بسم الله الرحمن الرحيم

# Introduction to medical virology

*( Foundation Block , Microbiology : 2018)*


***By: Dr.Malak El-Hazmi***

*Associate professor*

*Consultant Virologist*

*College of Medicine &*

*King Saud University Medical City*

# OBJECTIVES

- Distinguish the viruses from other microorganisms
- General characteristics of viruses.
- Structure & symmetry of viruses.
- Classification of viruses.
- Steps of virus replication .
- laboratory diagnosis of viral infections.

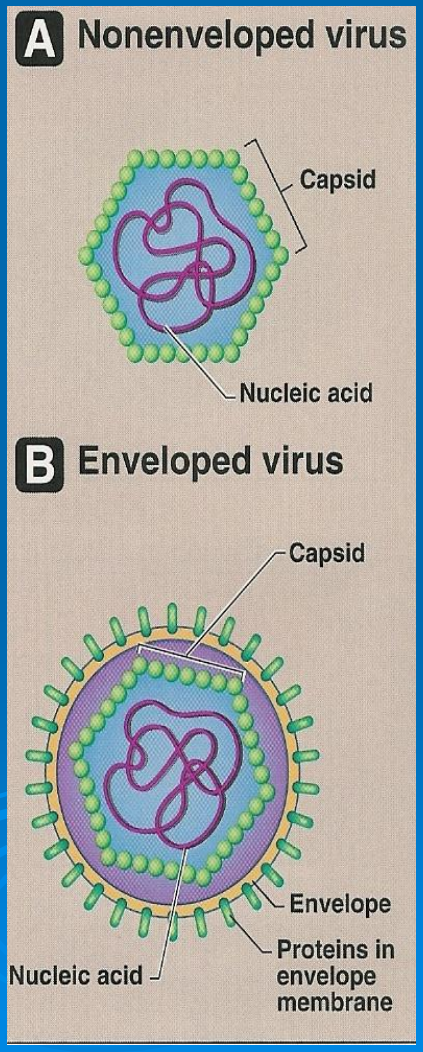
# Properties of Microorganisms

| *characteristic* | *Parasites* | *Fungi* | *Bacteria* | *Viruses* |
|---|---|---|---|---|
| *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*** |

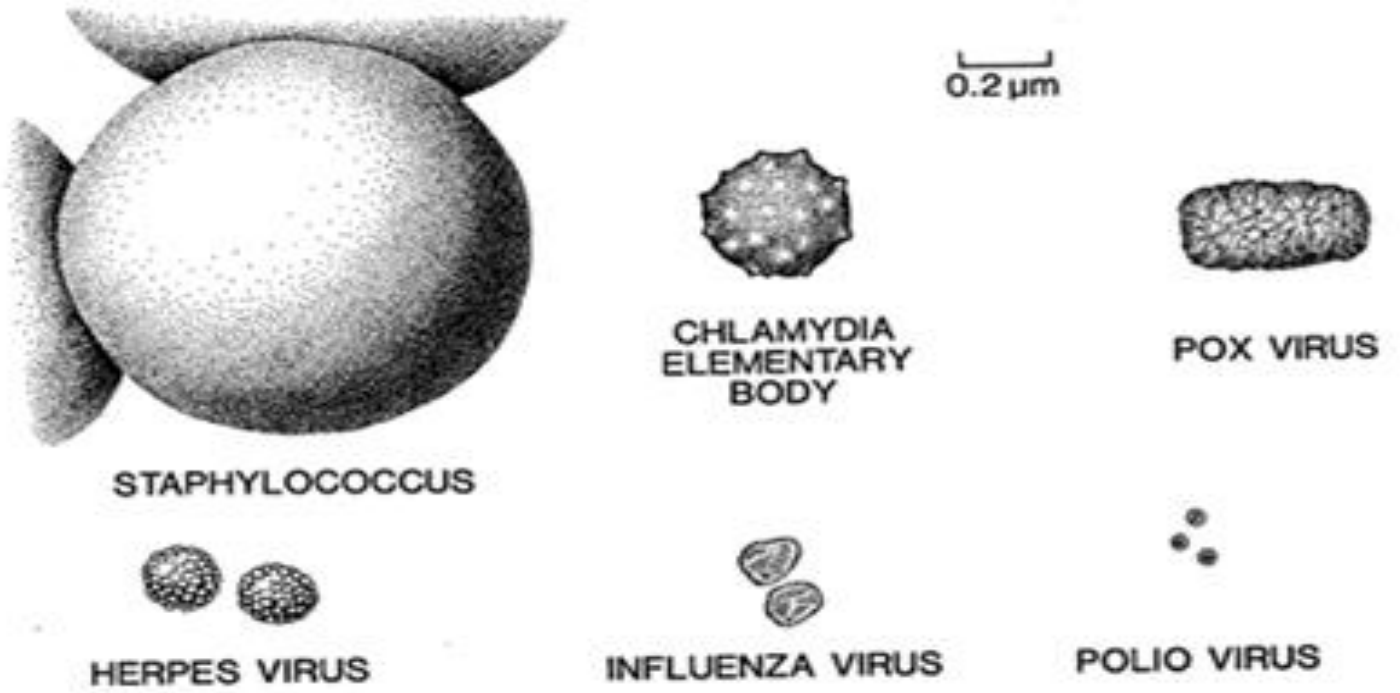
# Characteristics of viruses

- Acellular organisms
- Tiny particles
  - Internal core
  - Protein coat
  - Some Vs have lipoprotein mb
- Obligate intracellular organisms
- Replicate in a manner diff from cells

( 1V ⟶ many Vs )



# Size ; 20-300 nm

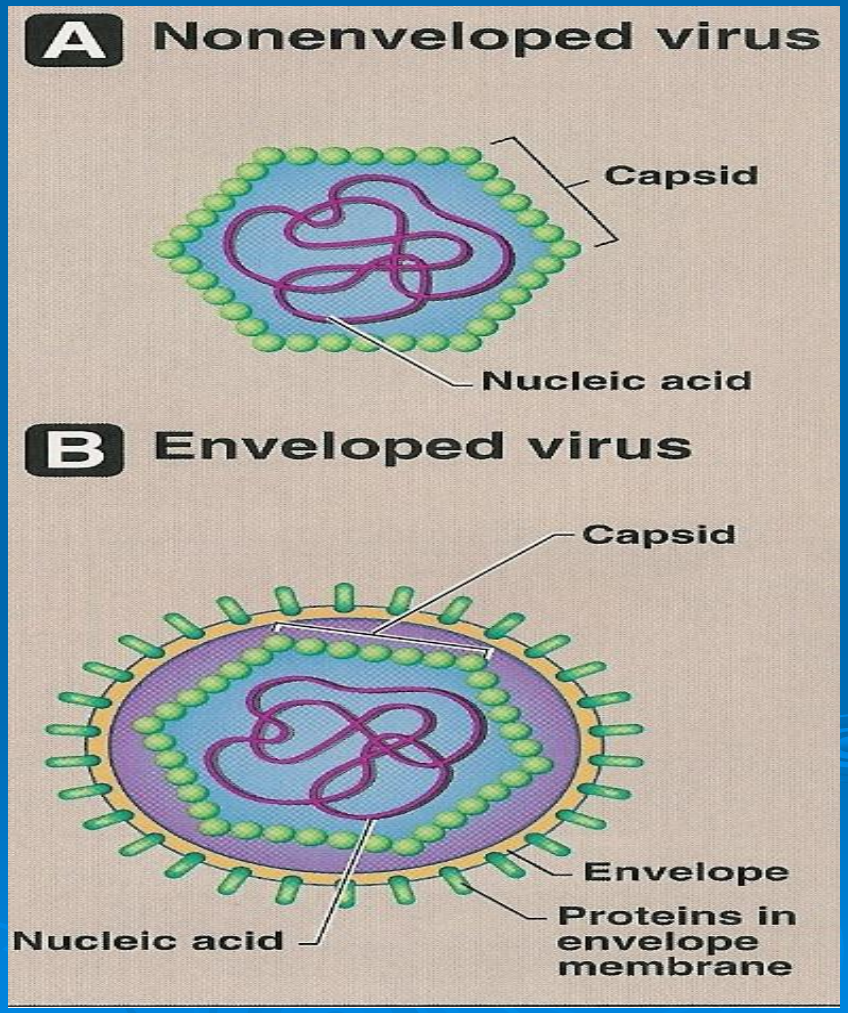


# Viral Structure

*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)

