

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

# Introduction to medical virology

*( Foundation Block ,\_Microbiology : 2016)*

By: Dr.Malak El-Hazmi

# *OBJECTIVES*

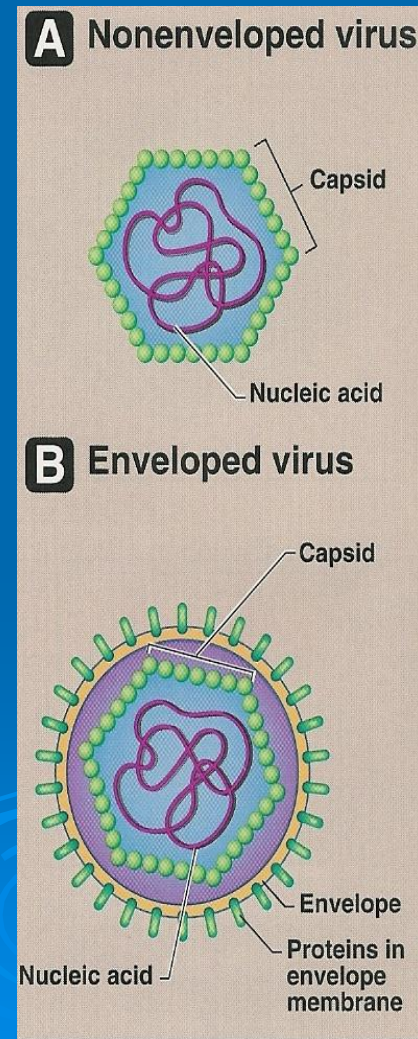
- *Distinguish the viruses from other microorganisms*
- *General characteristics of viruses.*
- *Structure & symmetry of viruses.*
- *Classification of viruses.*
- *Steps of virus replication .*
- *laboratory diagnosis of viral infections.*

# Properties of Microorganisms

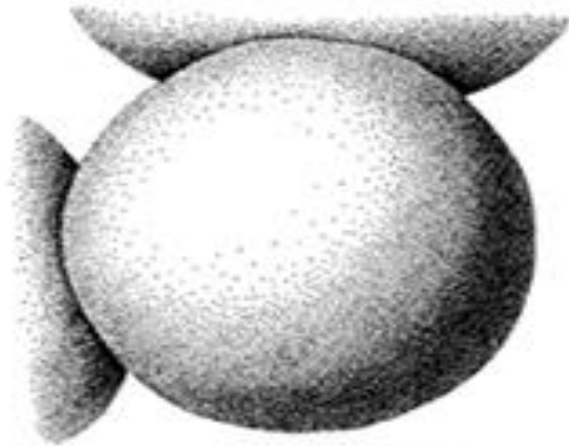
<i>characteristic</i>	<i>Parasites</i>	<i>Fungi</i>	<i>Bacteria</i>	<i>Viruses</i>
<i>Cell</i>	Yes	Yes	Yes	No
<i>Type of nucleus</i>	Eukaryotic	Eukaryotic	Prokaryotic	-----
<i>Nucleic acid</i>	Both DNA & RNA	Both DNA & RNA	Both DNA & RNA	DNA or RNA
<i>Ribosomes</i>	Present	Present	Present	Absent
<i>Mitochondria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

# 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



STAPHYLOCOCCUS



HERPES VIRUS



CHLAMYDIA  
ELEMENTARY  
BODY



INFLUENZA VIRUS

0.2  $\mu\text{m}$



POX VIRUS



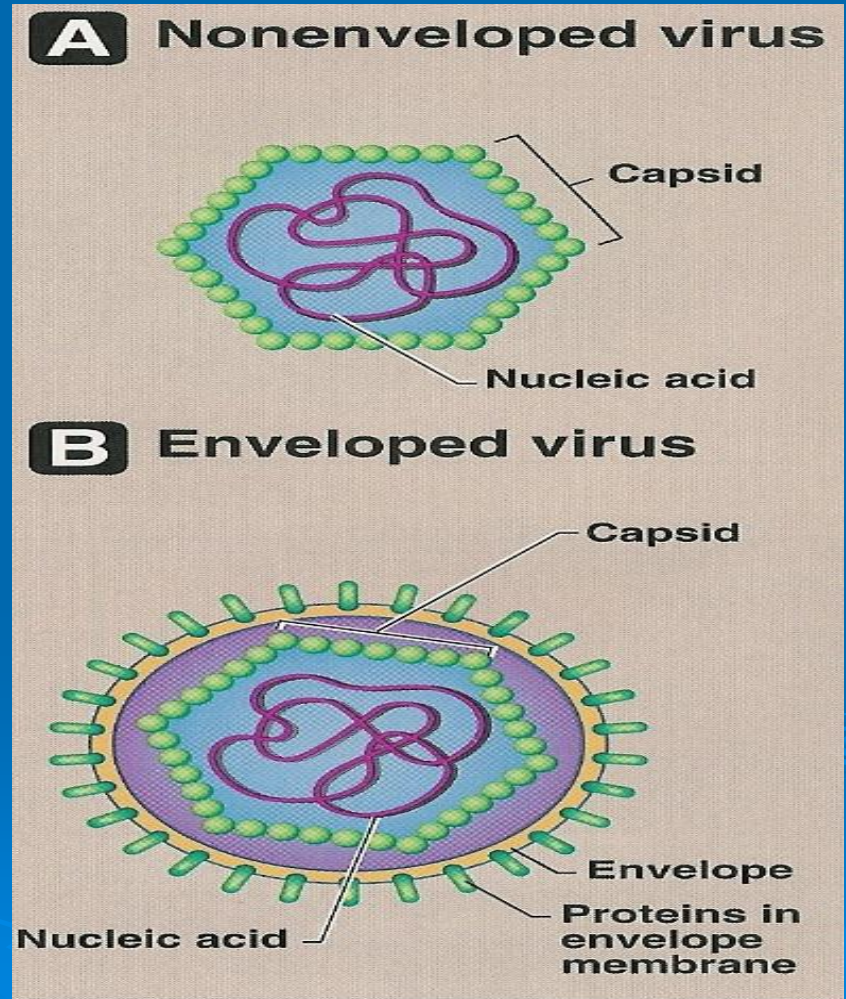
POLIO VIRUS

# 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)

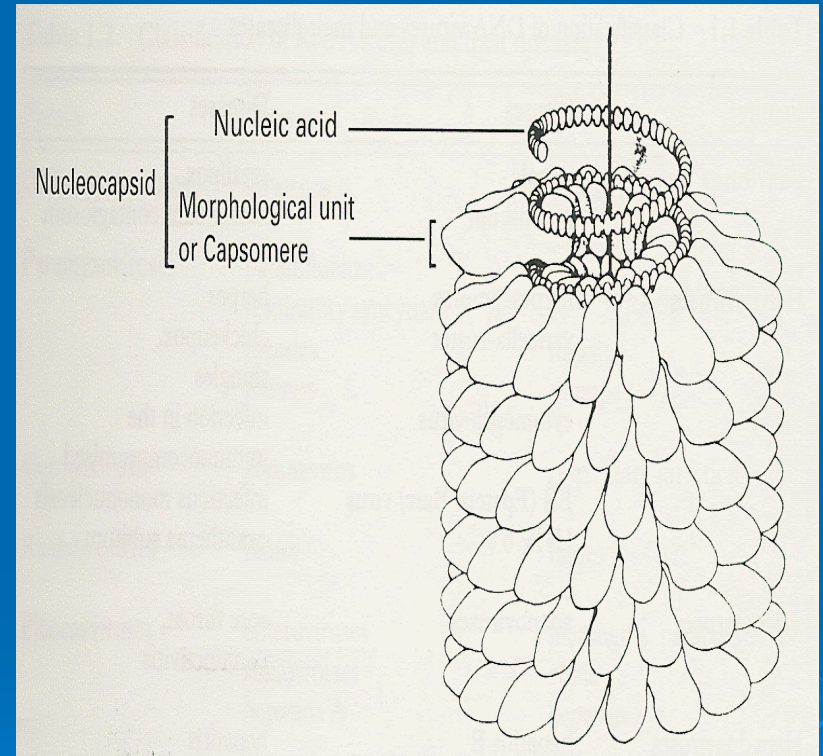
- All RNA Vs have ss except Reoviruses
- single / multiple
- (+) polarity
- (-) polarity

