Introduction to medical virology

"Viral structure and Classification"

Dr. Abdulkarim Alhetheel

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.

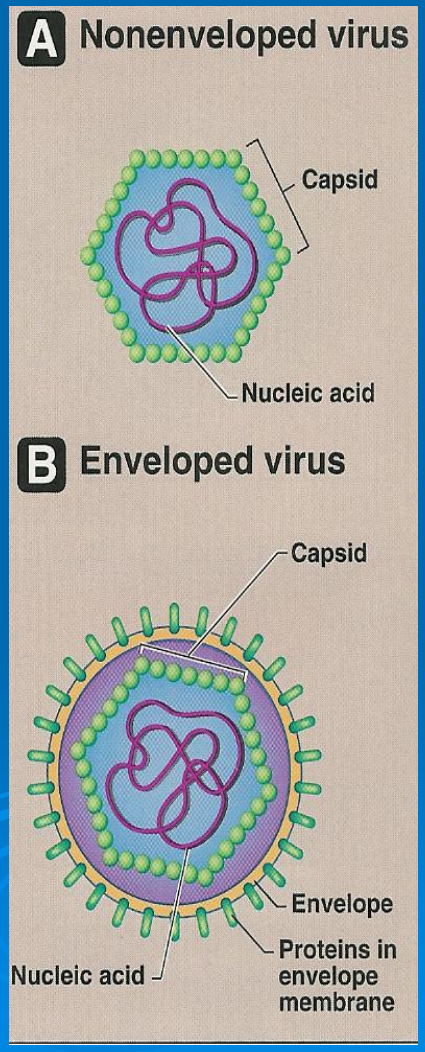
Properties of Microorganisms

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

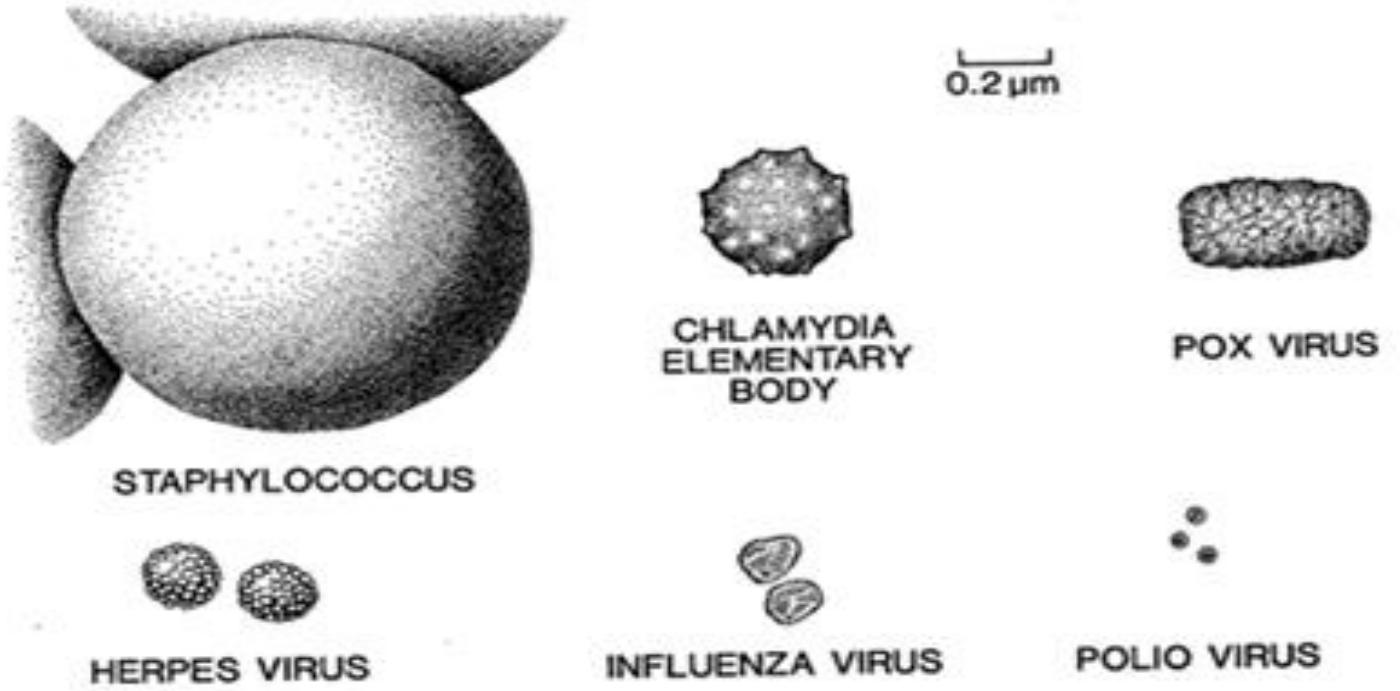
Characteristics of viruses

- 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

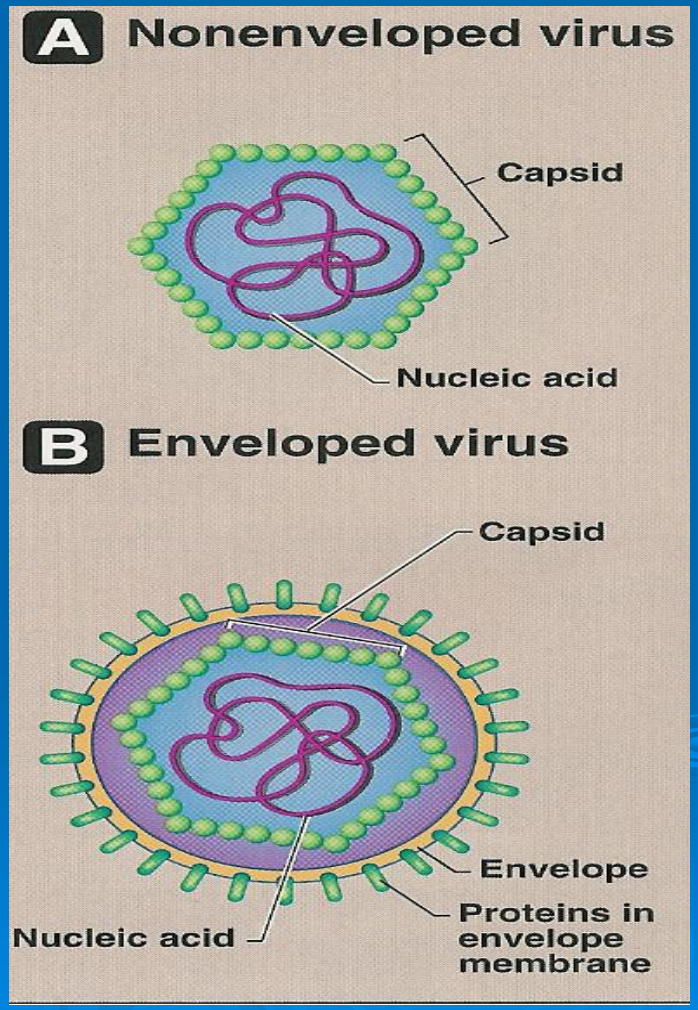


Viral Structure

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)

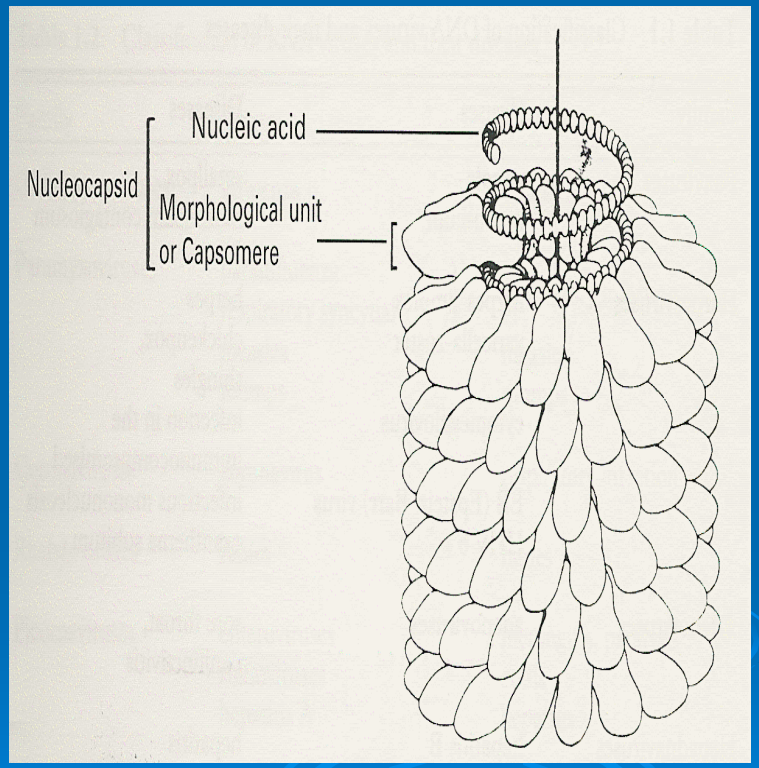
- All RNA Vs have ss except Reoviruses
- Single / double
- (+) polarity
- (-) polarity

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

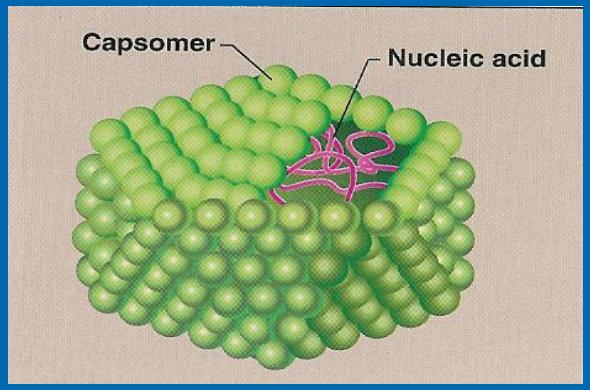
- Cubic symmetry
  (Icosahederal)
- Helical symmetry
- Complex symmetry