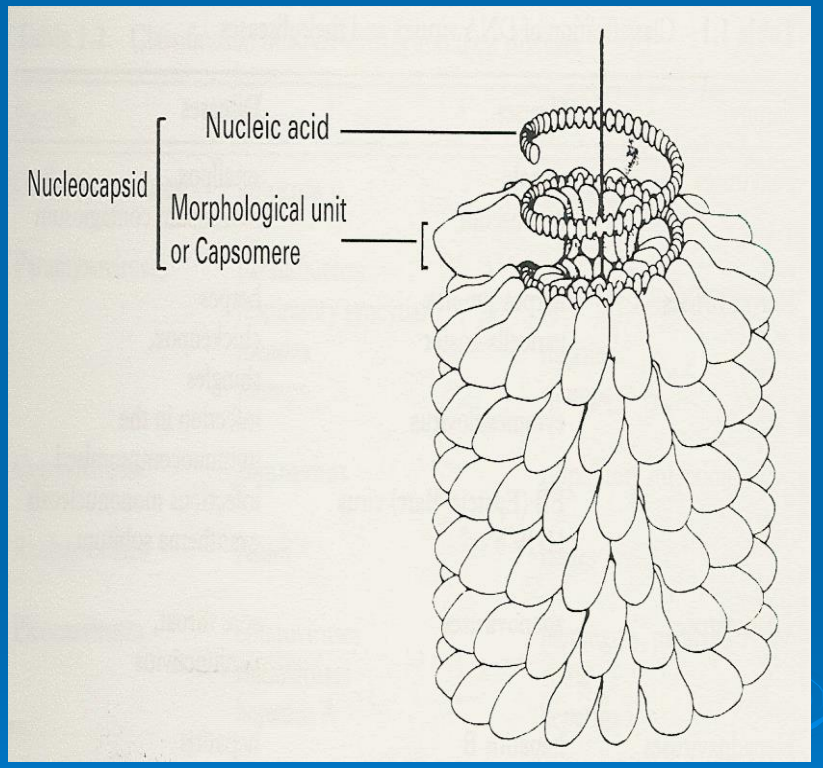
- All RNA Vs have ss except Reoviruses
- single / multiple
- (+) polarity
- (-) polarity

***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

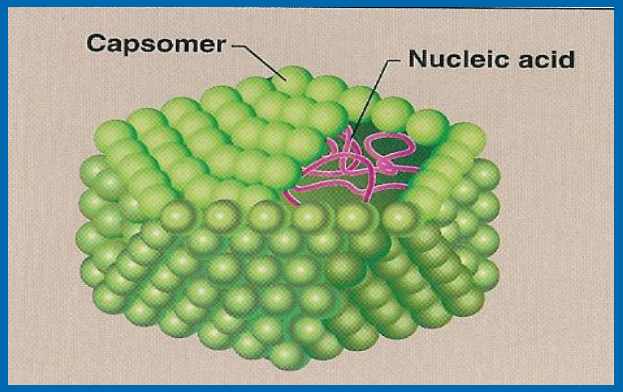
- Cubic symmetry
  ( Icosahederal )
- Helical symmetry
- Complex symmetry

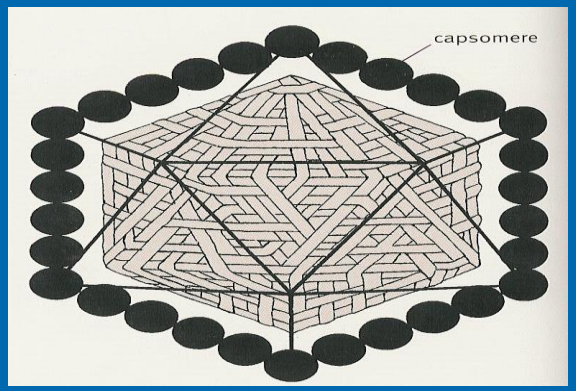
# Symmetry

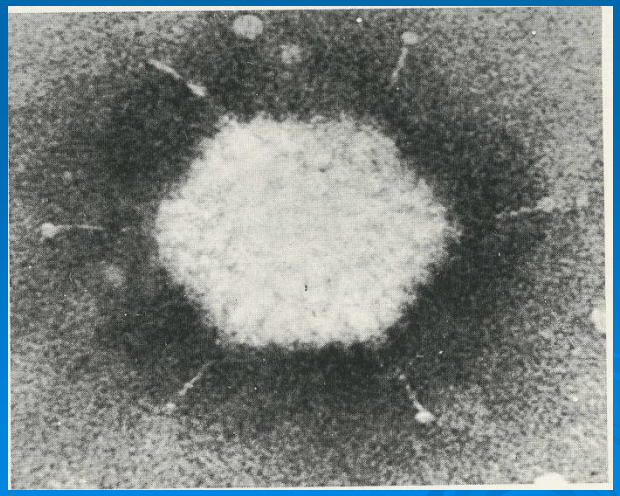
## based on arrangement of capsomeres

- **1-Cubic symmetry**

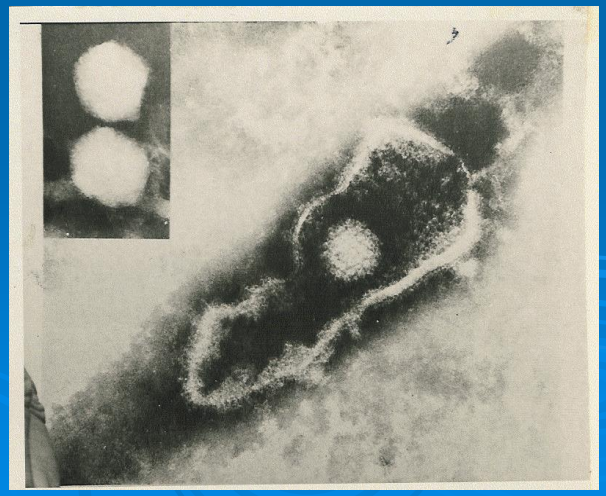
  **( Icosahedral )**



Adenovirus

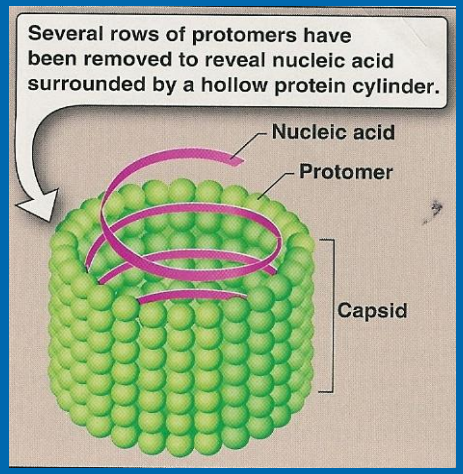


Herpesvirus

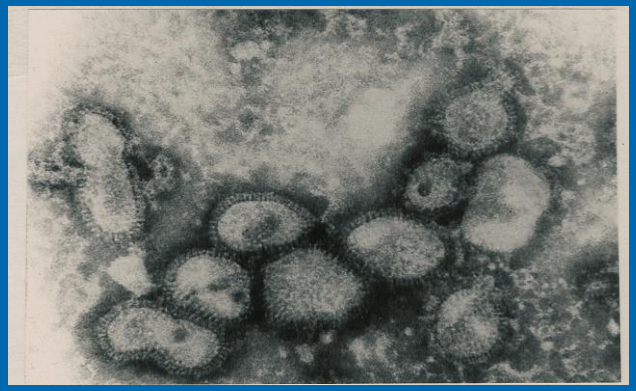
# Symmetry

## based on arrangement of capsomeres

- **2- Helical symmetry**



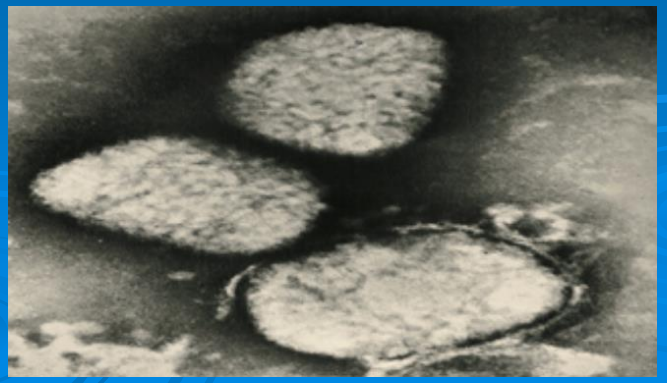

*Elongated (filoviruses)*



*Pleomorphic ( influenza v.)*

- **3- Complex symmetry**

poxviruses

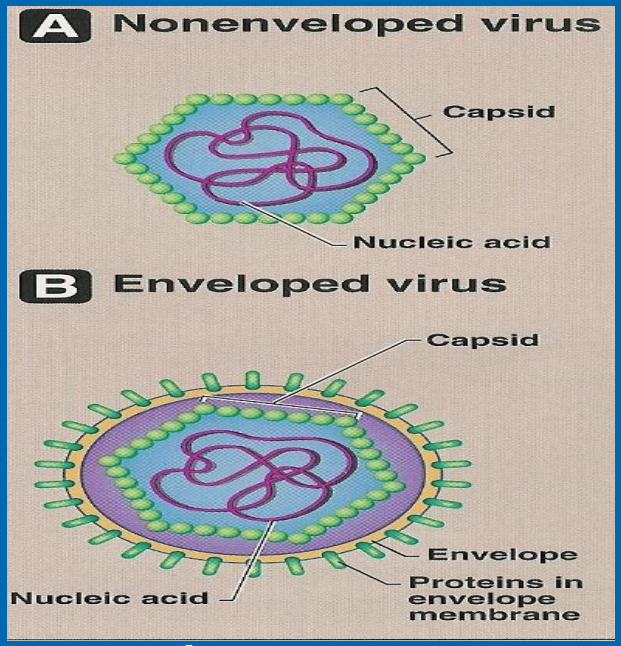


# Viral structure

## 3-Envelope

Lipoprotein mb

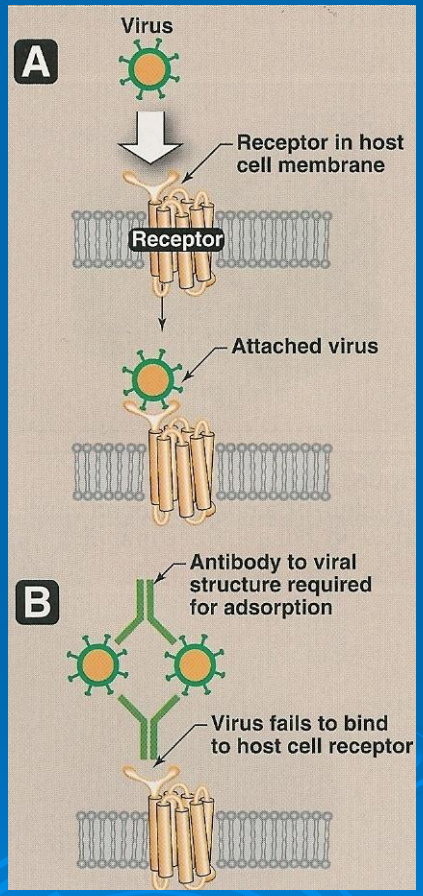
(host lipid ,virus specific protein )