*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*

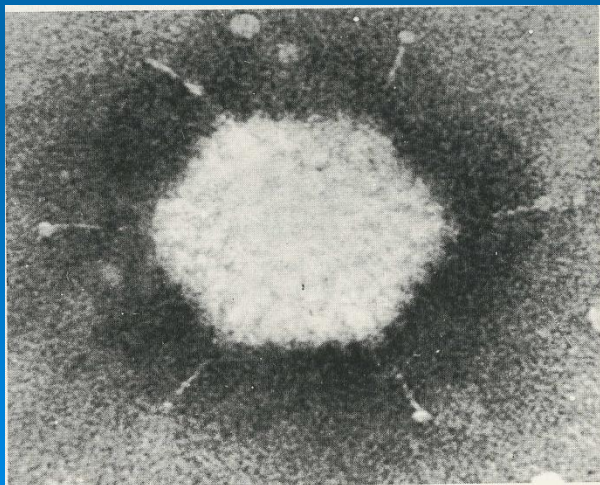
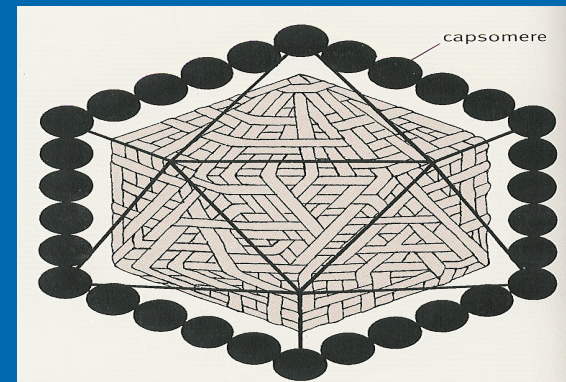
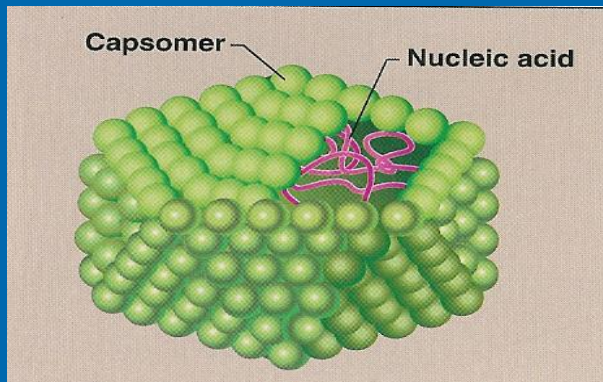
*based on arrangement of capsomeres*