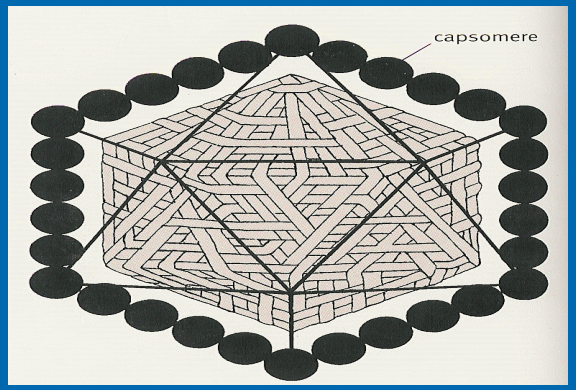
Symmetry

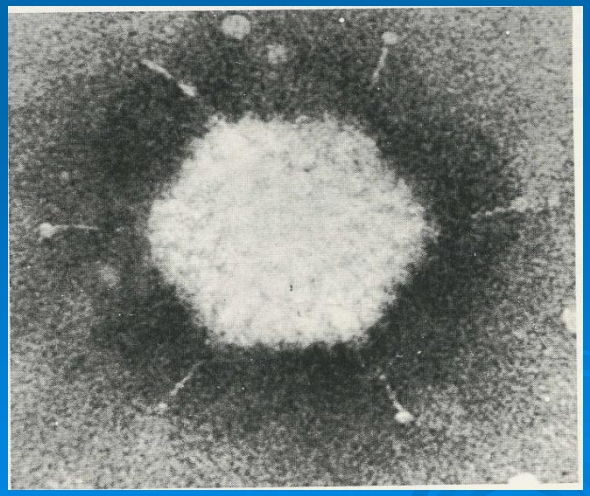
based on arrangement of capsomeres

- **1-Cubic symmetry**

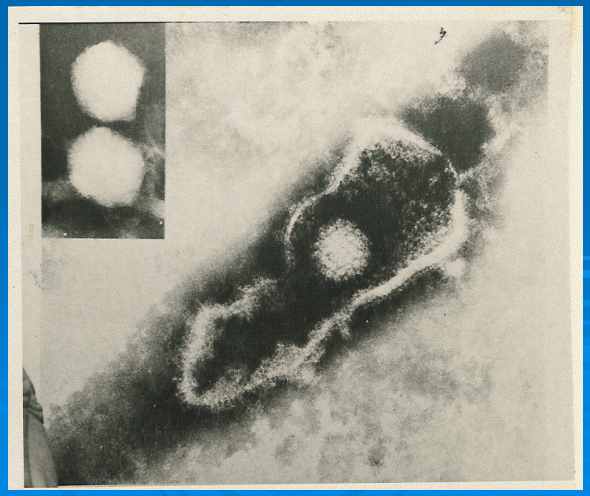
  (Icosahedral)







Adenovirus

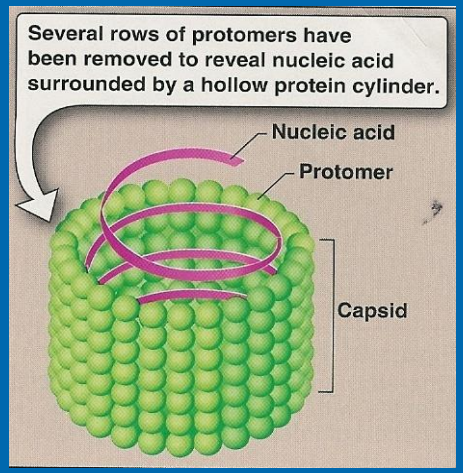


Herpes virus

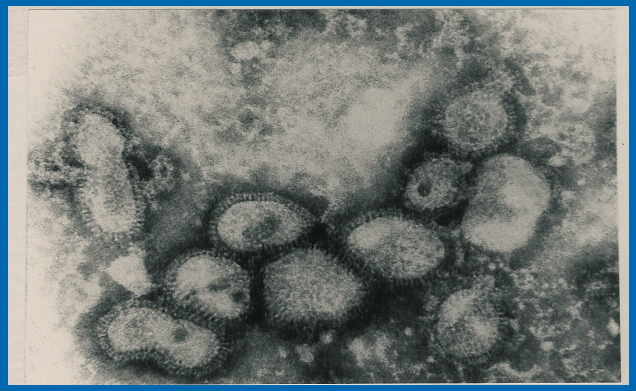
Symmetry

based on arrangement of capsomeres

- **2- Helical symmetry**



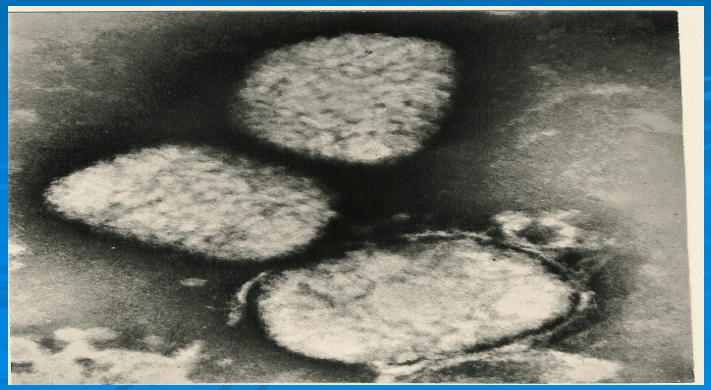
Elongated (filoviruses)



Pleomorphic (influenza v.)

- **3- Complex symmetry**

poxviruses

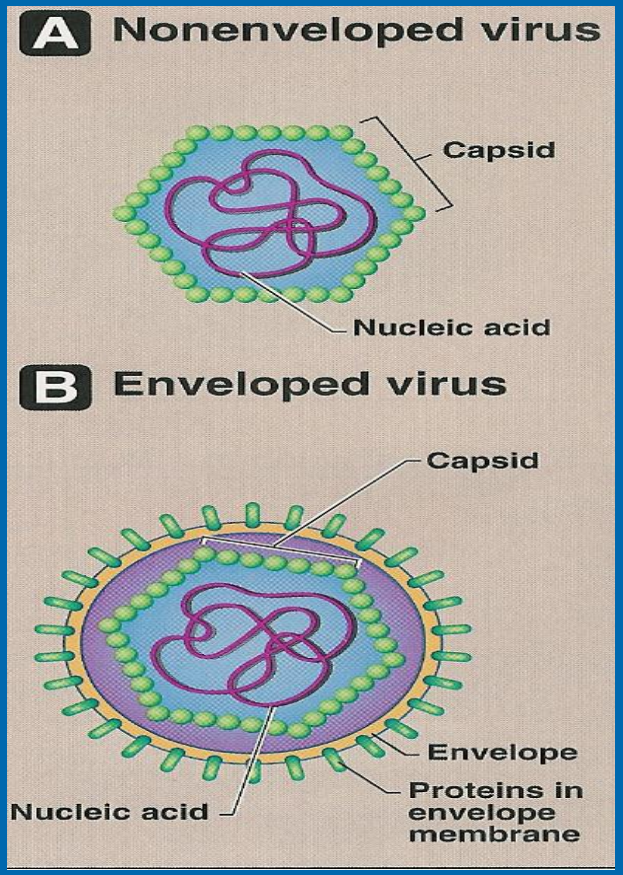


Viral structure

3-Envelope

Lipoprotein mb

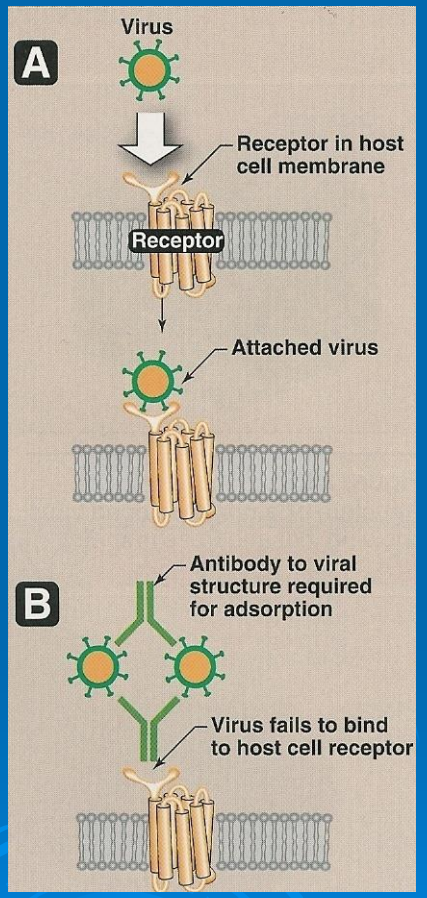
(host lipid, virus specific protein)