- ***Budding***
- Envelope is derived from cell mb
  except herpesviruses from nuclear mb
- Enveloped Vs are more sensitive to
  heat ,dry & ether than nonenveloped Vs
- Glycoprotein attaches to host cell receptor

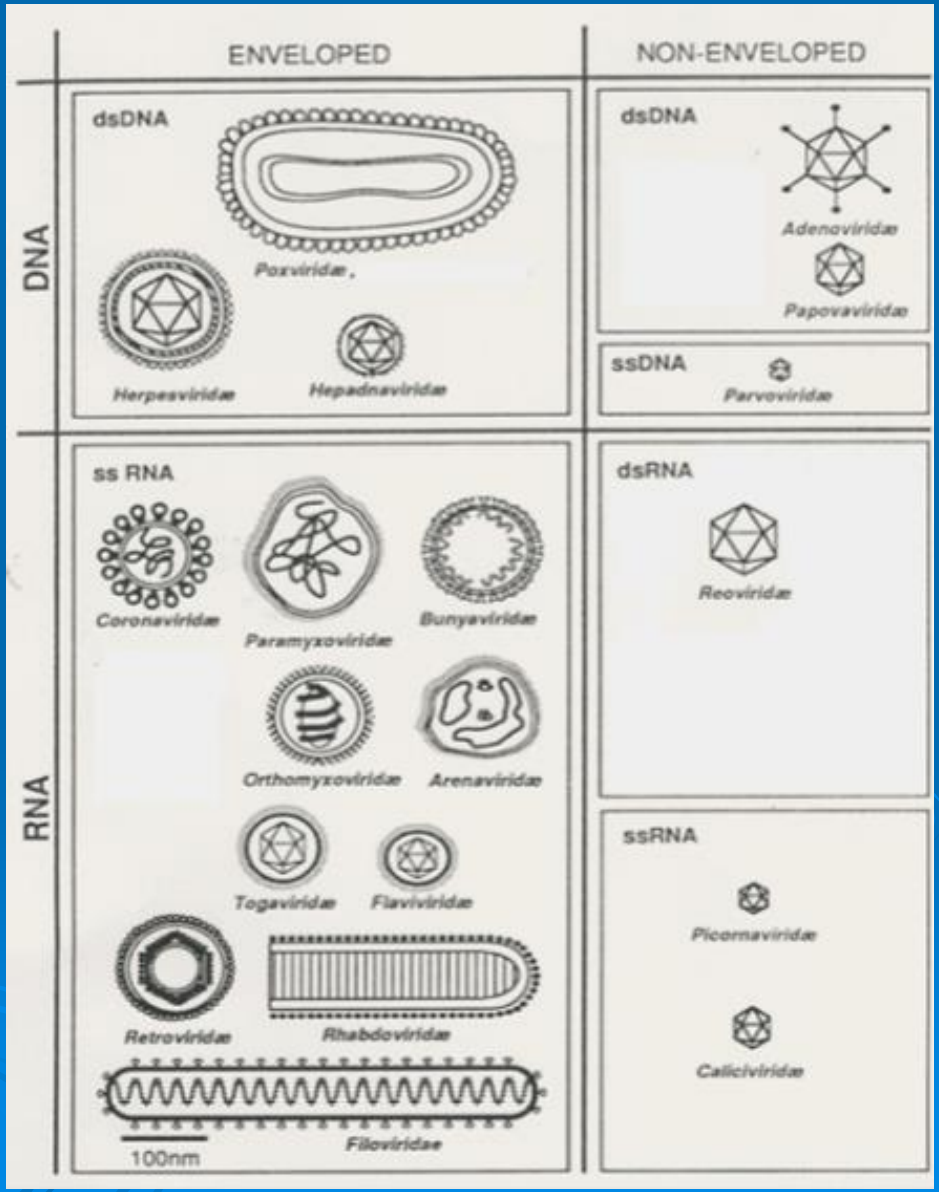
# Viral proteins

- ***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

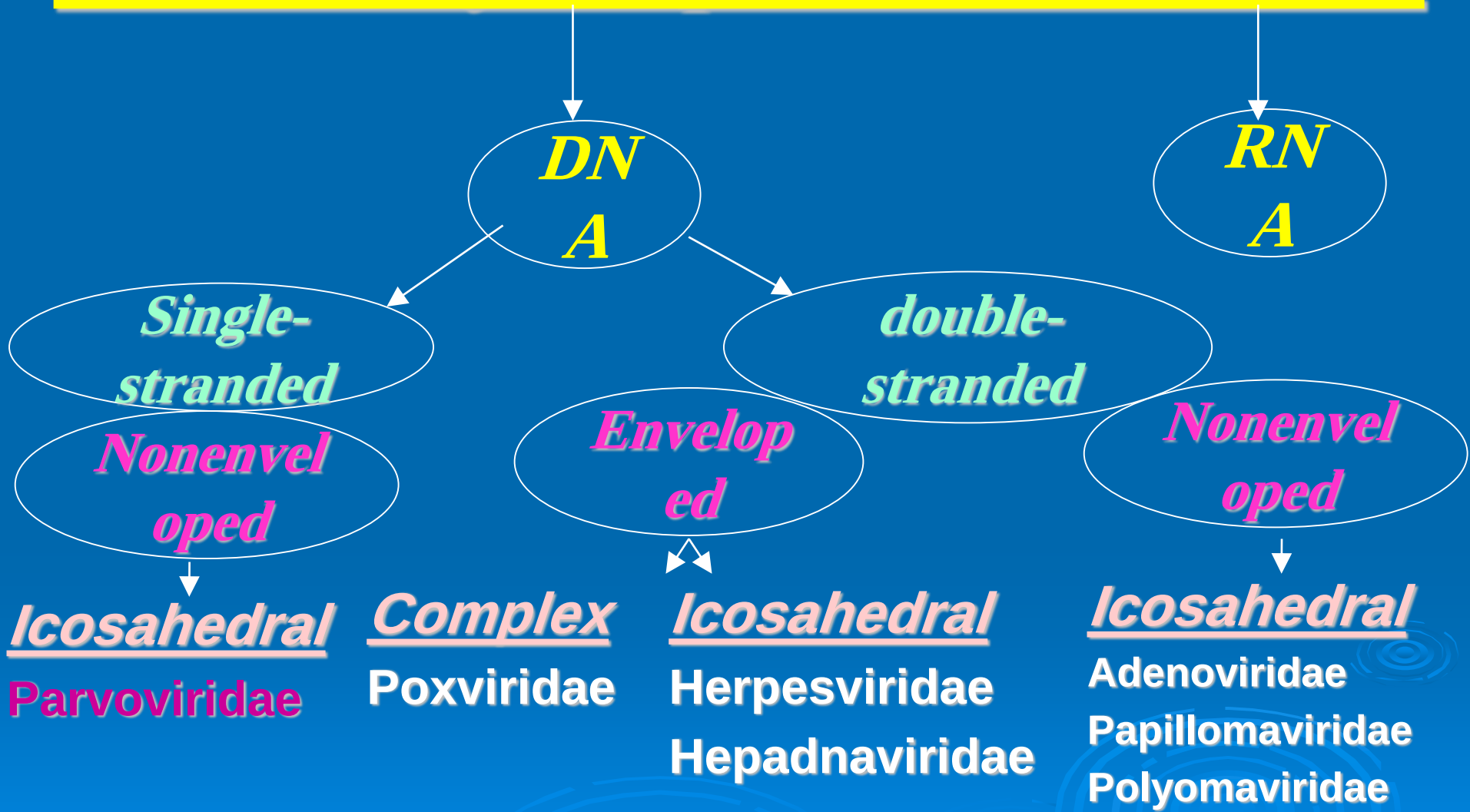


# Classification of viruses

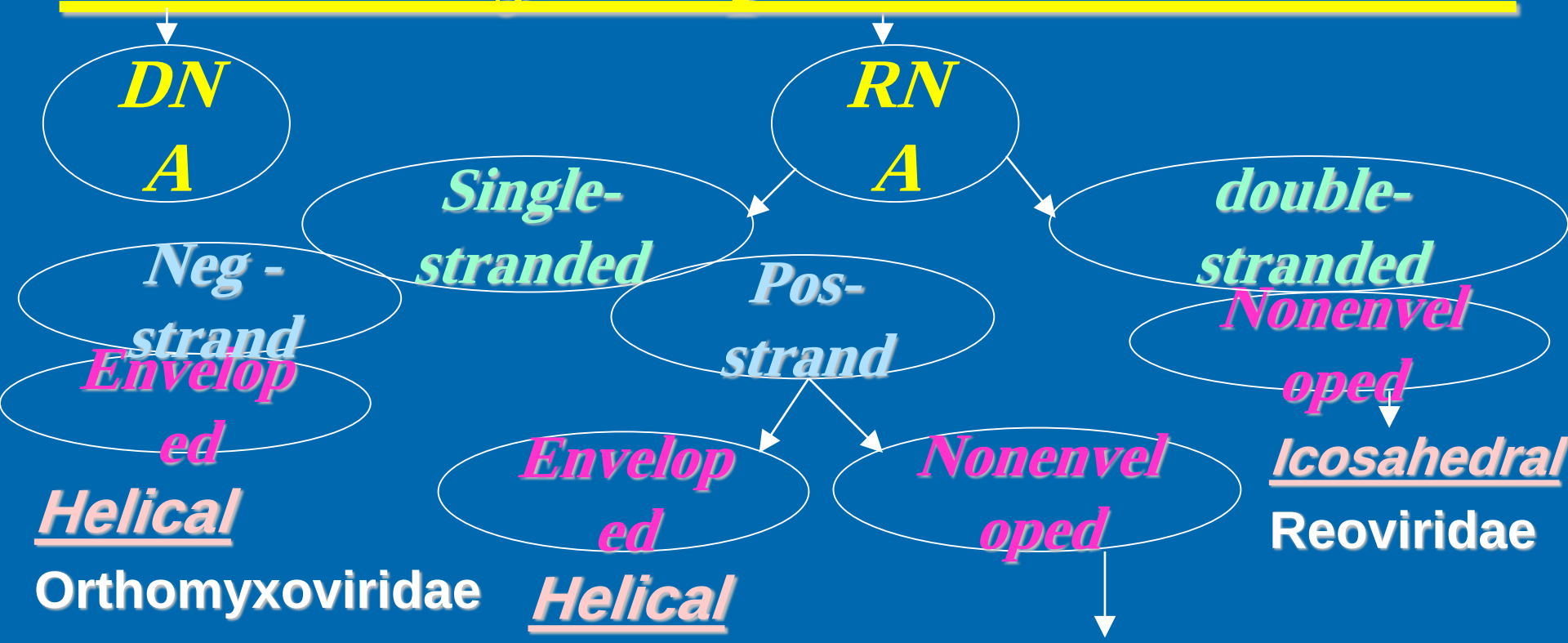