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

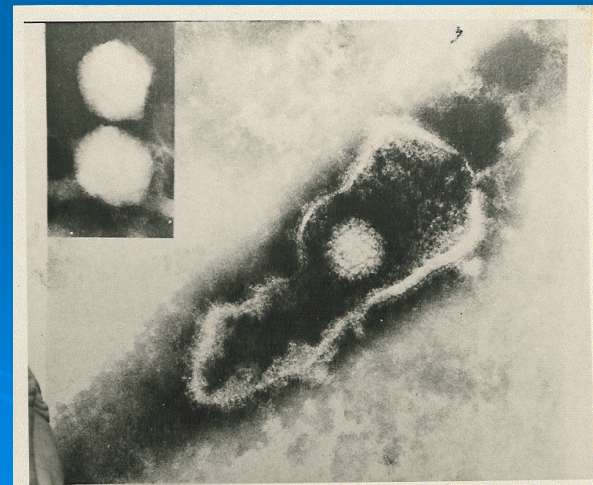
# Symmetry

based on arrangement of capsomeres

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



Adenovirus

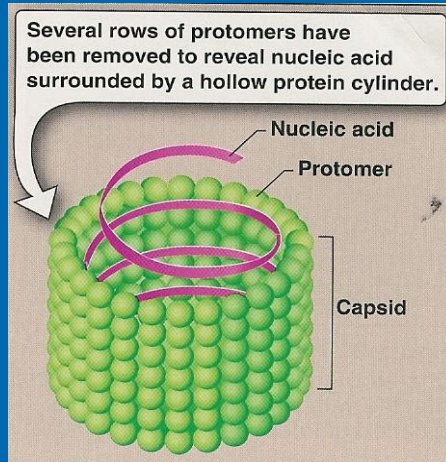


Herpesvirus

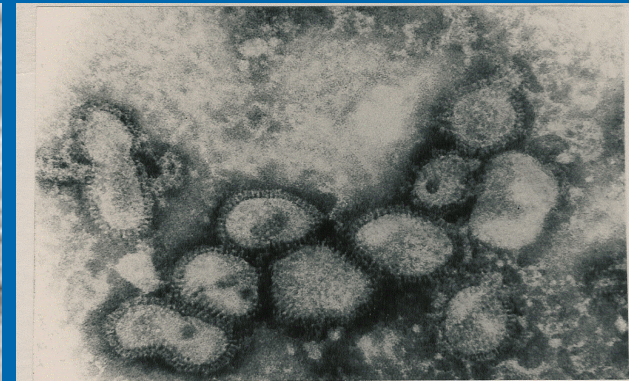
# Symmetry

based on arrangement of capsomeres

## ➤ 2- Helical symmetry



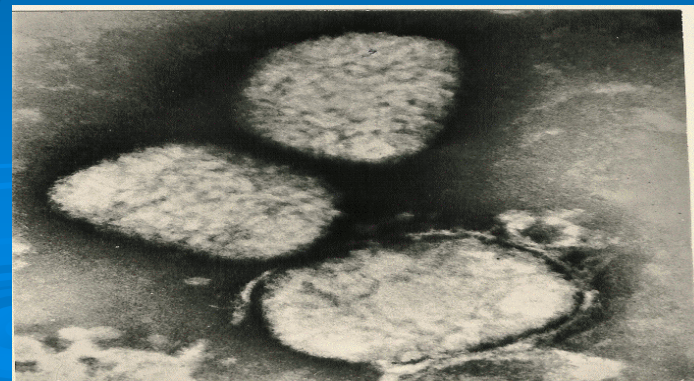
*Elongated  
(filoviruses)*



*Pleomorphic  
(influenza v.)*

## ➤ 3- Complex symmetry

poxviruses



# Viral structure

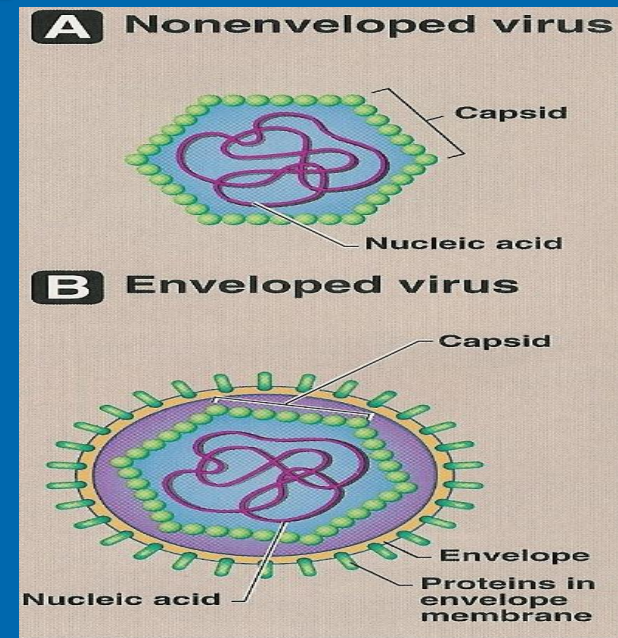
## *3-Envelope*

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



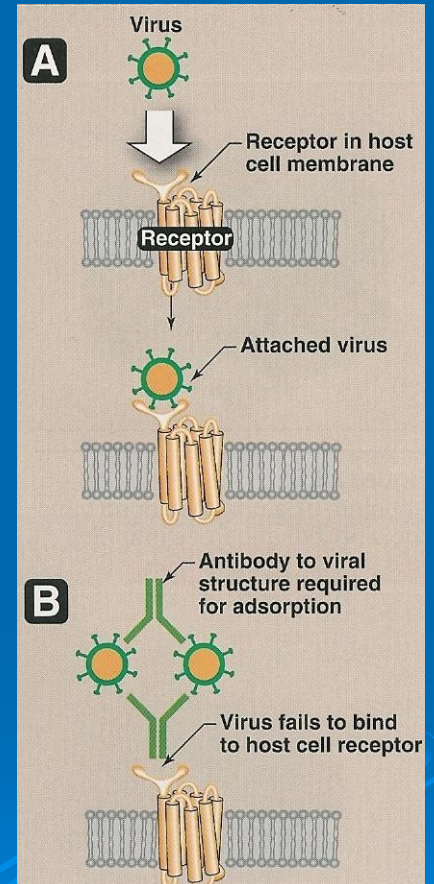
# Viral proteins

## ❖ *The outer viral ps*

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

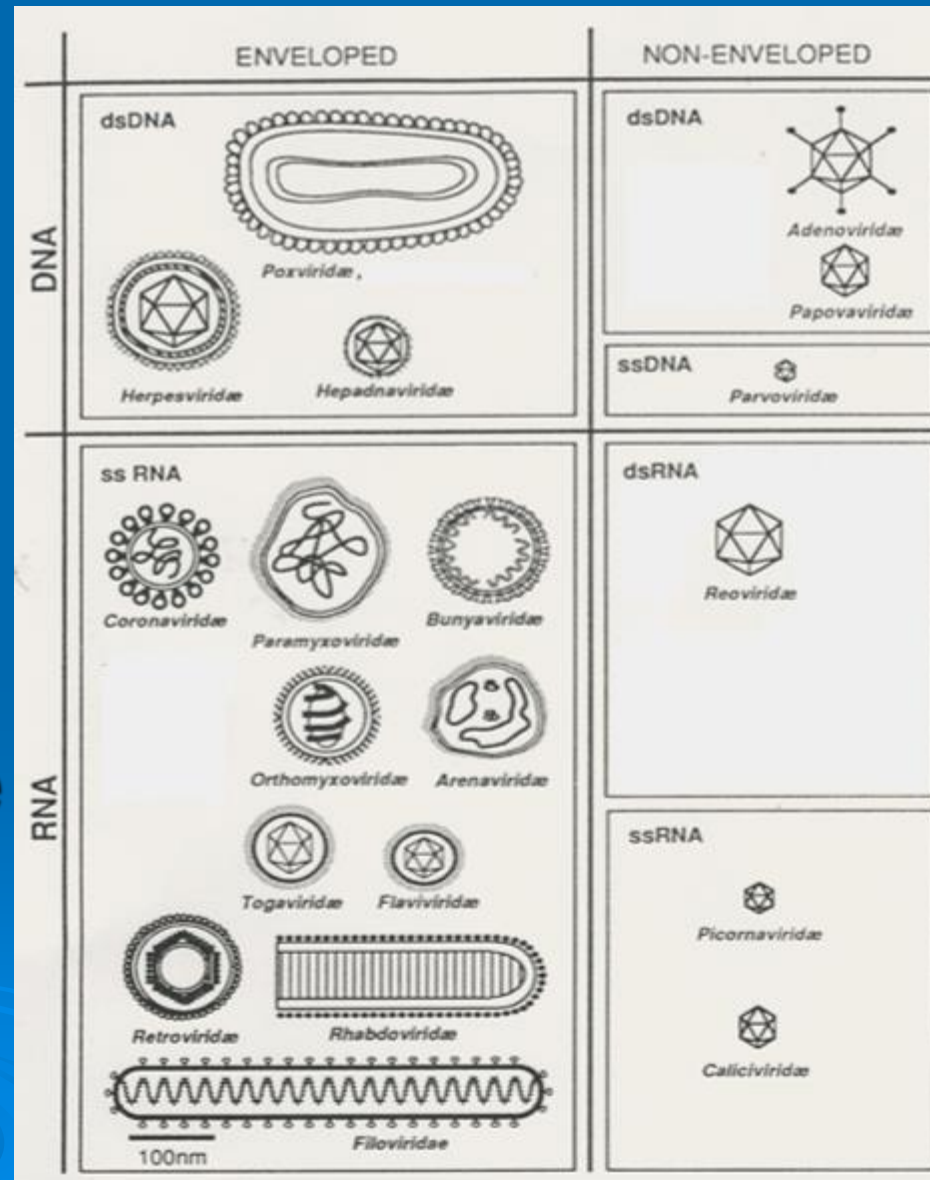
## ❖ *The internal viral ps*

- 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