- ***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

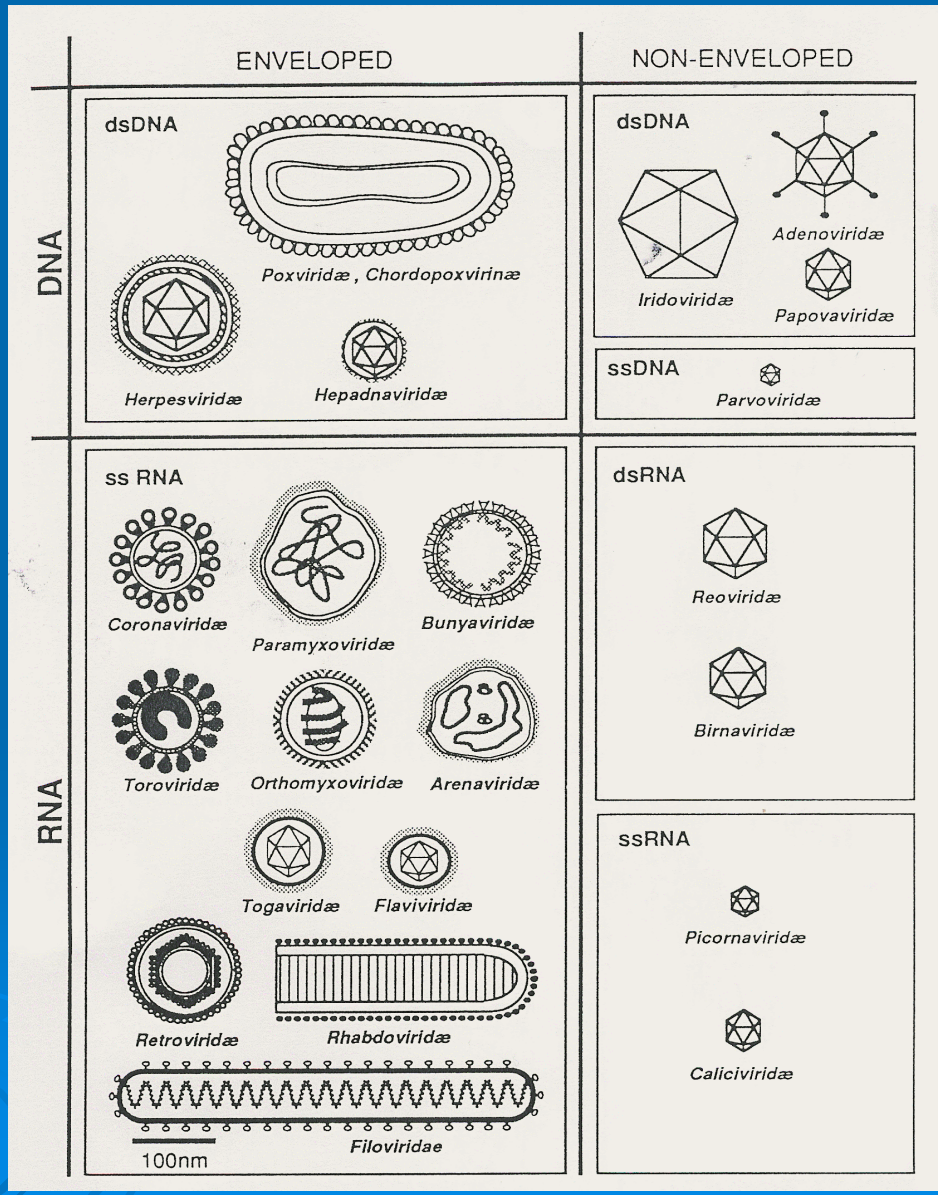
Viral proteins

- ***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

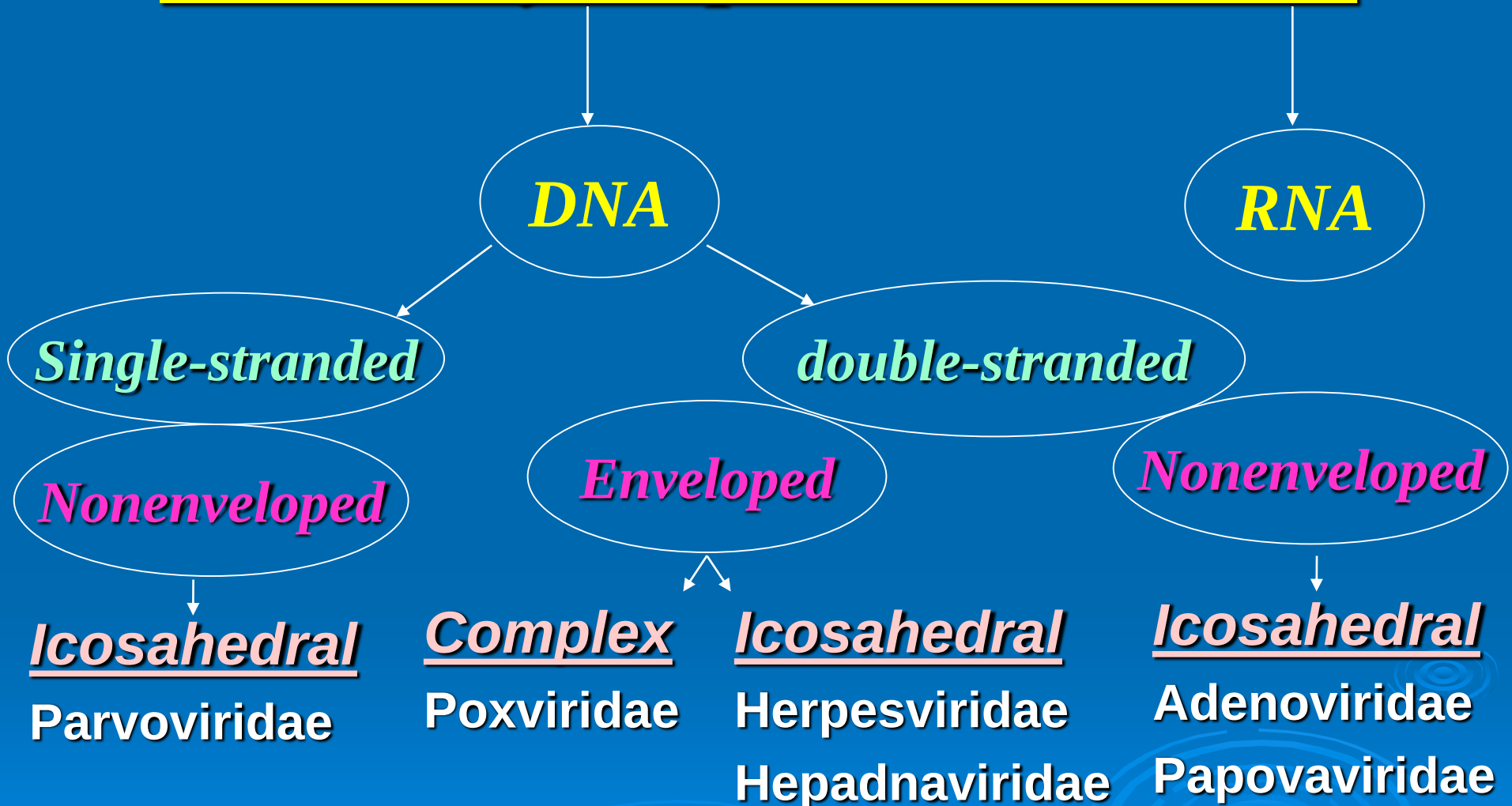


Classification of viruses

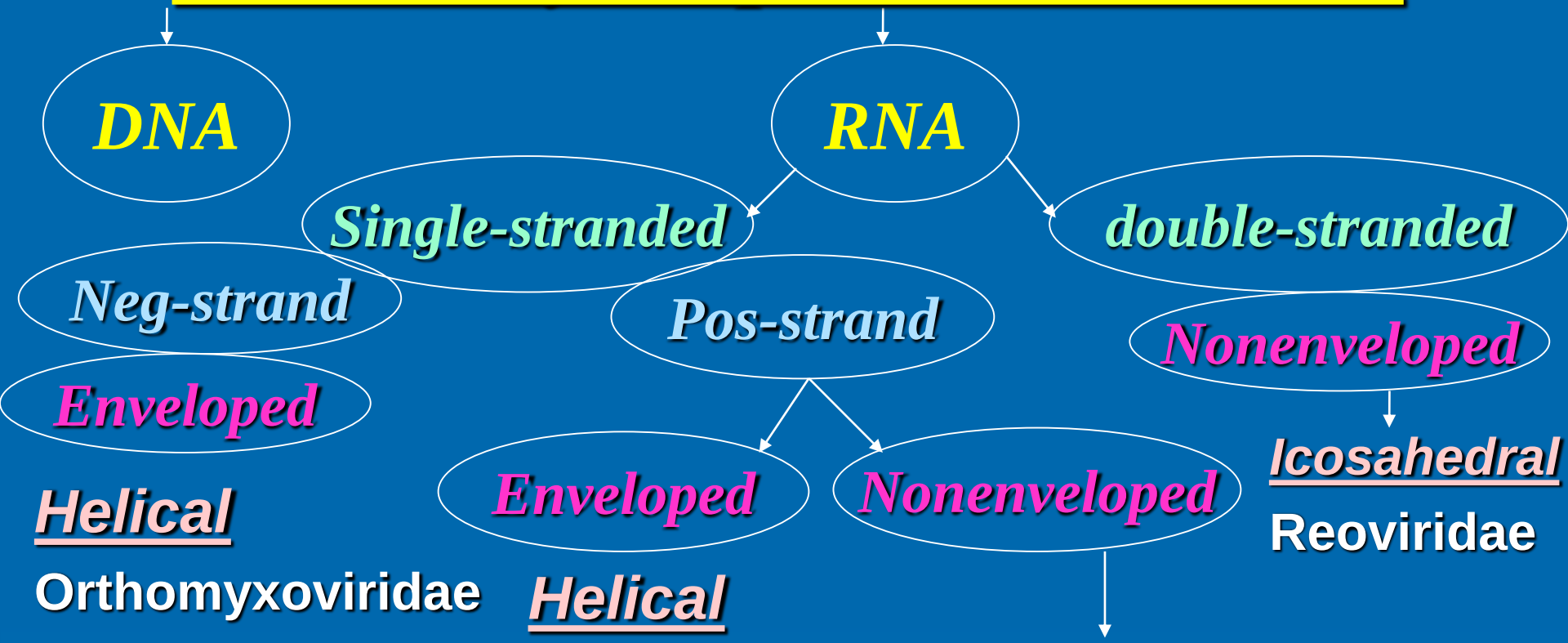
- Type of NA
- The no. of strand
- The polarity
  of viral genome
- The presence or absence of envelope
- Type of symmetry