- Type of NA*
- The no. of strand
- The polarity of viral genome
- The presence or absence of envelope
- Type of symmetry



# Medically Important Viruses

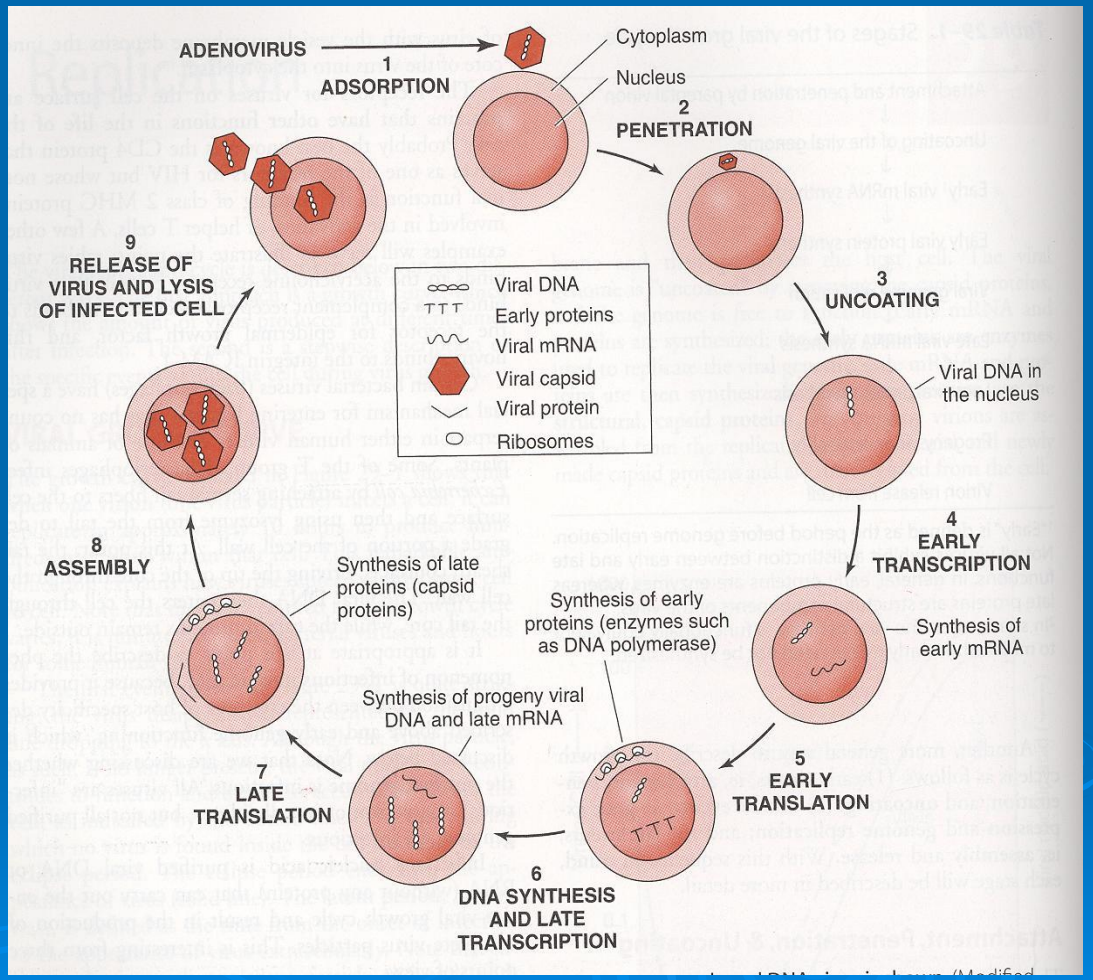


# Medically Important Viruses



# Replication

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

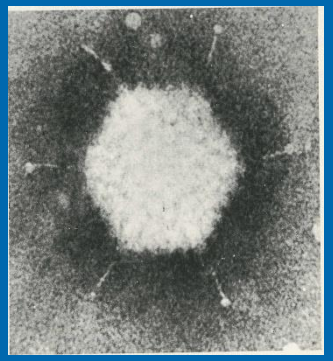


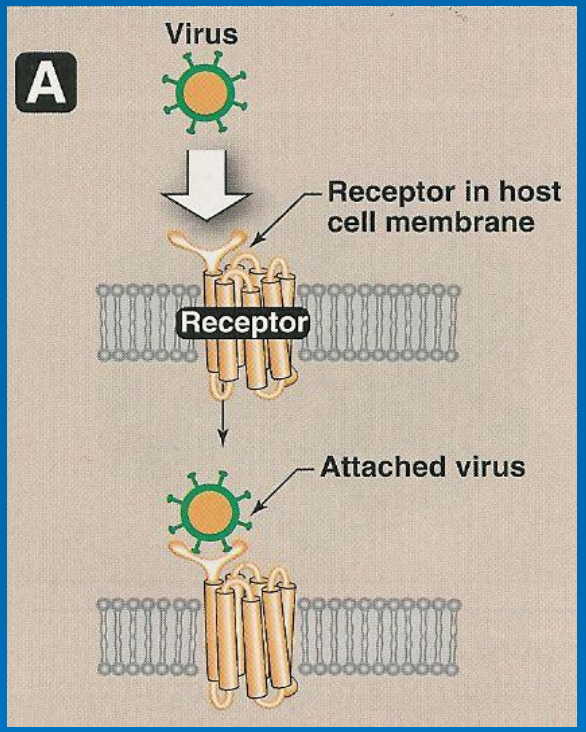

Viral growth cycle

# Adsorption

- Attachment site ;