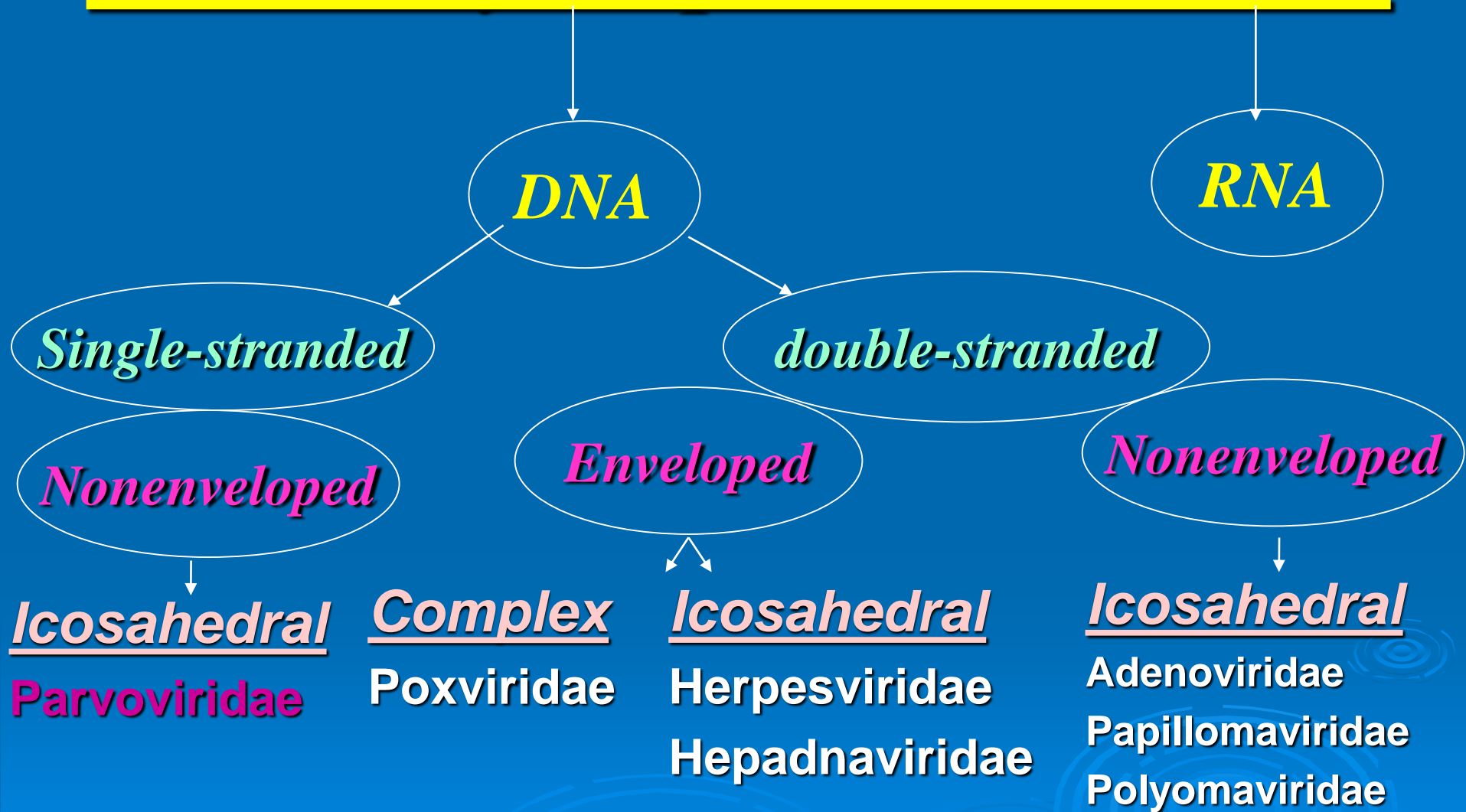


# Classification of viruses

- 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

**DNA**

**RNA**

**Single-stranded**

**double-stranded**

**Neg - strand**

**Pos - strand**

**Nonenveloped**

**Enveloped**

**Enveloped**

**Nonenveloped**

**Icosahedral**  
Reoviridae

**Helical**

Orthomyxoviridae

Paramyxoviridae

Rhabdoviridae

Filoviridae

Bunyaviridae

Arenaviridae

**Helical**

Coronaviridae

**Icosahedral**

Togaviridae

Flaviviridae

Retroviridae

**Icosahedral**

Picornaviridae

Hepeviridae

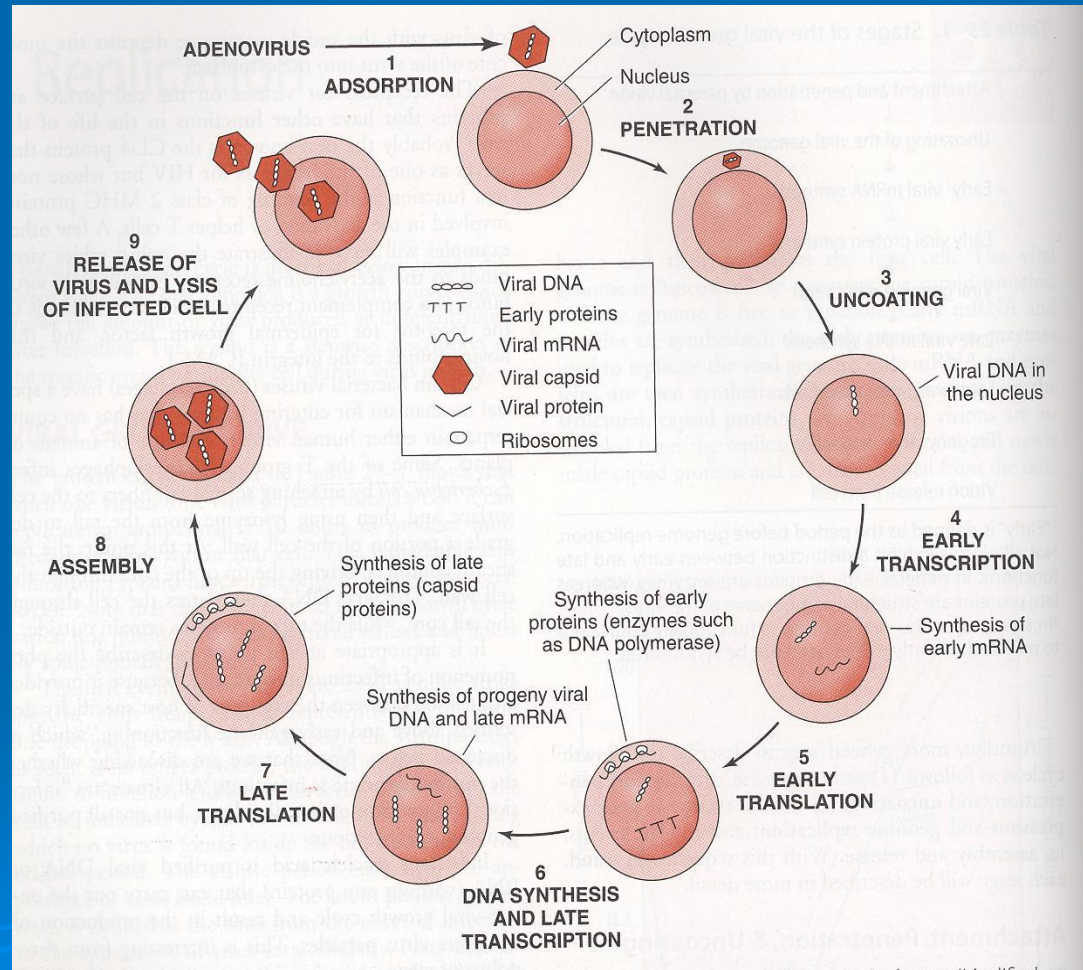
Caliciviridae

Astroviridae



# Replication

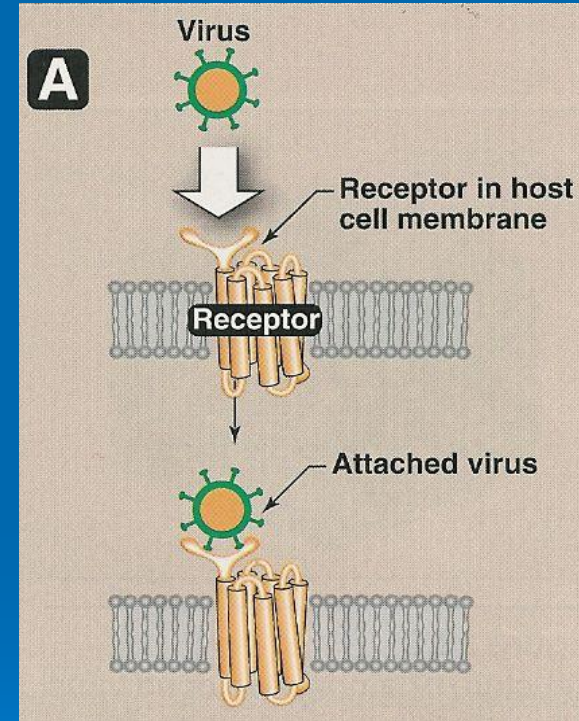
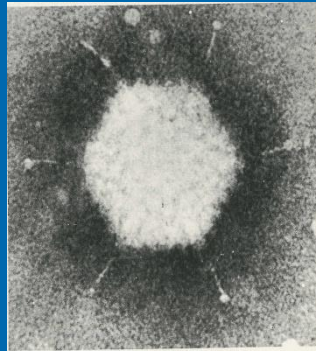
- Adsorption (Attachment)
- Penetration
- Uncoating
- Synthesis of viral components
  - mRNA
  - Viral proteins
  - NA
- Assembly
- Release



