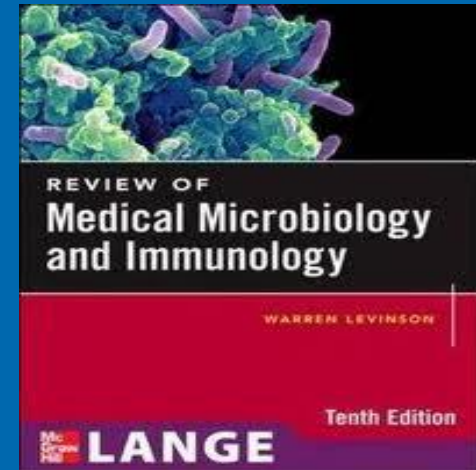
# Reference book and the relevant page numbers

## ➤ Medical Microbiology and Immunology

By: Warren Levinson .

10<sup>th</sup> Edition, 2008.

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



## ➤ Lippincott's Illustrated Reviews: Microbiology

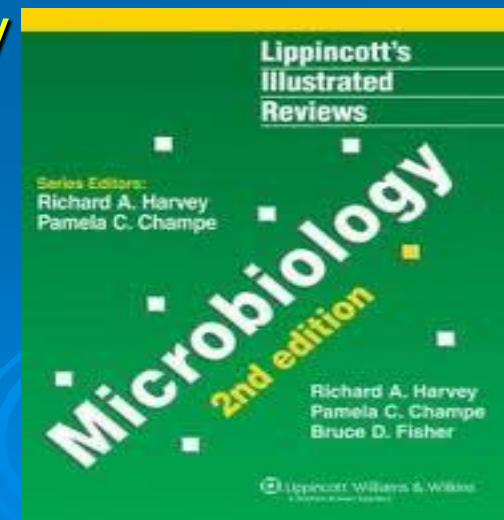
By: Richard A. Harvey ,

Pamela C Champe &

Bruce D. Fisher

2<sup>nd</sup> Edition, 2007 .

Pages;233-242





*Thank you*