Medically Important Viruses



Medically Important Viruses



Helical

Orthomyxoviridae

Paramyxoviridae

Rhabdoviridae

Filoviridae

Bunyaviridae

Arenaviridae

Helical

Coronaviridae

Icosahedral

Togaviridae

Flaviviridae

Retroviridae

Icosahedral

Picornaviridae

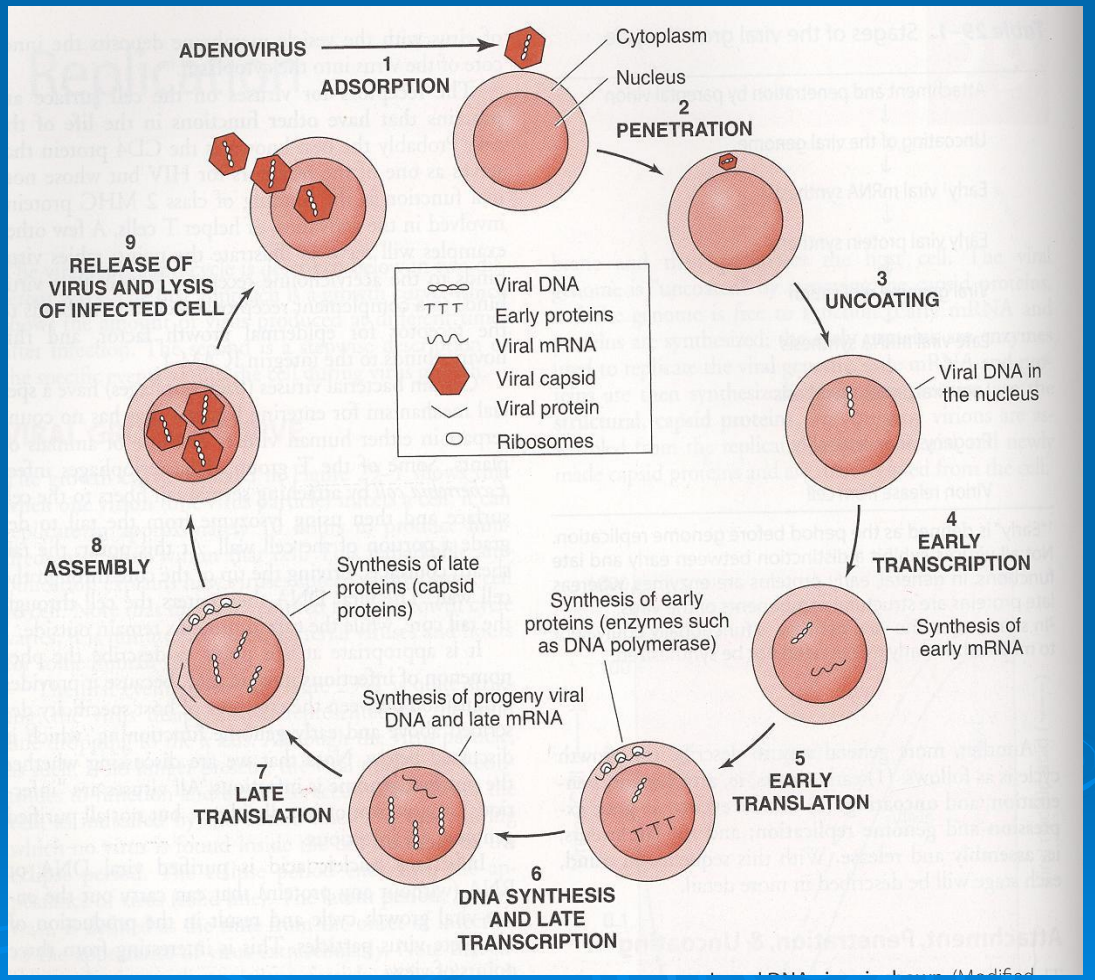
Hepeviridae

Caliciviridae

Astroviridae

Replication

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

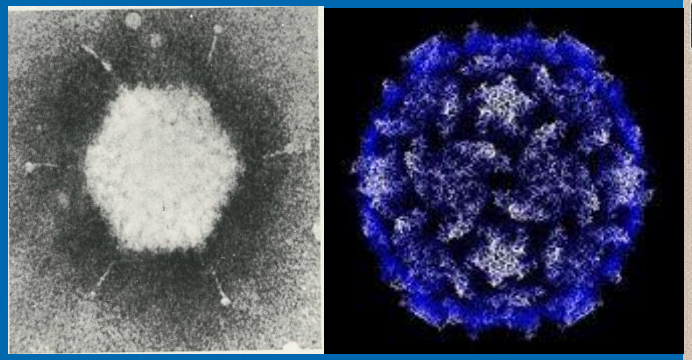


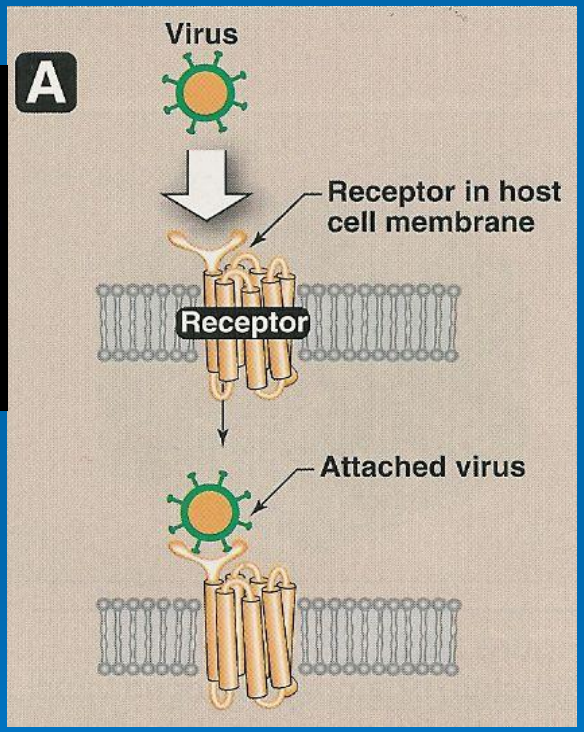
Viral growth cycle

Adsorption

- Attachment site;

  - glycoprotein

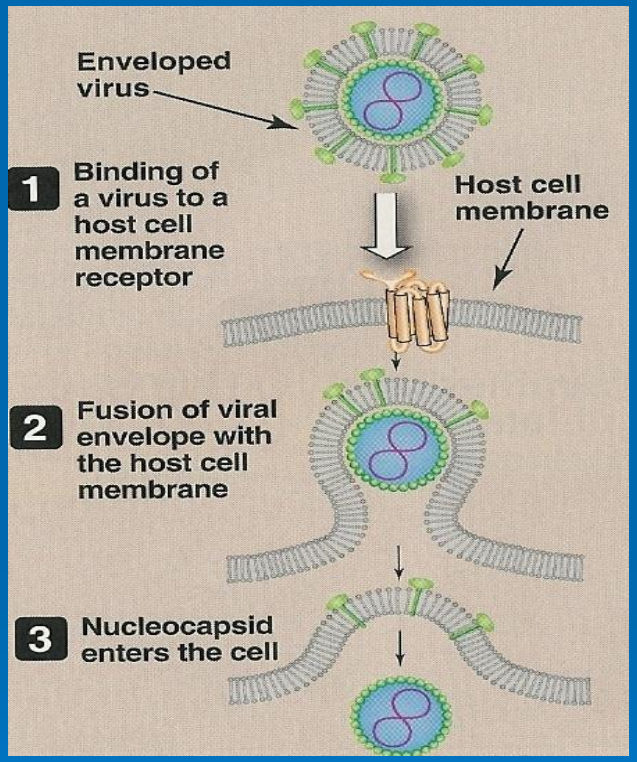




  - folding in the capsid proteins.

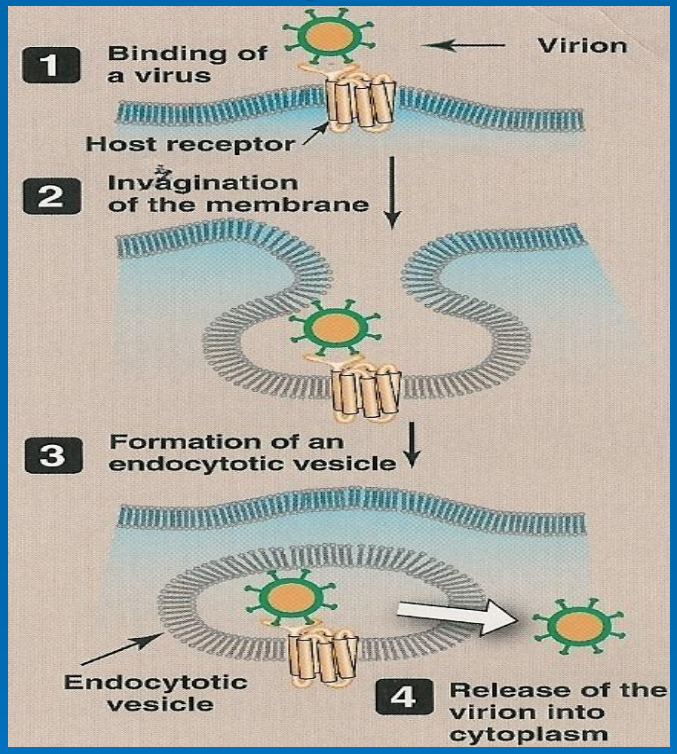
Penetration

1-Fusion



(enveloped virus)