*Viral growth cycle*

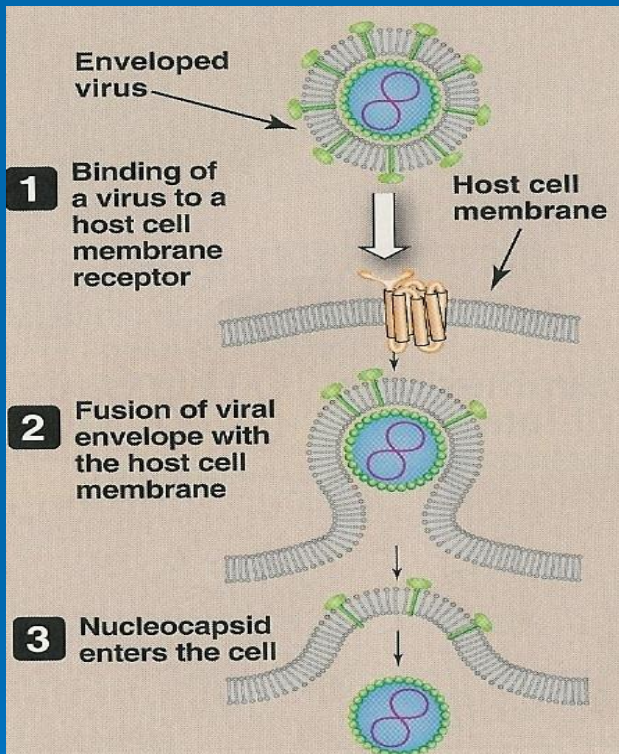
# Adsorption

- Attachment site ;  
ex- glycoprotein  
fiber



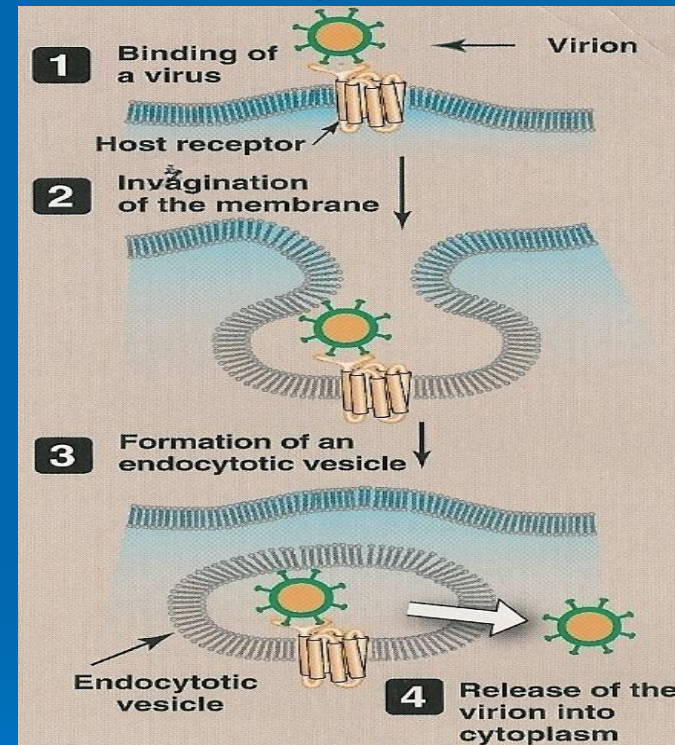
# Penetration

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

## ➤ Viral proteins

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

## ➤ replication of viral genome

# Replication

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

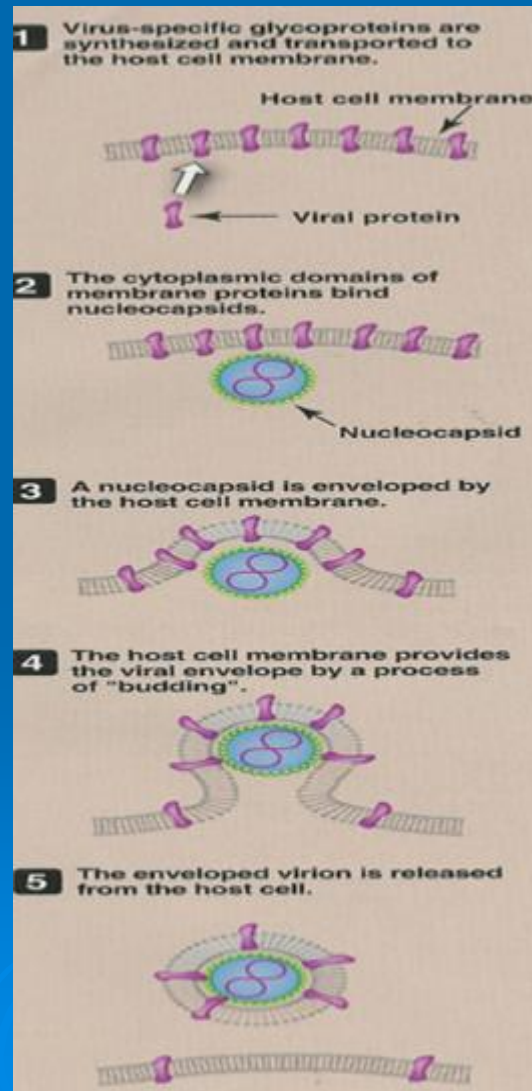
## ➤ *Assembly*

***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 .*

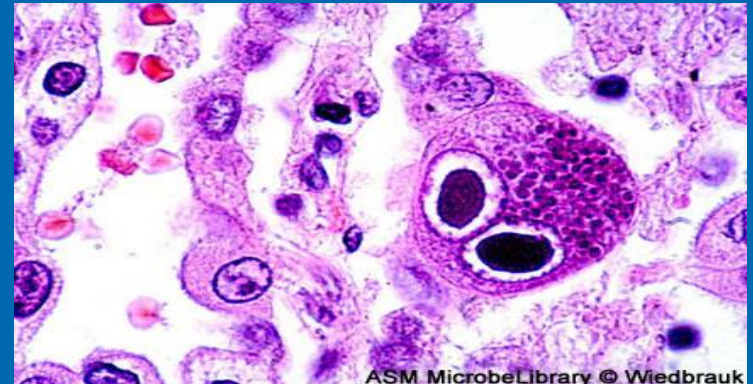


# Microscopic examination

## ➤ *Light microscopy;*

Histological appearance

Ex. Inclusion bodies



*Owl's eye (CMV)*

## ➤ *Electron microscopy;*

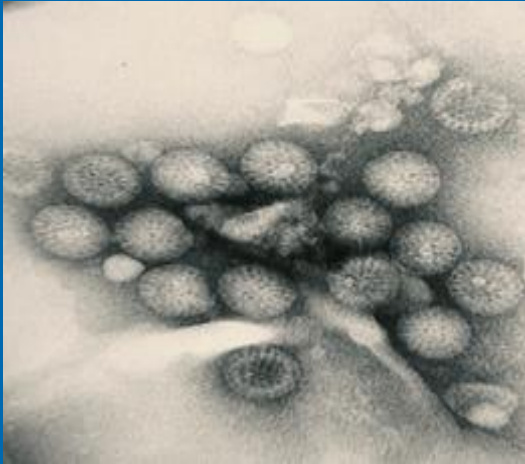
- Morphology & size of virions
- Ex. Dx of viral GE , rotav. , adenov.

Dx of skin lesion caused by herpesv, poxv.

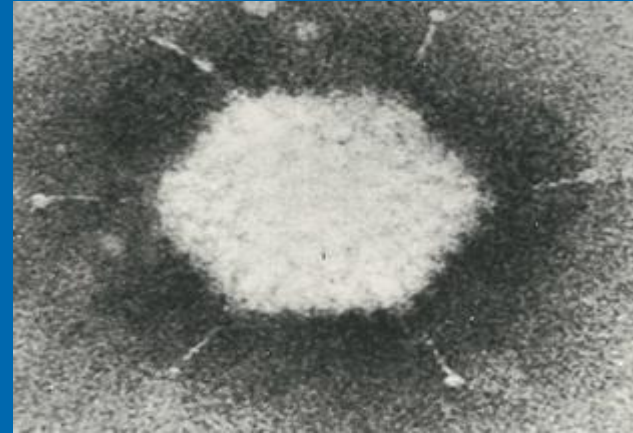
- It is replaced by Ag detection & molecular tests

➤ Electron micrographs

**Rotavirus**



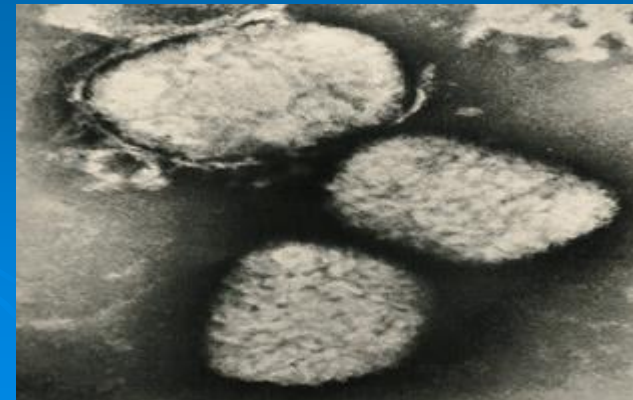
**Adenovirus**



**Herpesvirus**



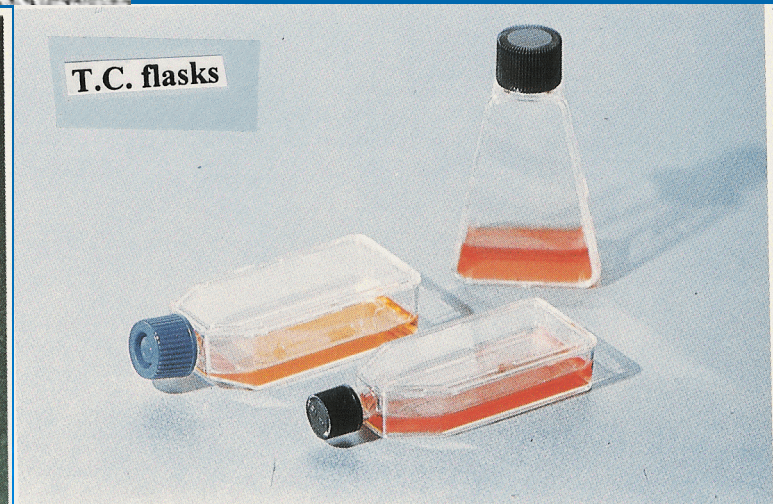
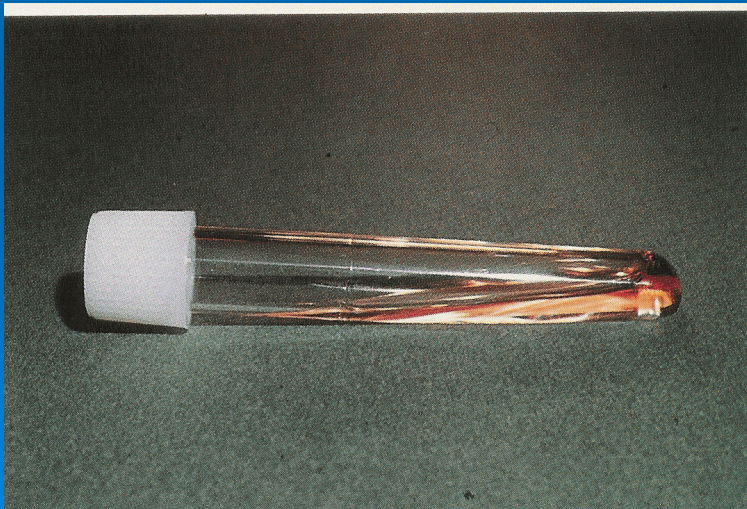
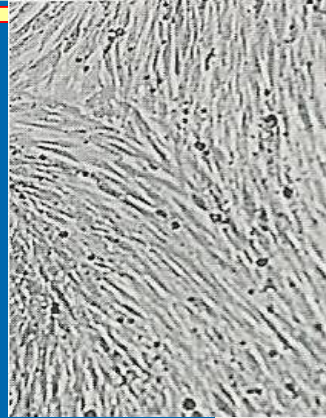
**Poxvirus**



