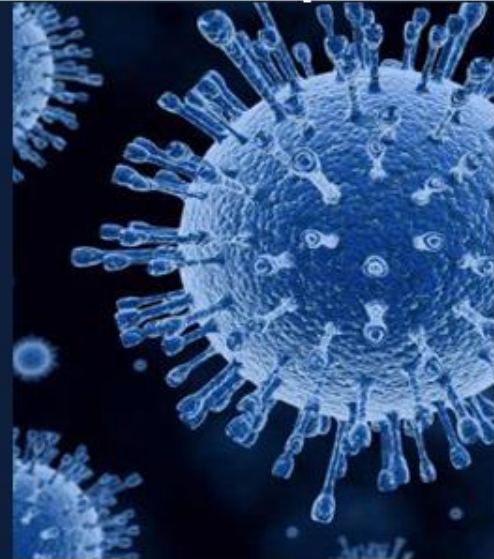
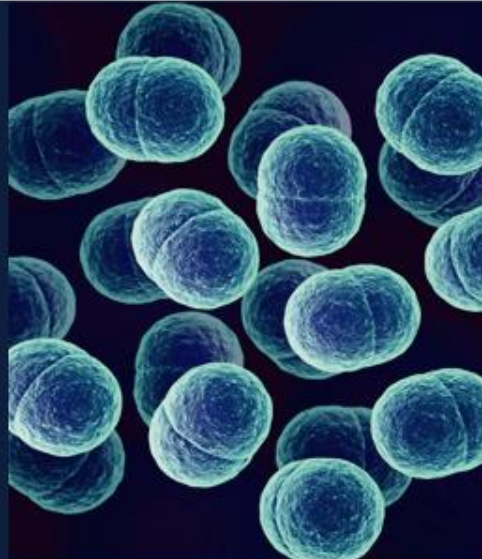


# MICRObiology

TEAM 435

هذا العمل لا يغني عن المرجع الأساسي للمذاكرة



## Lecture 5 Introduction to Viruses

● Important

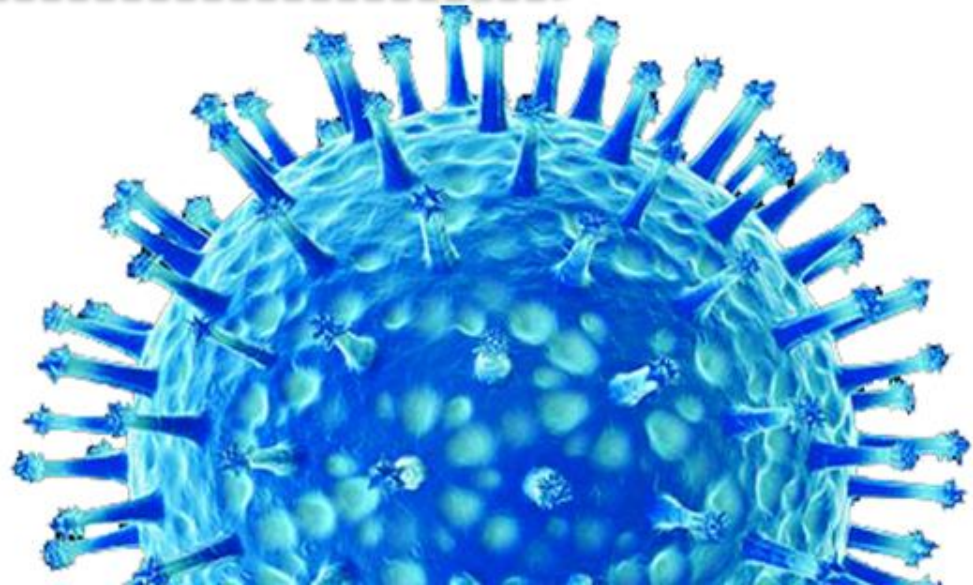
● Term

● Extra explanation

● Additional notes

# Objectives

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



REMEMBER!