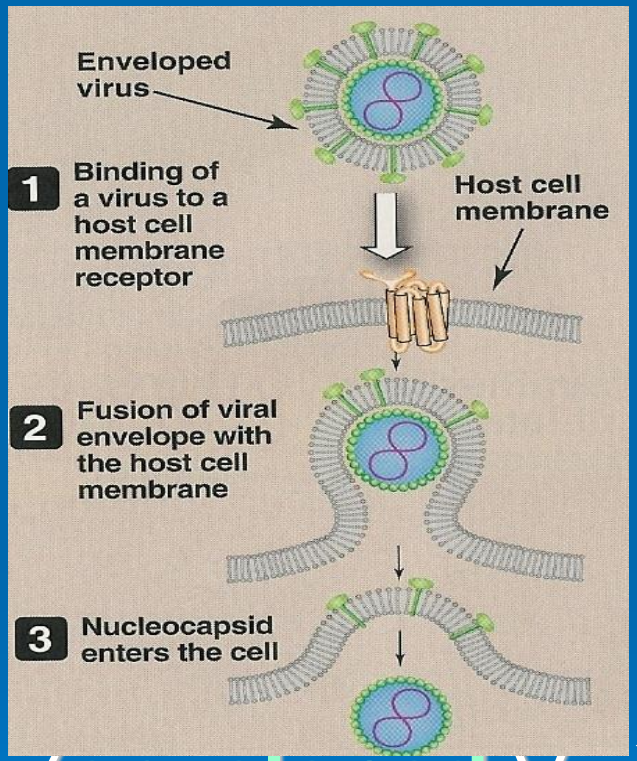
  ex- glycoprotein fiber





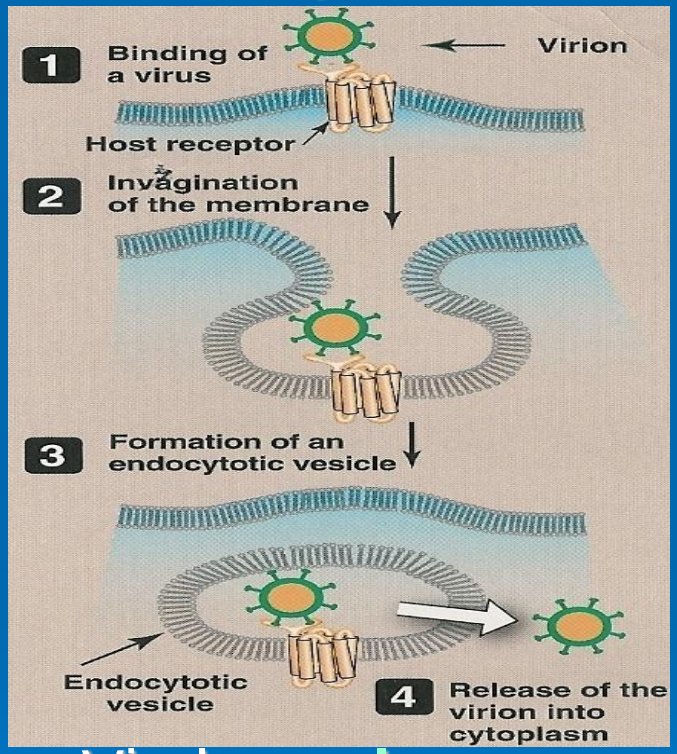
# Penetration

## 1-Fusion




(enveloped Vs )

## 2-Endocytosis




- Viral envelope fuses with endosome mb
- Nonenveloped V. lysis ,pore

# Replication

- Adsorption (Attachment)
- Penetration
- Uncoating

  Release of viral genome - cytoplasm

  - nucleus

# Synthesis of viral components

- mRNA

  Viral genome —transcription (+ssRNA acts directly)→ mRNA

- Viral proteins

  mRNA —translation (cell ribosome)→ viral proteins
  - enzymes
  - structural ps

- replication of viral genome

# Replication

- Adsorption (Attachement)
- Penetration
- Uncoating
- Synthesis of viral components
  - mRNA
  - Viral proteins
  - NA
- ***Assembly***

***NA + V. proteins = Virions***

- Release

# Release

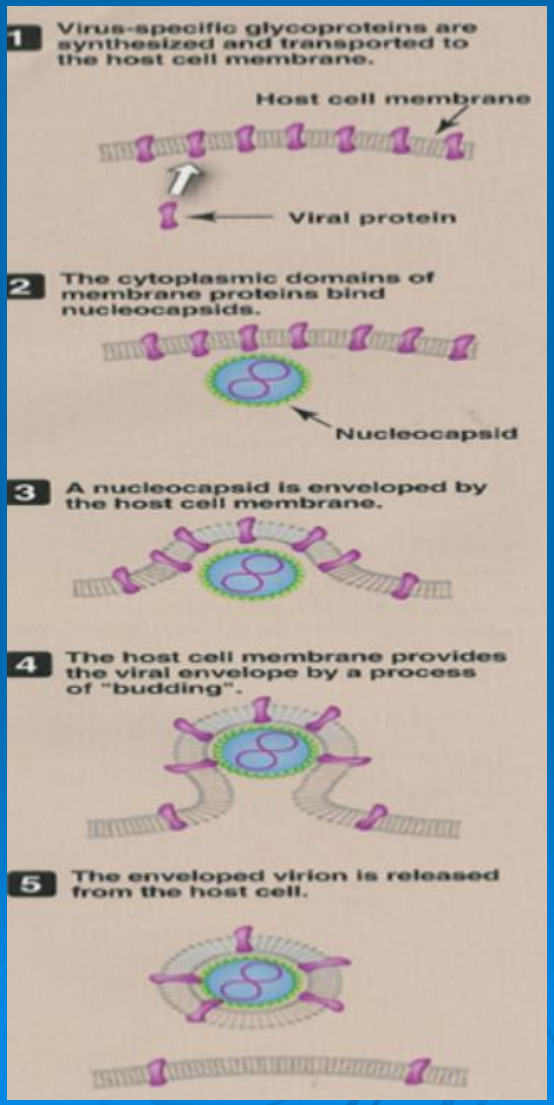
- 1-Budding

(enveloped Vs)

-cell mb*

-nuclear mb

(herpesVs)




- 2- Cell lysis or rupture (nonenveloped)

# laboratory diagnosis of viral infections

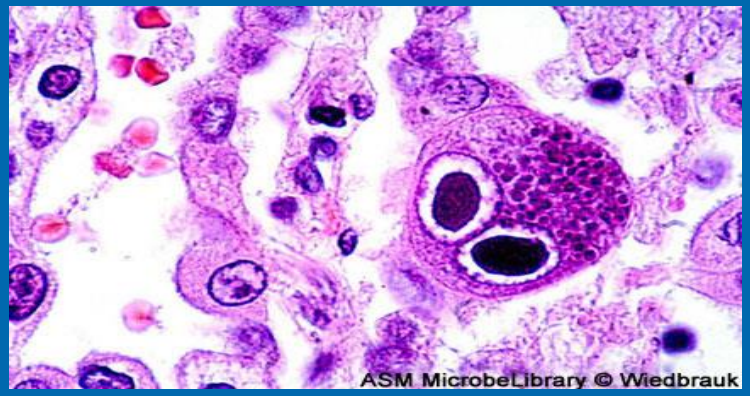
- Microscopic examination.
- Cell culture.
- Serological tests .
- Detection of viral Ag.
- Molecular method .

# Microscopic examination

- ***Light microscopy,***

  Histological appearance

  Ex. Inclusion bodies




***Owl's eye*** (CMV)

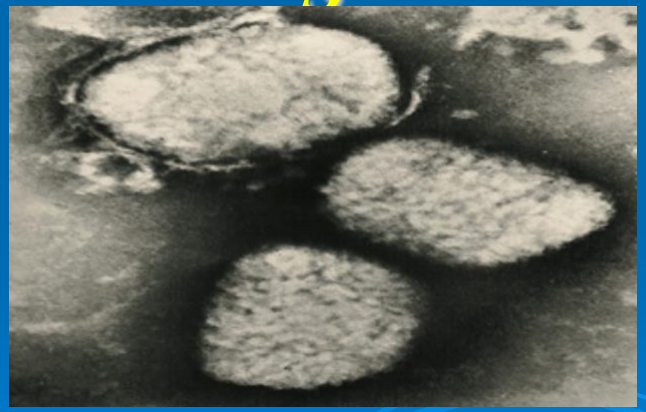
- ***Electron microscopy;***
  - Morphology& size of virions
  - Ex.

    Dx of skin lesion caused by herpesv, poxv.
  - It is replaced by Ag detection & molecular tests