# *Virus cultivation*

- *Laboratory animal*
- *Embryonated egg*
- *Cell culture*

# Cell culture

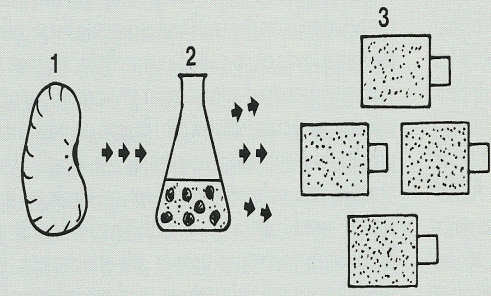


Cell culture

No of sub passages

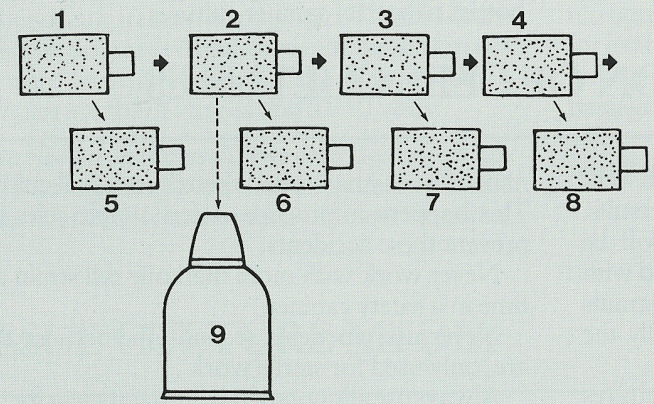
Primary C/C

1 or 2



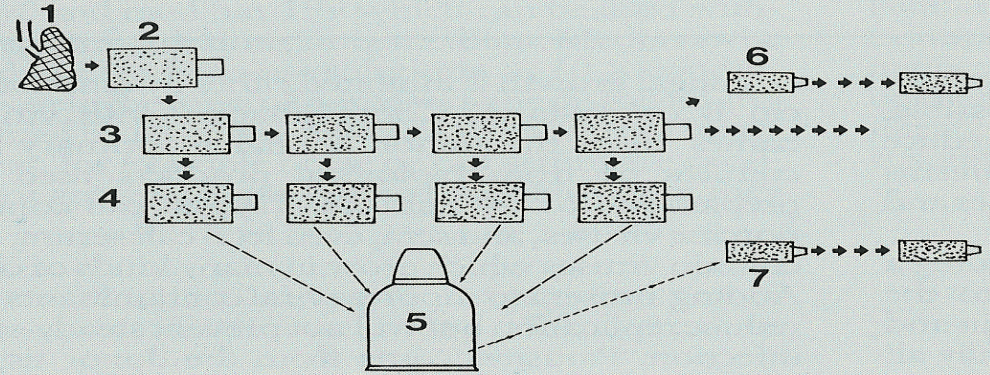
Diploid C/C  
[semi continuous]

20 to 50



Continuous cell  
line

Indefinite



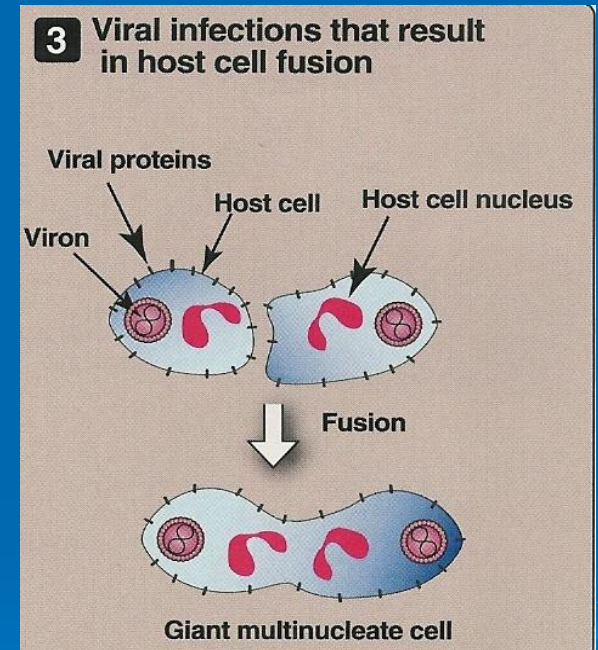
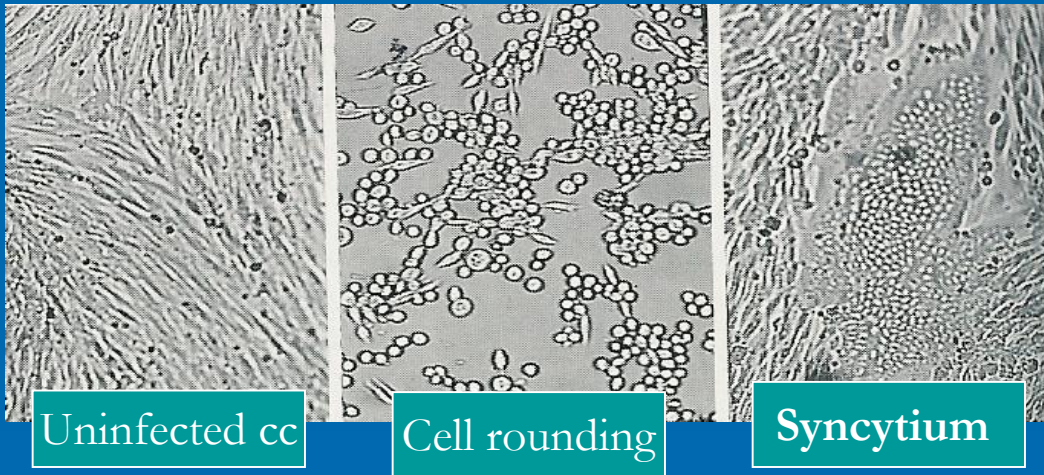
## Variation in Sensitivity of cell cultures to infection by viruses commonly isolated in clinical virology laboratories