2-Endocytosis



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

Replication

- Adsorption (Attachment)
- Penetration
- Uncoating

Release of viral genome - cytoplasm

- nucleus

Synthesis of viral components

- mRNA

  Viral genome → transcription → mRNA

  +ssRNA acts directly

- Viral proteins

  mRNA → translation → viral proteins

  cell ribosome

  - 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

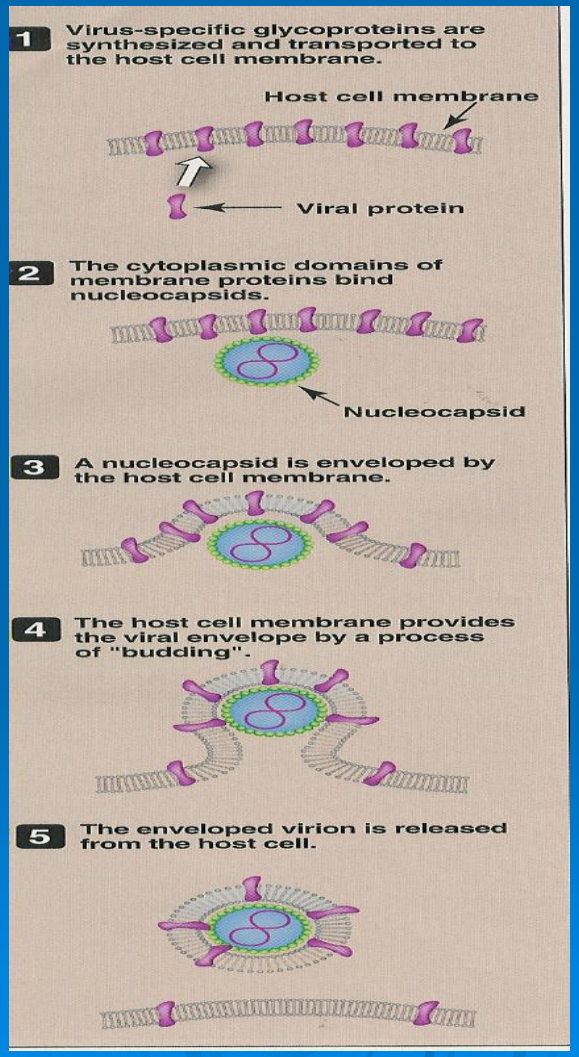
- 1-Budding

(enveloped Vs)

-cell mb*

-nuclear mb

(herpesVs)



- 2- Cell lysis

or rupture of the cm

(nonenveloped Vs)

laboratory diagnosis of viral infections

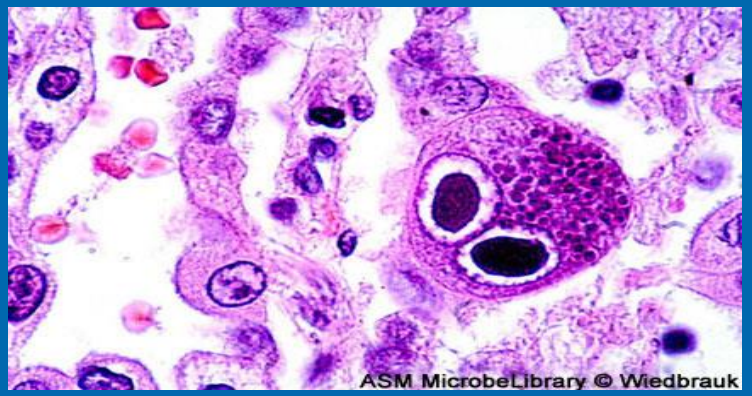
- Microscopic examination.
- Cell culture.
- Serological tests .
- Molecular method .

Microscopic examination

- ***Light microscopy***;

  Histological appearance

  Ex. Inclusion bodies



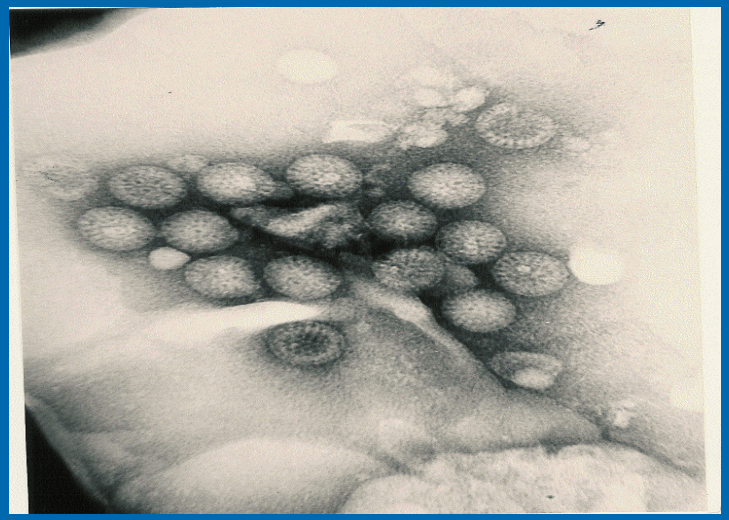
Owl's eye (CMV)

- ***Electron microscopy;***
  - Morphology& size of virions
  - Ex. Diagnosis of viral GE such as rota, adenoviruses.

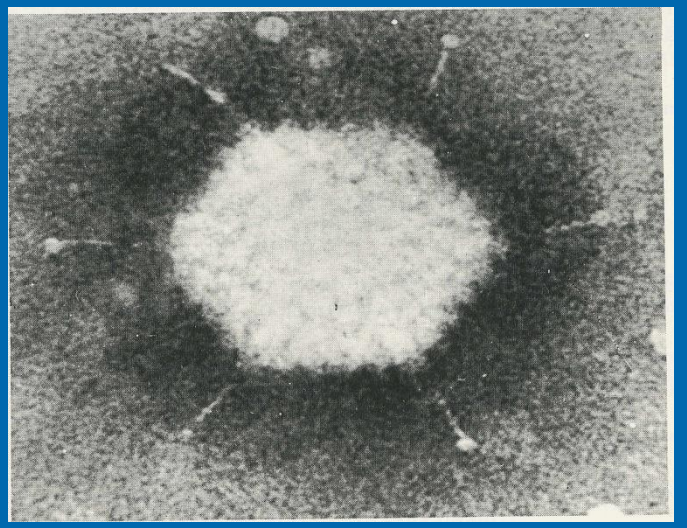
    Diagnosis of skin lesion caused by herpes, or poxviruses.
  - It is replaced by Ag detection & molecular tests