- Electron micrographs

***Herpesv***

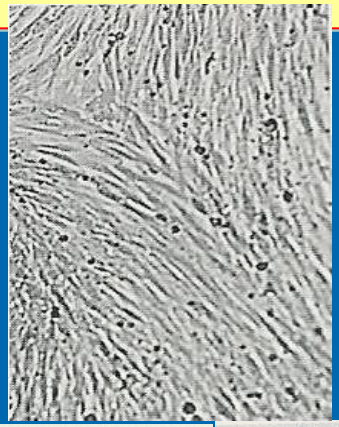
***Poxviruses***

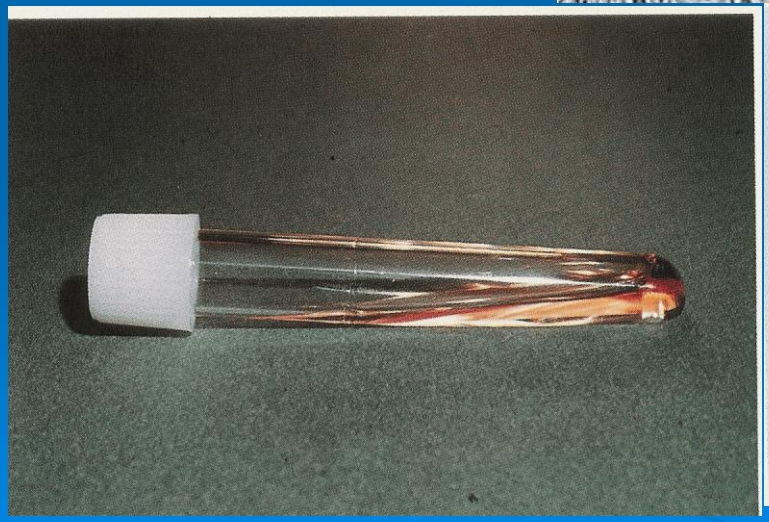


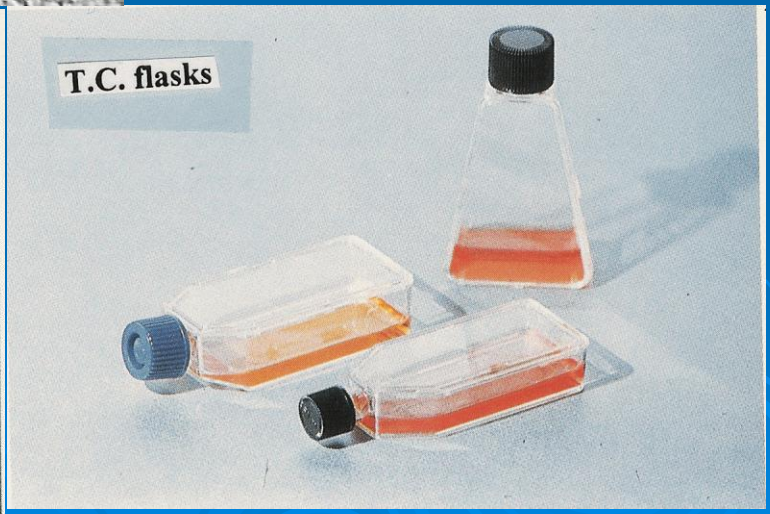
# Virus cultivation

- Laboratory animal
- Embryonated egg
- Cell culture

# Cell culture







# ***Cell culture*** C/C)

**1-Primary C/C**

**2-Diploid C/C**

**[semi continuous]**

**3-Continuous cell line**

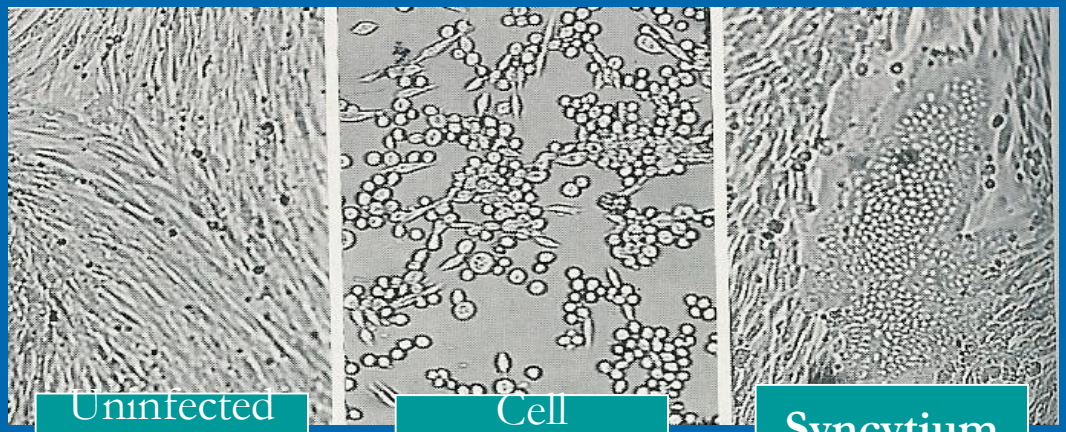
## Variation in Sensitivity of cell cultures to infection by viruses commonly isolated in clinical virology laboratories

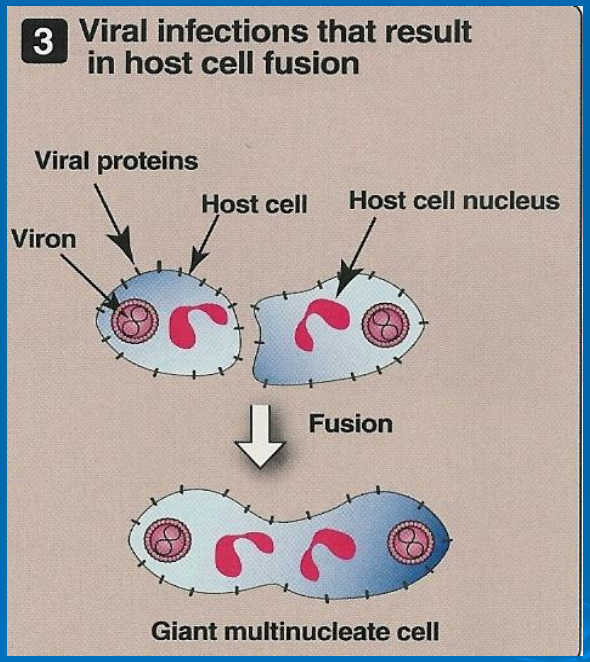
| Virus | Cell culture[a] | | |
|---|---|---|---|
| | PMK | HDF | HEp-2 |
| RNA virus | | | |
| Enterovirus | +++ | ++ | +/- |
| Rhinovirus | + | +++ | + |
| Influenza virus | +++ | + | - |
| RSV | ++ | + | +++ |
| DNA virus | | | |
| Adenovirus | + | ++ | +++ |
| HSV | + | ++ | ++ |
| VZV | + | +++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

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

# Detection of viral growth

- Cytopathic effects



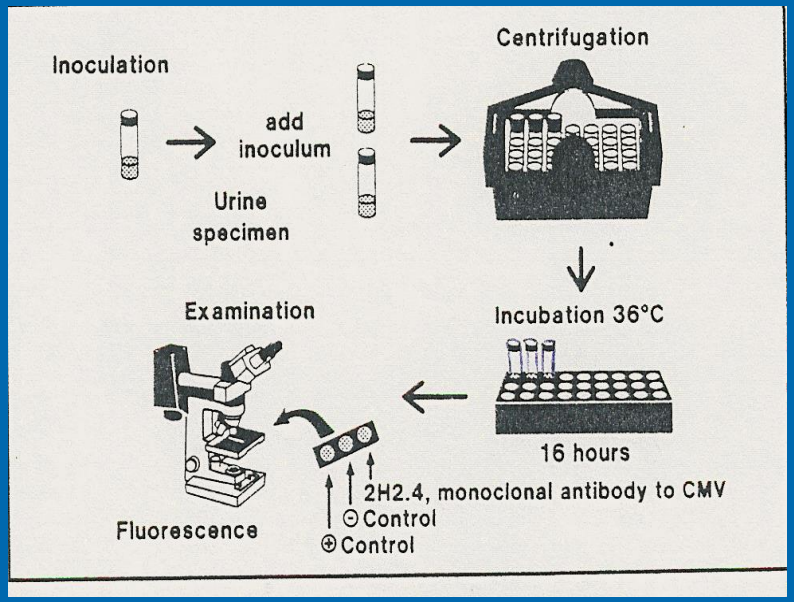

- Others

# ***Problems with cell culture*** ;

- Long incubation
- Sensitivity is variable
- Susceptible to bacterial contamination
- Some Vs do not grow in c/c ex. HCV

# Rapid culture technique

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



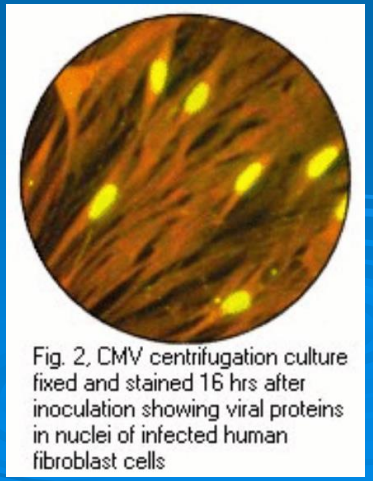



Fig. 2, CMV centrifugation culture fixed and stained 16 hrs after inoculation showing viral proteins in nuclei of infected human fibroblast cells