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



## ➤ 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

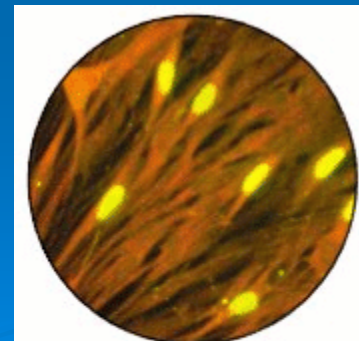
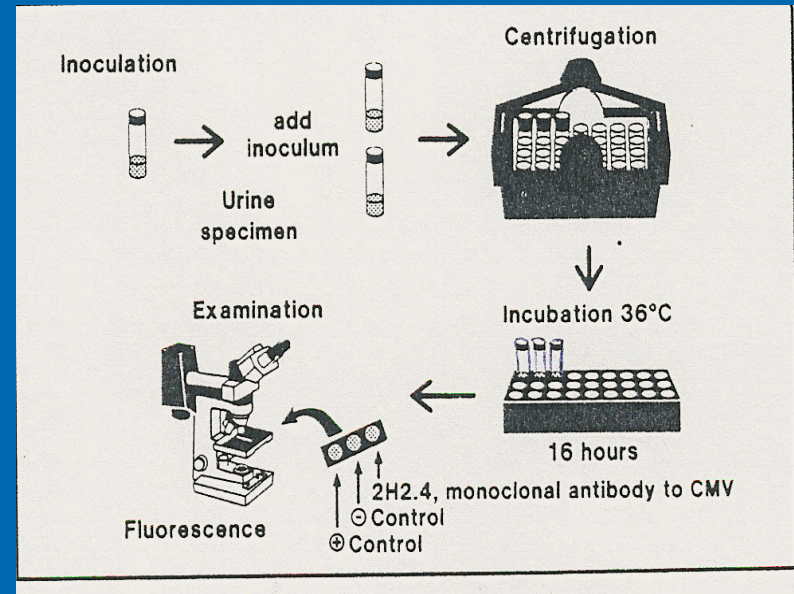


Fig. 2, CMV centrifugation culture fixed and stained 16 hrs after inoculation showing viral proteins in nuclei of infected human fibroblast cells

# Serological test; Antigen detection;

sample

virus

test

➤ Skin scraping

HSV

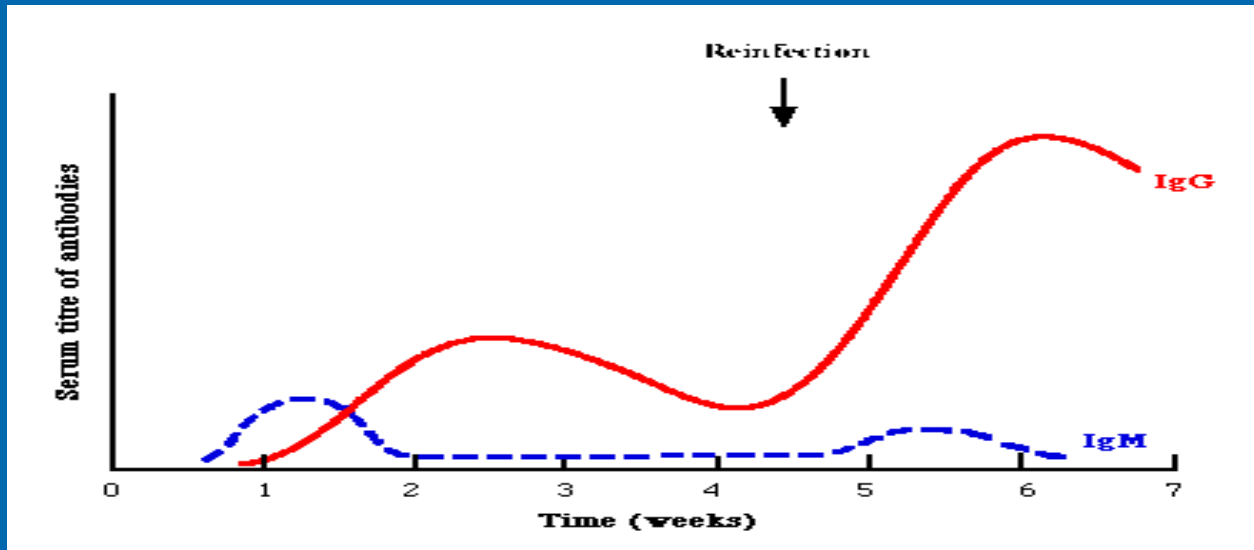
IF

➤ Blood

HBV(HBsAg)

ELISA

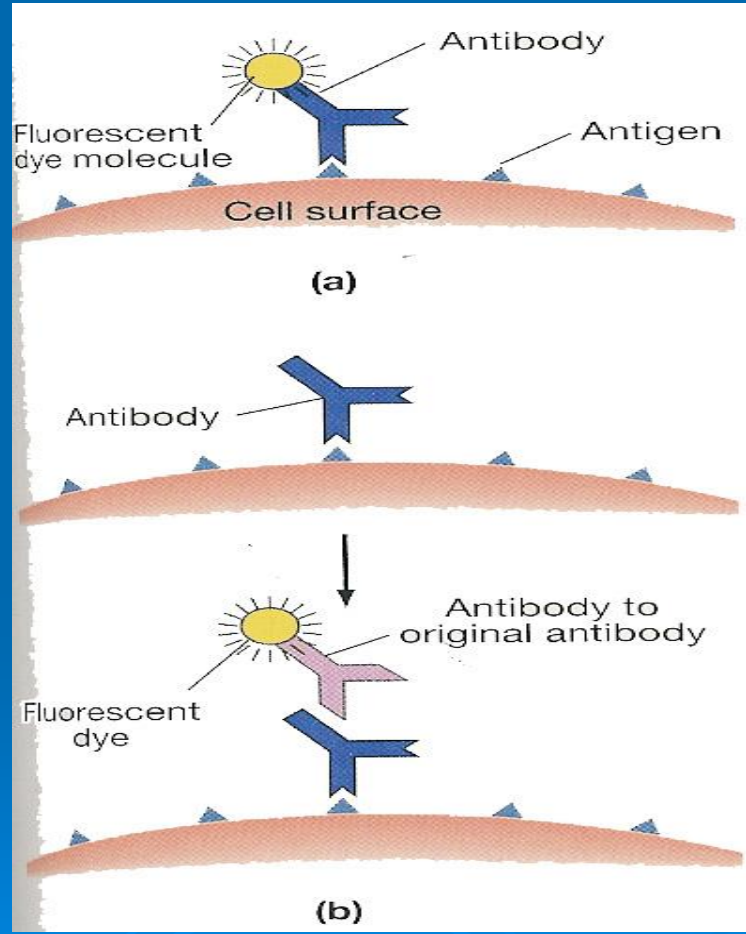
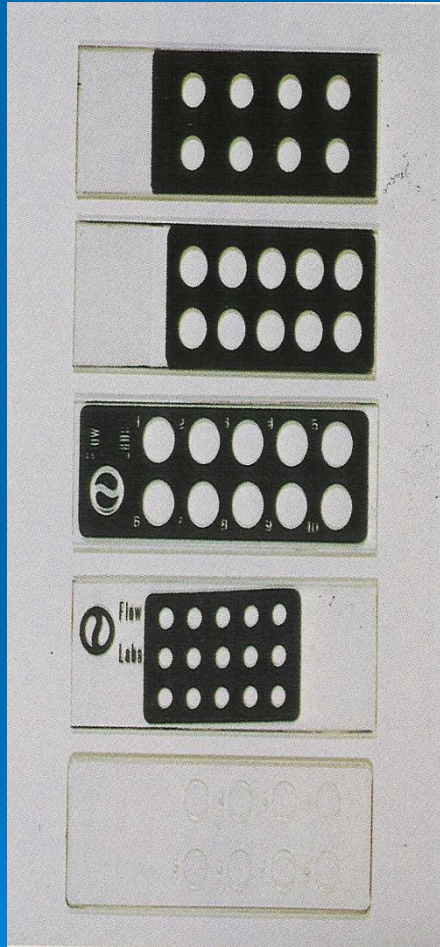
# Serological test; Antibody detection;



## ➤ Ex of techniques

- Immunofluorescence (IF)
- Enzyme-linked immunosorbent assay (ELISA)