- Electron micrographs

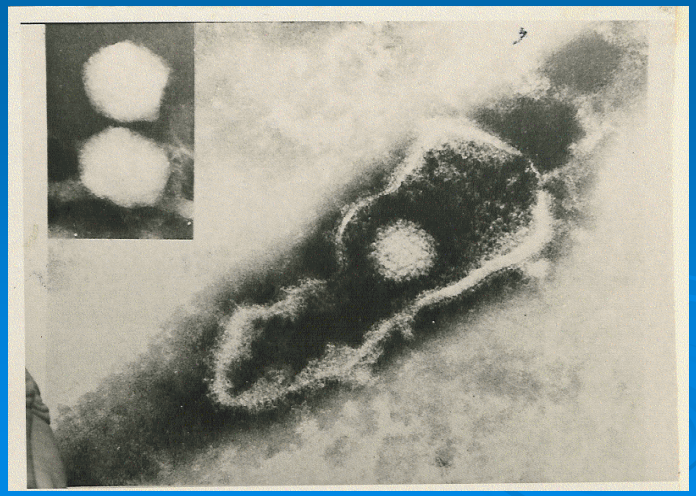
Rotavirus



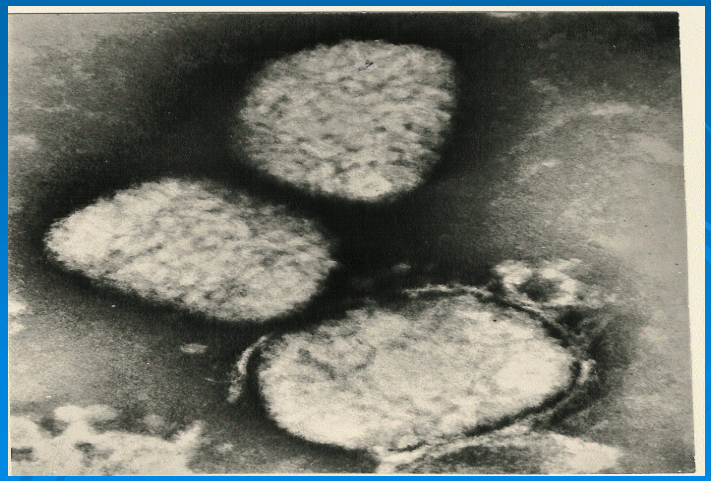
Adenovirus



Herpesvirus



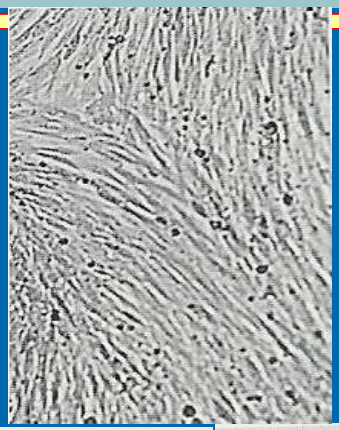
Poxvirus

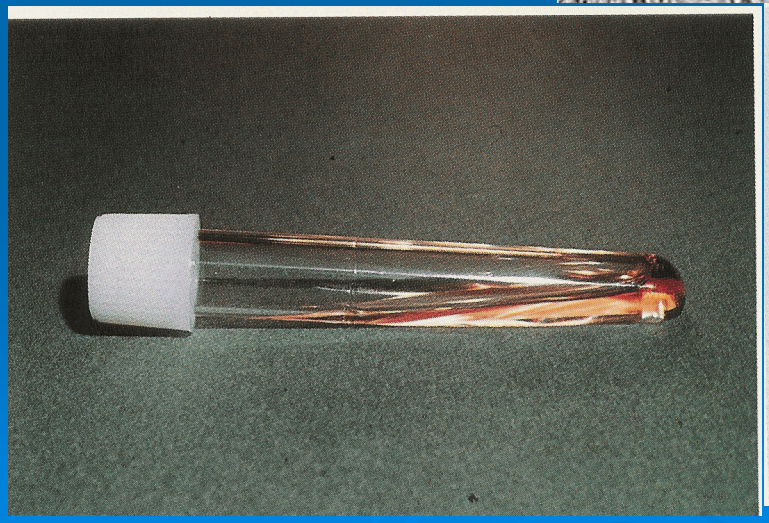


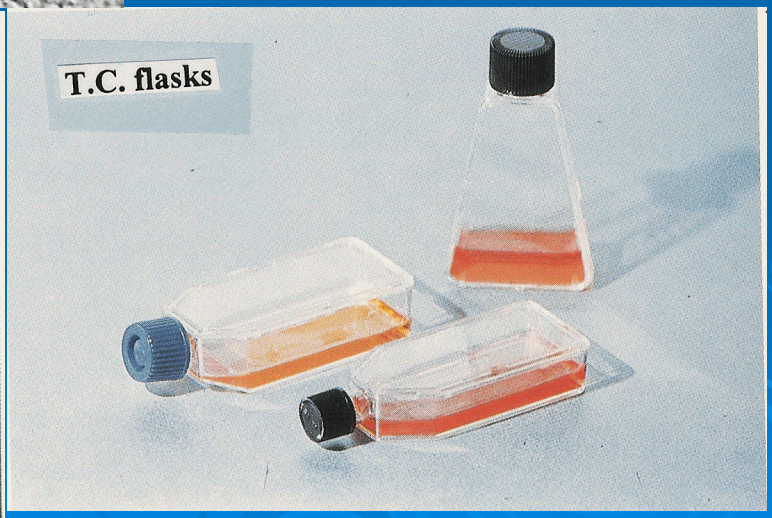
Virus cultivation

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

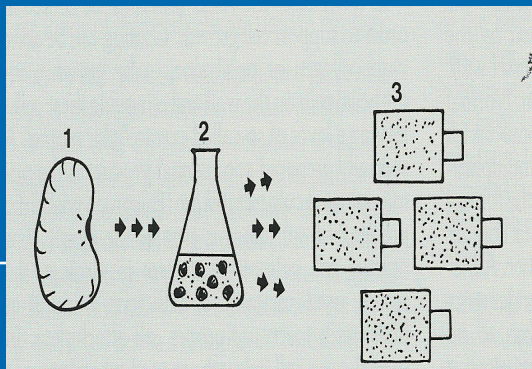
Cell culture

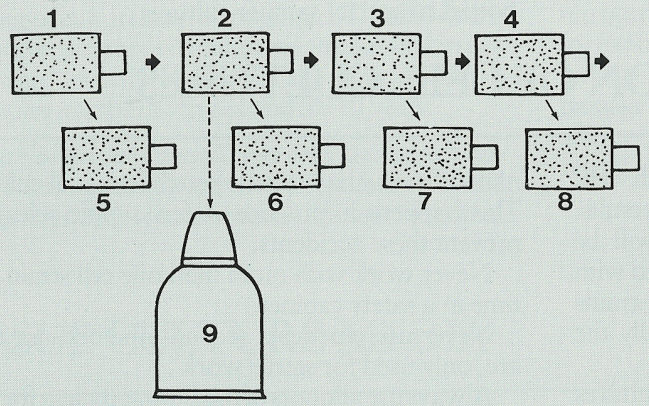


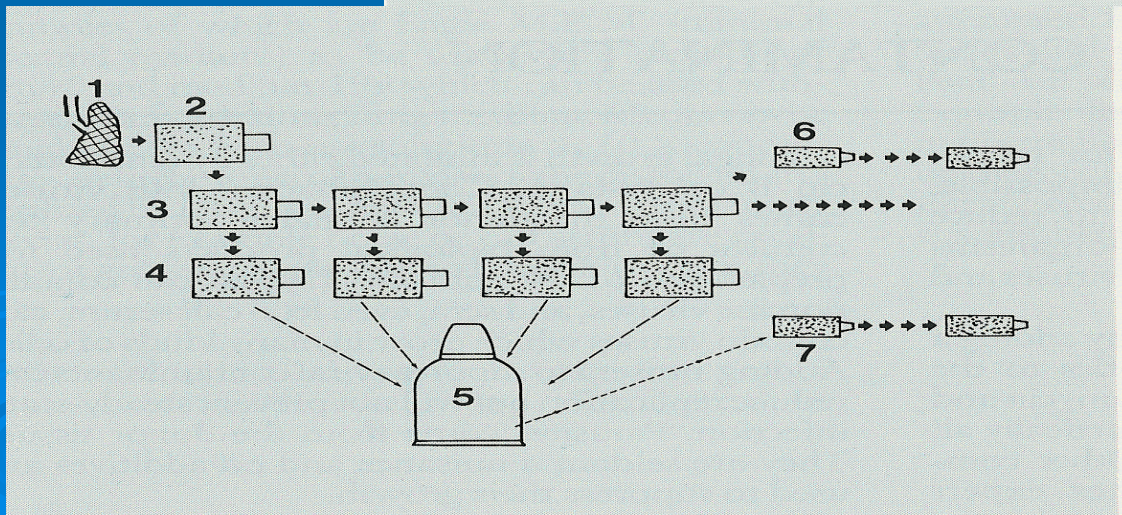




Cell culture	No of sub passages
Primary C/C	1 or 2
Diploid C/C [semi continuous]	20 to 50
Continuous cell line	Indefinite







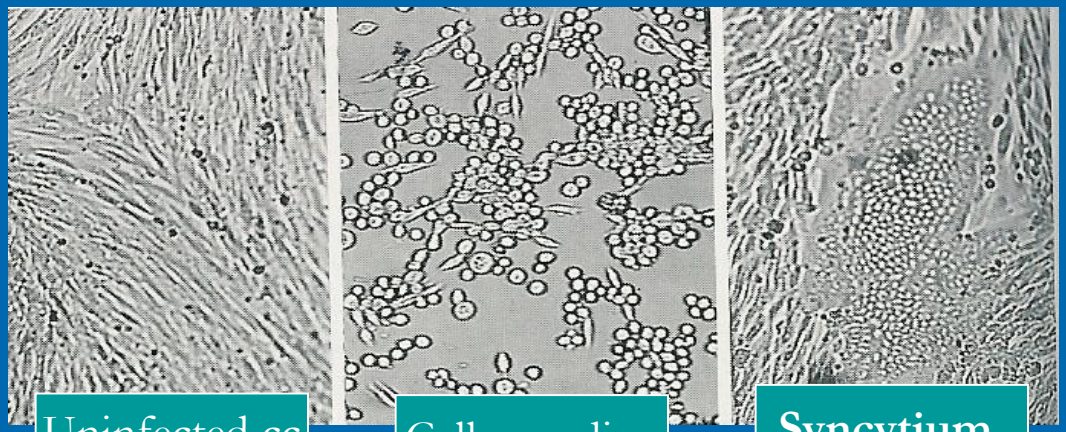
Variation in Sensitivity of cell cultures to infection by viruses commonly isolated in clinical virology laboratories

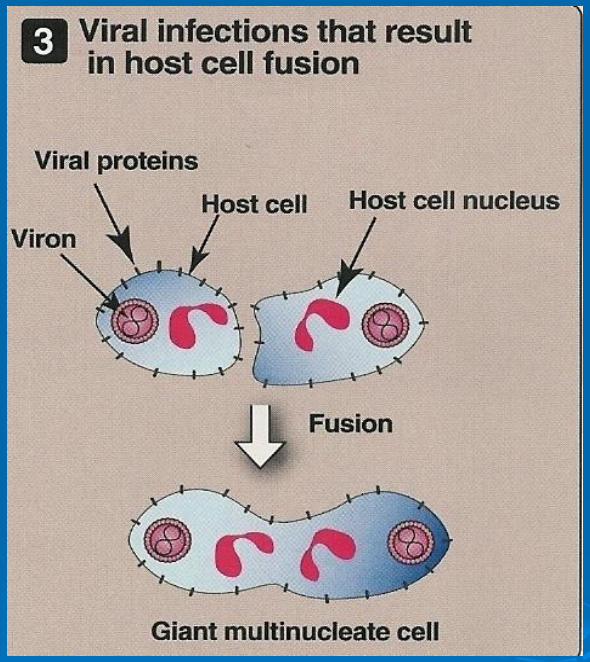
Virus	Cell culture[a]		
	PMK	HDF	HEp-2
RNA virus			
Enterovirus	+++	++	+/-
Rhinovirus	+	+++	+
Influenza virus	+++	+	-
RSV	++	+	+++
DNA virus			
Adenovirus	+	++	+++
HSV	+	++	++
VZV	+	+++	-
CMV	-	+++	-