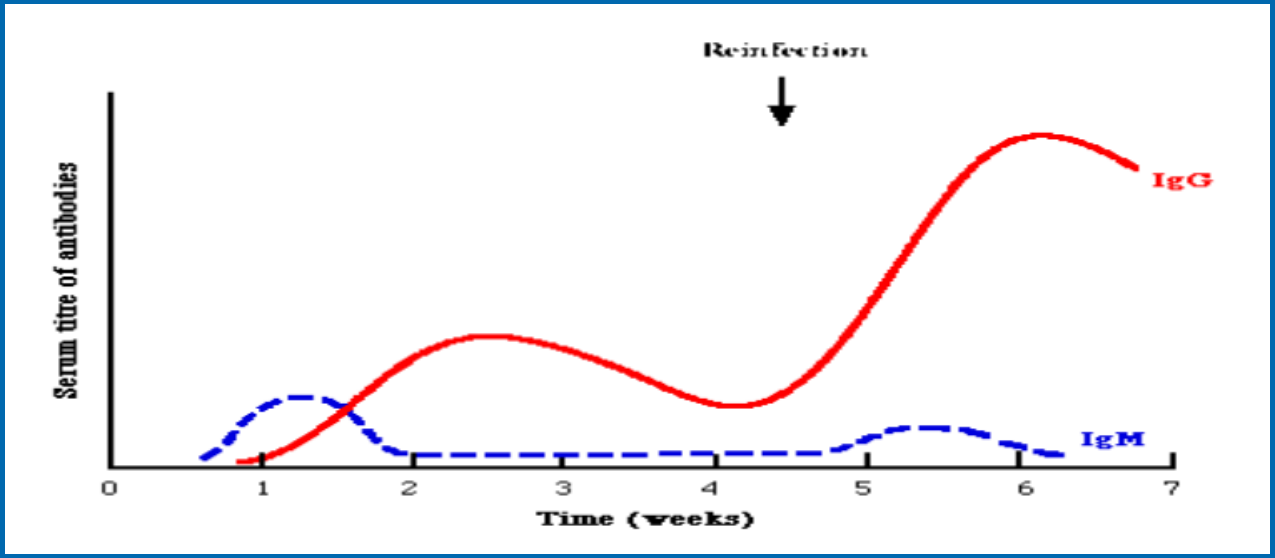
# Serological test;

# Antigen detection;

| sample | virus | test |
| --- | --- | --- |
| Skin scrapings | HSV | IF |
| Blood | HBV(HBsAg) | ELISA |

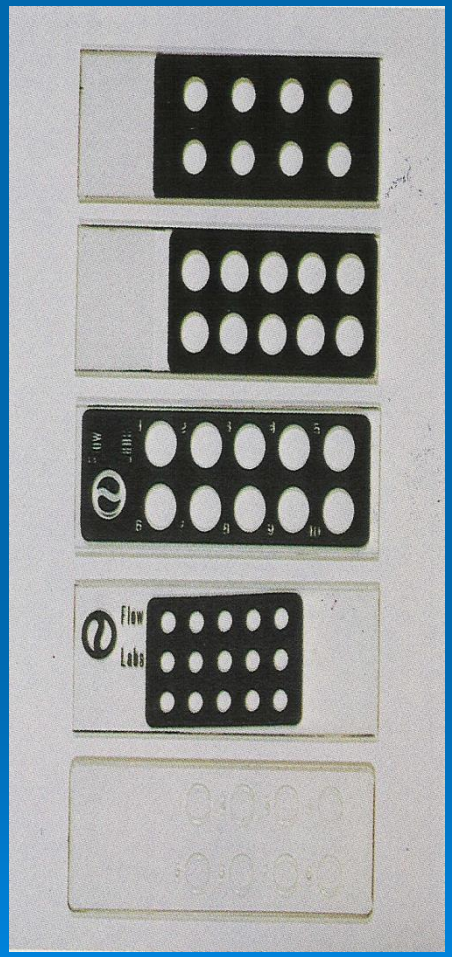
# Serological test;

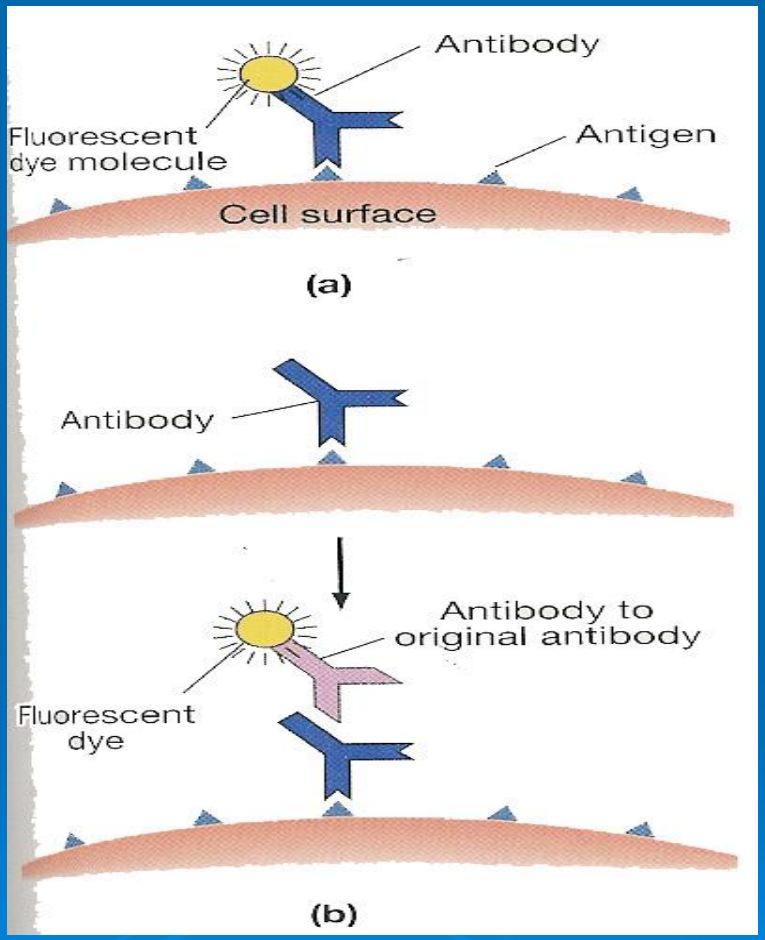
## Antibody detection;



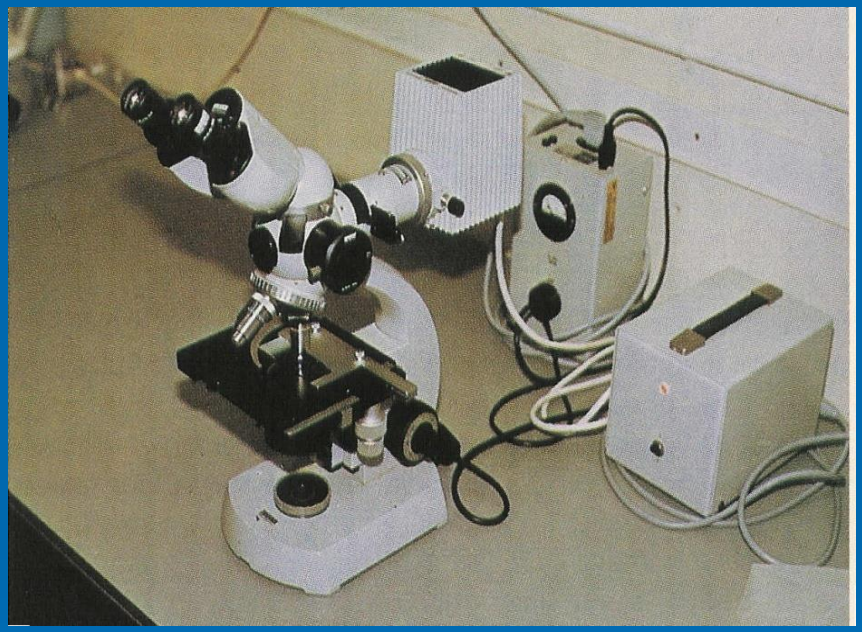

- Ex of techniques
  - Immunofluorescence (IF)
  - Enzyme- linked immunosorbent assay (ELISA)

# Immunofluorescence ; IF






- A- Direct
  Ag detection;
  - Sample (Ag)
- B- Indirect
  Ab detection;
  - Sample (Ab)



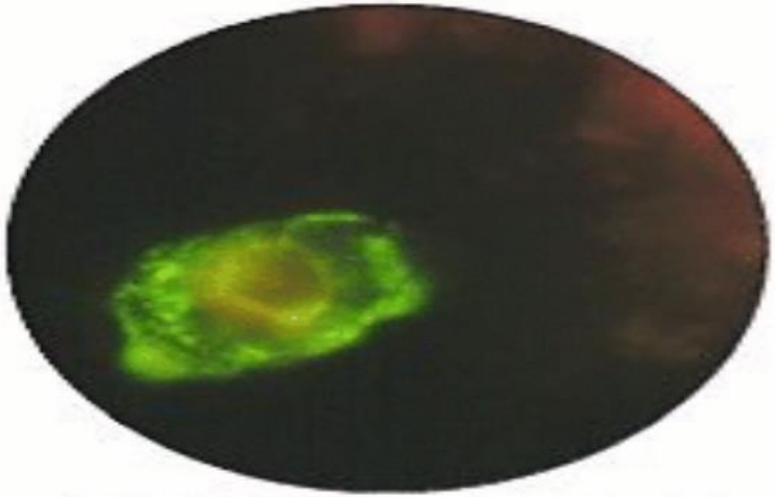
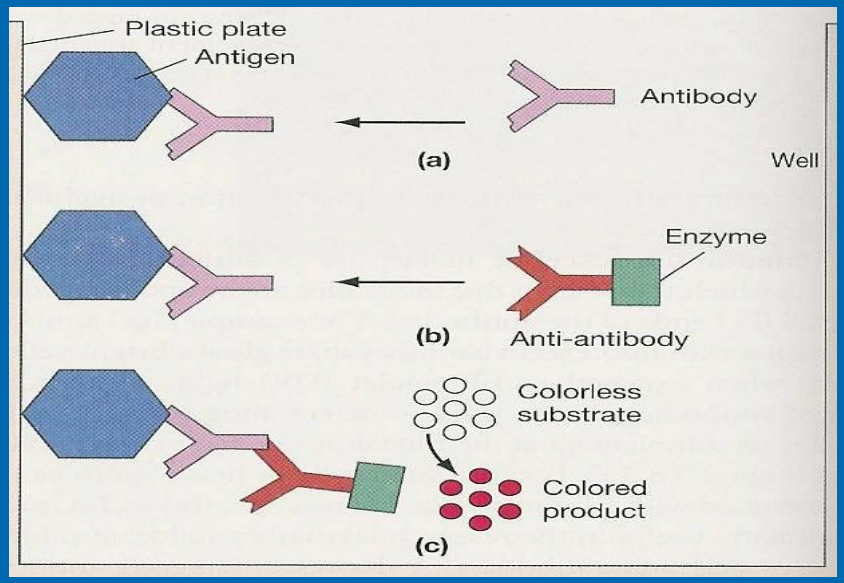