# Immunofluorescence ; IF



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

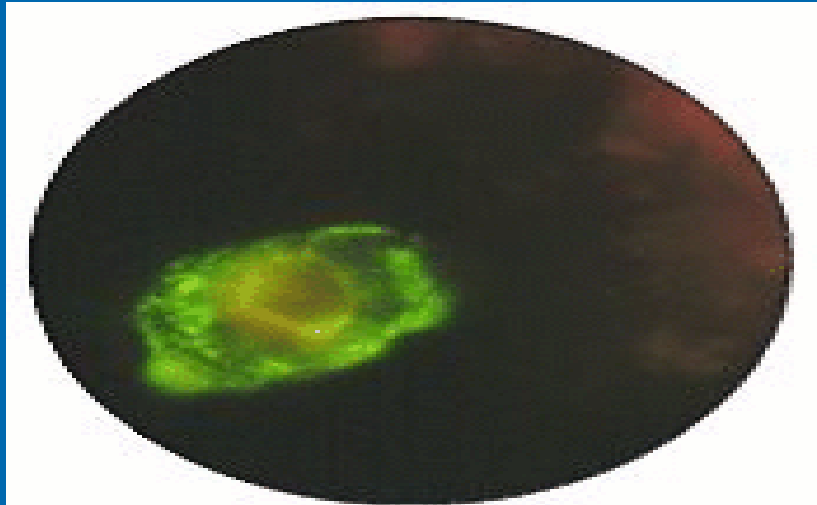
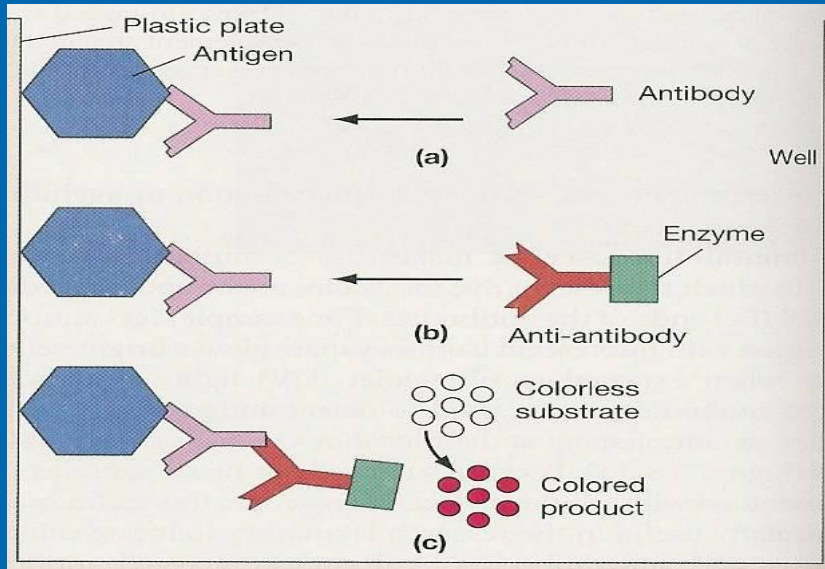


Fig. 3, HSV-infected epithelial cell from skin lesion (DFA)

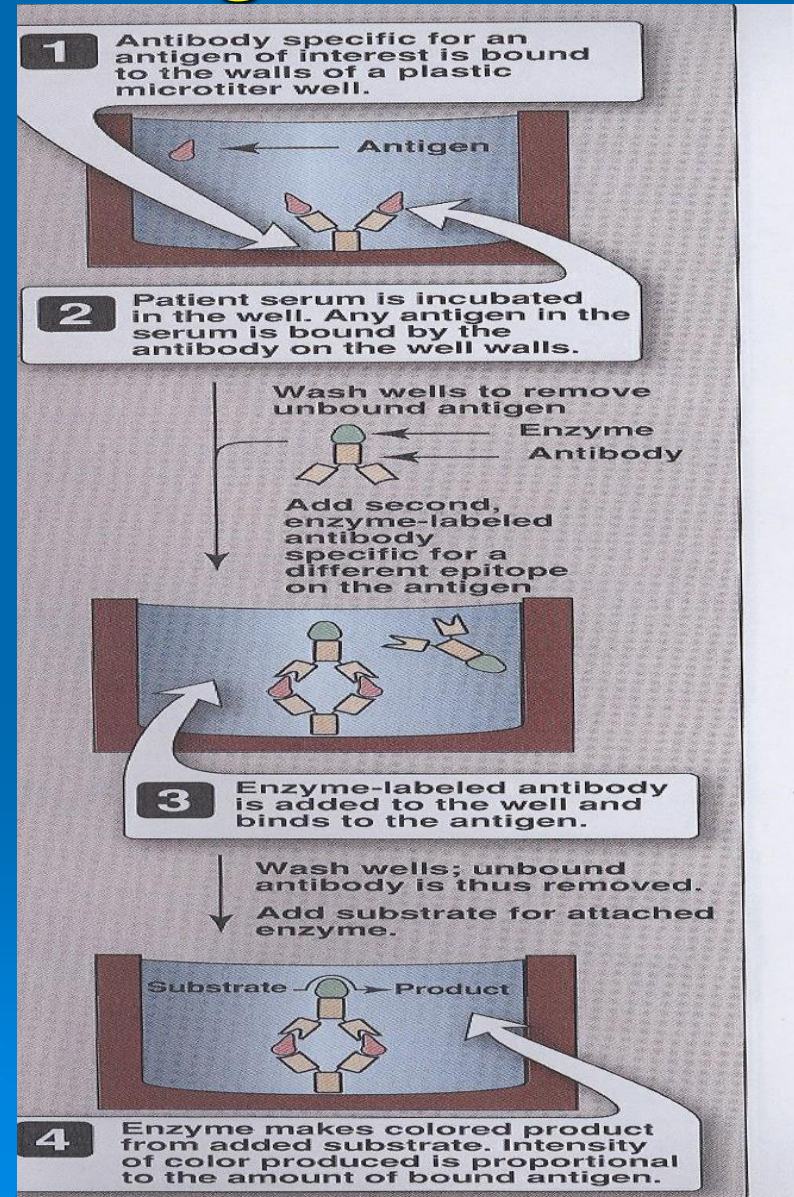
# ELISA

## 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

# قال تعالى : ( يَا أَيُّهَا الَّذِينَ آمَنُوا قُوا أَنْفُسَكُمْ وَأَعْلُوا كَمَا نَسُوا )



## شروط الحجاب :

- ساتر جميع البدن بما لا يكتشف العورة والستورين إليه أصبح فركي أهل العفة
- أن يظهر واسعة غير ضيقة حتى لا يشفه عند الحركة
- أن يظهر سميكتاً لا يشفه عند المشي
- أن لا يظهر اللباس زينة له نفسها
- أن لا يظهر مطبقاً يمتص ويضع العطر
- أن لا يشفه ملامح الوجه
- أن لا يشفه ملامح الساقين
- أن لا يظهر البدن كله

رسالة هامة : ألبس الرجل لا تكن ميوثاً فإن لم تكن رجلاً . فتشبه بالرجس

## التسام المسلمات في العصر الحاضر



قال الله تعالى :  
**ولا تبرزن تبرج الجاهلية الأولى**  
(الأعراف : 31)

**الإماء  
وملك اليمين**

**امهات المؤمنين  
والصالحات  
والعرائر**



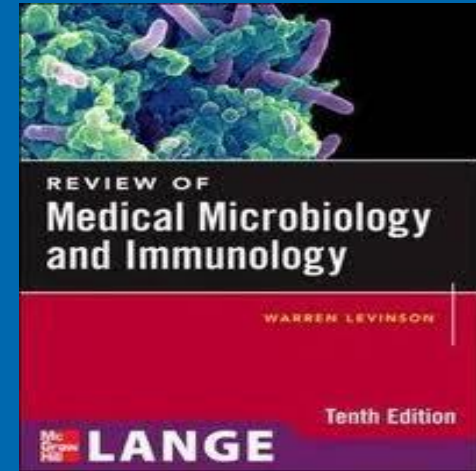
# Reference book and the relevant page numbers

## ➤ Review of Medical Microbiology and Immunology

By: Warren Levinson .

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

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

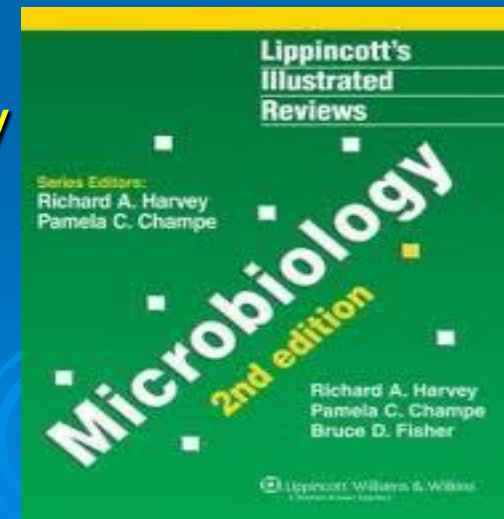


## ➤ Lippincott's Illustrated Reviews: Microbiology

By: Richard A. Harvey ,  
Pamela C Champe &  
Bruce D. Fisher

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

Pages;233-242



*Thank you*