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

Detection of viral growth

- Cytopathic effects





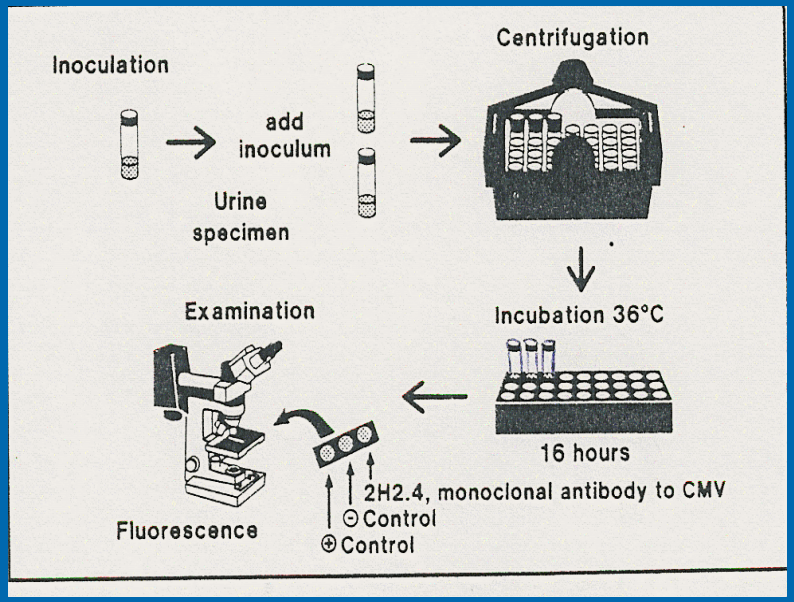
- IF
- Other

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



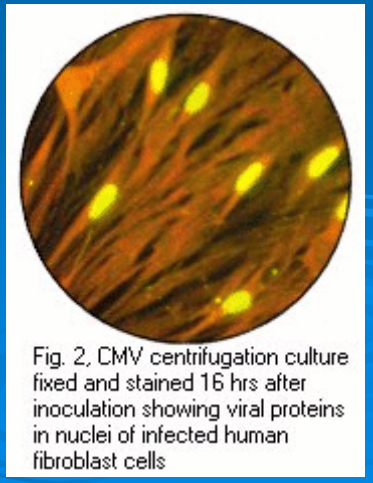


Fig. 2. CMV centrifugation culture fixed and stained 16 hrs after inoculation showing viral proteins in nuclei of infected human fibroblast cells

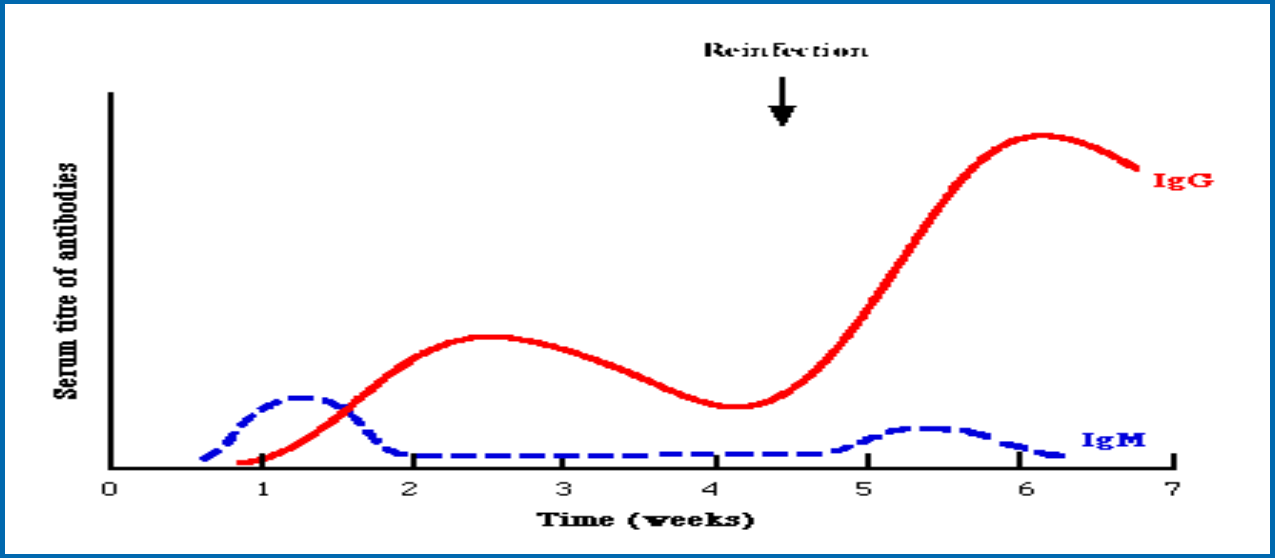
Serological test;

Antigen detection;

sample	virus	test
Nasopharyngeal aspirate	Influenza V.	IF
Skin scrapings	HSV	IF
Faeces	Rotavirus	ELISA
Blood	HBV(HBsAg)	ELISA

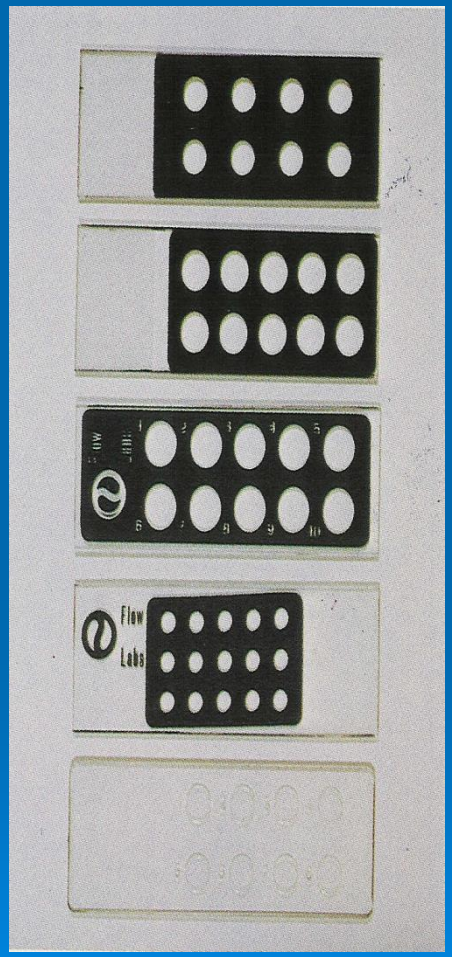
Serological test;

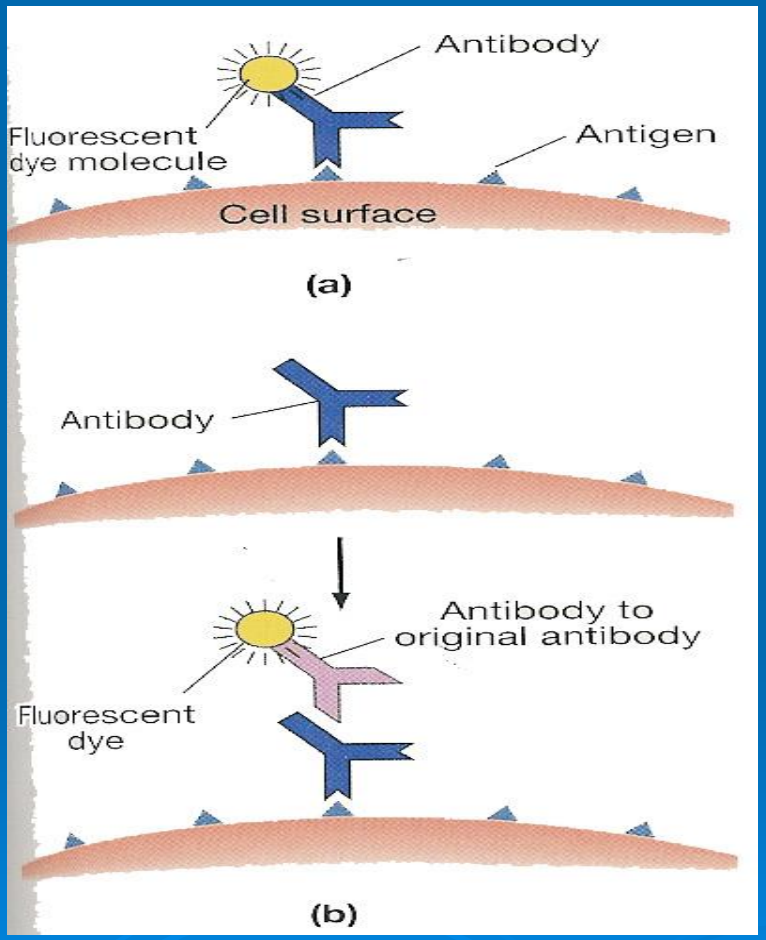
Antibody detection;