Fig. 3, HSV-infected epithelial cell from skin lesion (DFA)

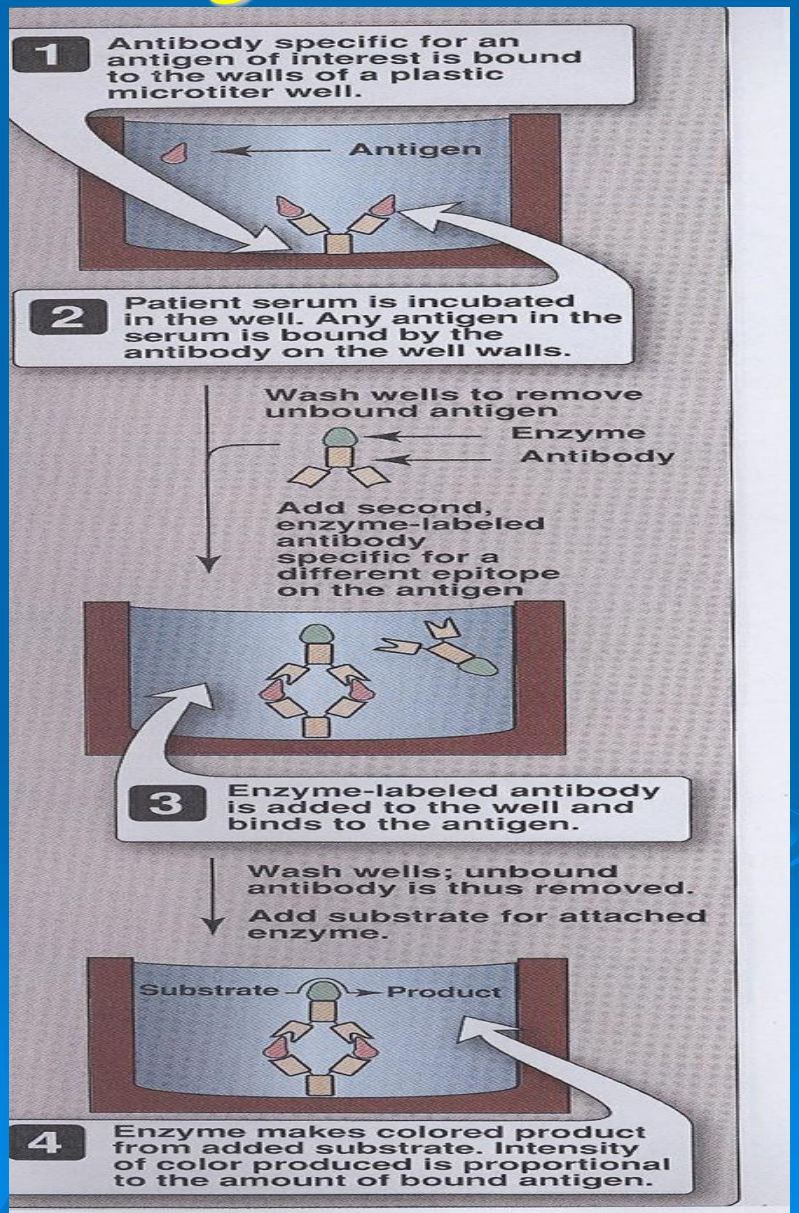
# ELISA

## Ab detection




Indirect ELISA for Ab detection ; coloured wells indicate reactivity

## Ag detection

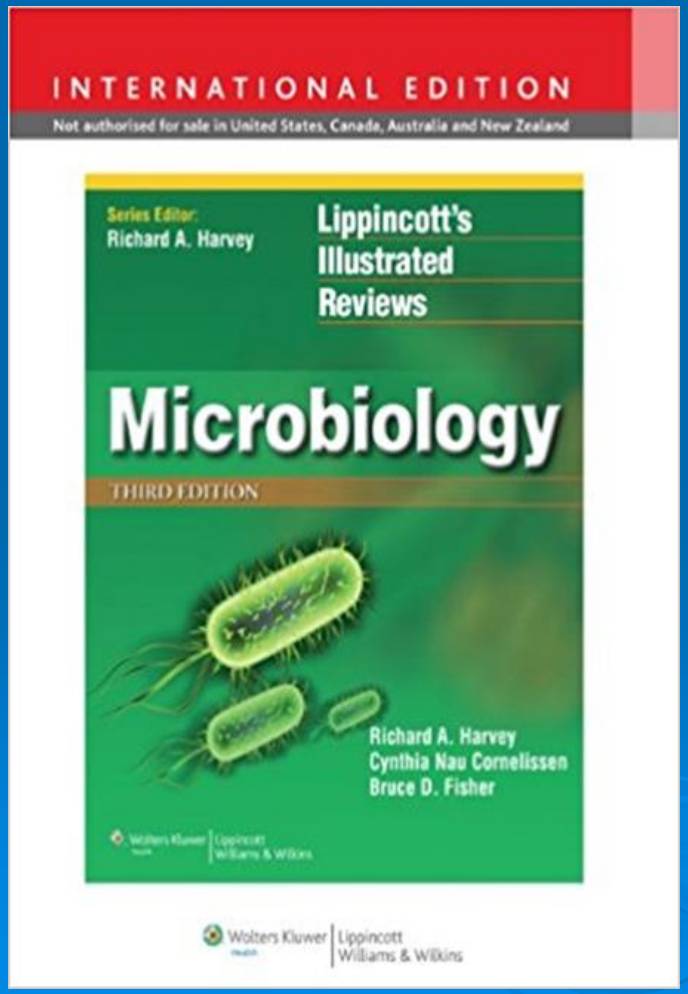


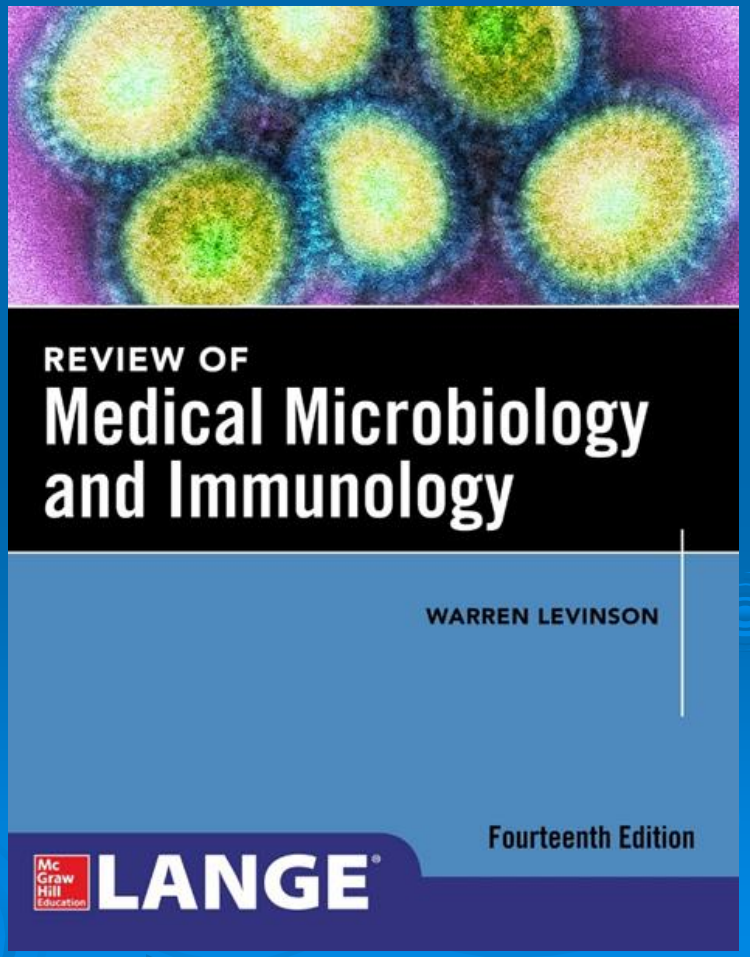
# ***Molecular test;***

- Polymerase chain reaction (PCR)
  - Amplification tech.
  - Viral genome
- Uses;
  - Dx
  - Monitoring response to Rx


الطريق الى الجنة
من سلك طريقا يلتمس فيه علما
سهل الله له به طريقا إلى الجنة
رواه مسلم

# Reference books




Thank you