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

Immunofluorescence; IF



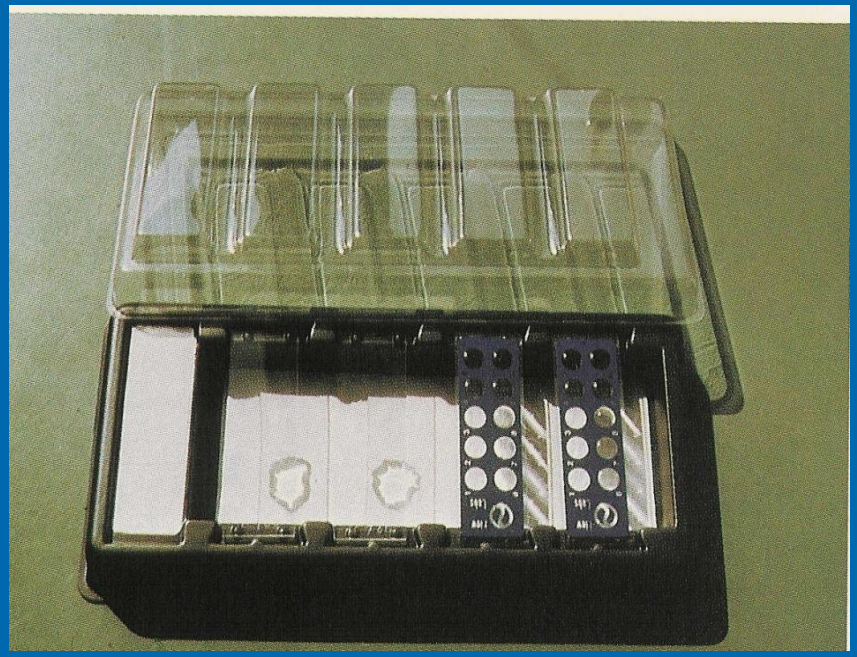


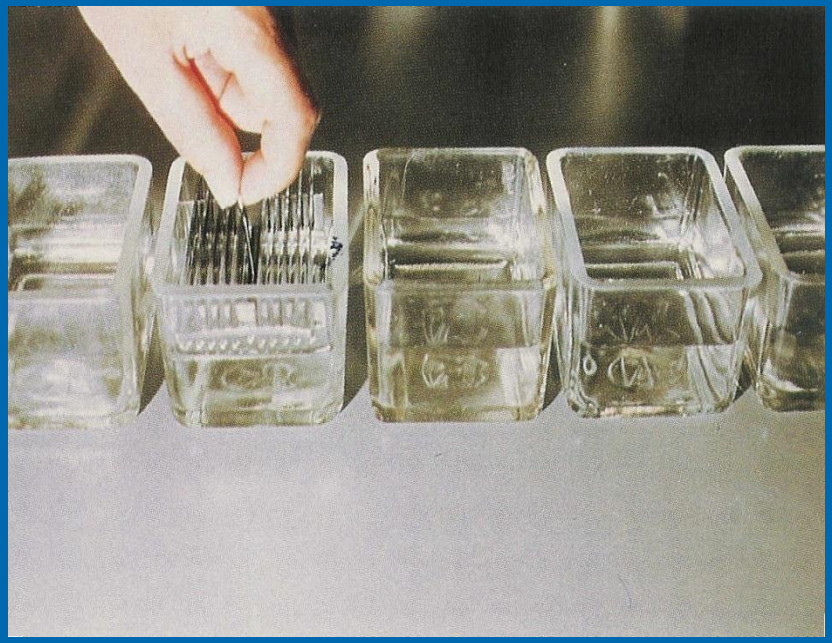
- A- Direct

  Ag detection;
  - Sample (Ag)

- B- Indirect

  Ab detection;
  - Sample (Ab)





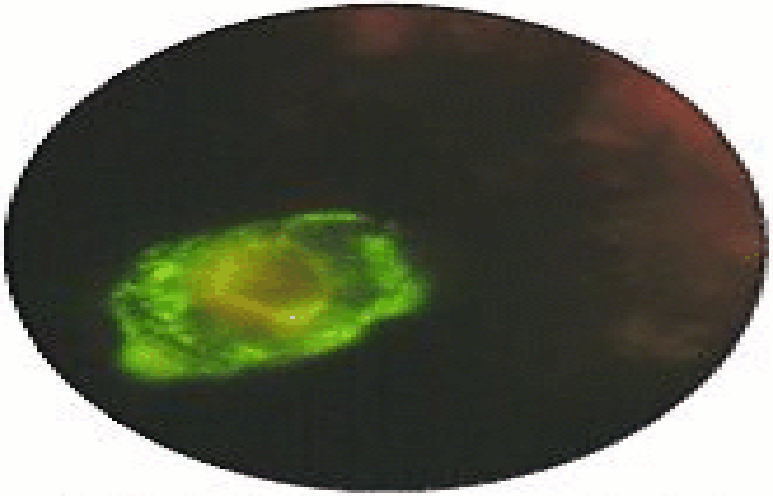
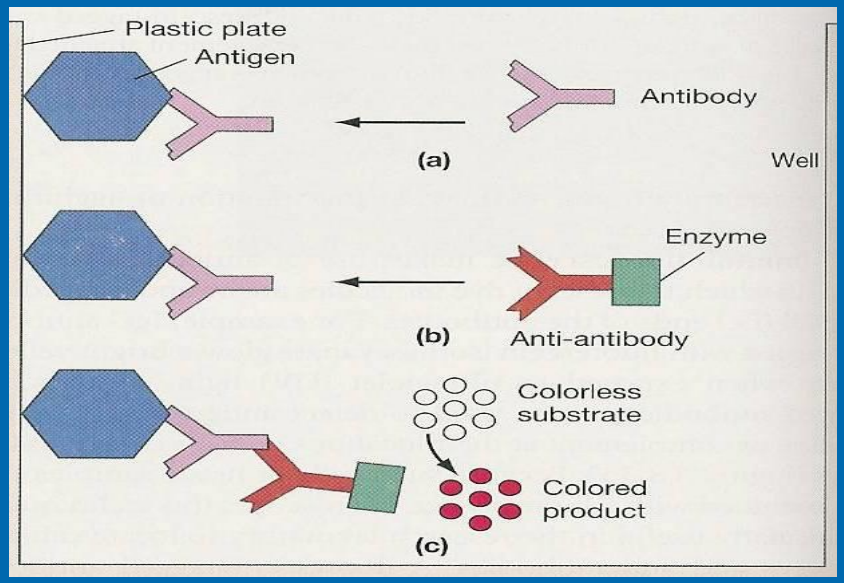


Fig. 3, HSV-infected epithelial cell from skin lesion (DFA)

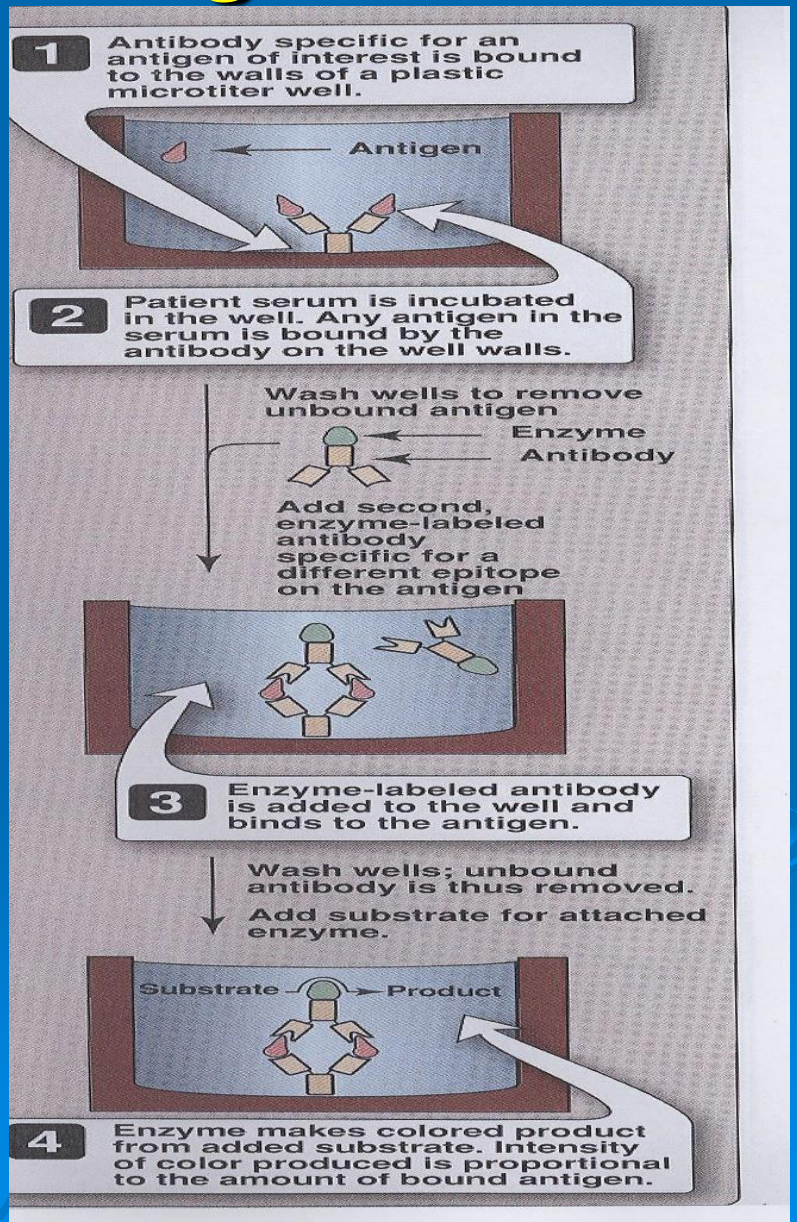
ELISA

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

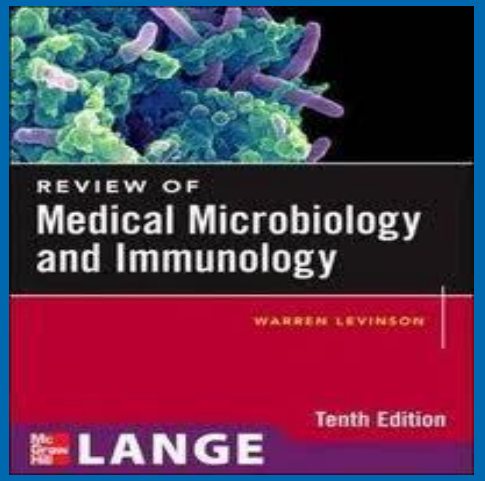
Reference book and the relevant page numbers

- Medical Microbiology and Immunology

  By: Warren Levinson .

  10th Edition, 2008.

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



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