## Properties of Microorganisms

Characteristics	Parasites	Fungi	Bacteria	Viruses
Cell	Yes	Yes	Yes	<b>NO</b>
Type of Nucleus	Eukaryotic	Eukaryotic	Prokaryotic	-
Nucleic Acid	DNA <b><u>and</u></b> RNA	DNA <b><u>and</u></b> RNA	DNA <b><u>and</u></b> RNA	DNA <b><u>or</u></b> RNA
Ribosomes	Present	Present	Present	Absent
Mitochondria	Present	Present	Present	Absent
Replication	Mitosis	Budding or Mitosis	Binary Fission	Special

# General characteristics of Viruses

Non-living, non-cellular organism (Acellular organisms) that can't be observed by light microscope.

Obligate intracellular organism, doesn't live outside the host cell.

**Composed of tiny particles:**

Replicate in a matter of diff from cells  
1V (virus) → many Vs (Viruses)

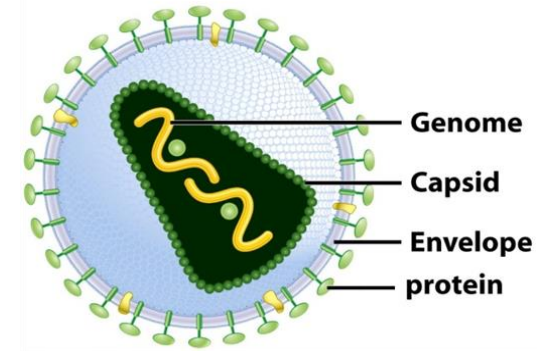
Don't have organelles like ribosomes or mitochondria

Internal core of nucleic acid "**DNA** or **RNA**".

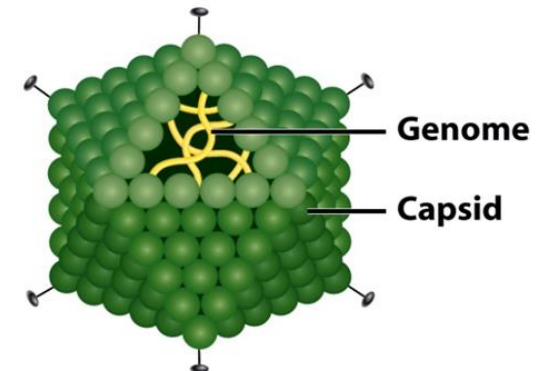
Protein coat surrounds the Nucleic Acid called "**Capsid**".

Some viruses have a lipoprotein membrane "**Envelope**".

**Enveloped virus**

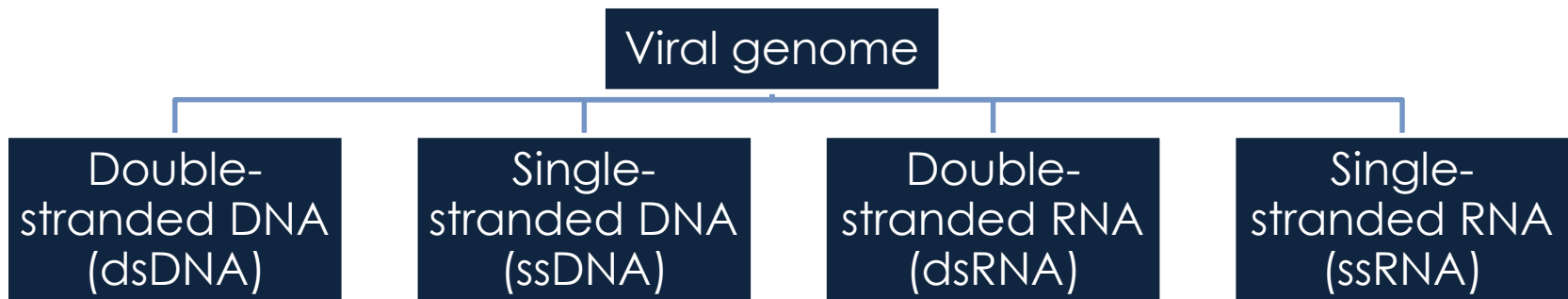


**Nonenveloped virus**



# Structure of viruses

- The tiniest virus is only 20 nm in diameter, while the largest is several hundred nanometers – which is barely visible under the L/M.
- Some viruses could be crystallized.
- Viruses that infect bacteria are called **Bacteriophage** or **Phages**



- The smallest virus has only 4 genes while the largest has several hundreds to thousand.
- All DNA Viruses have Double-stranded (ds) except Parvoviruses.
- All RNA Viruses have Single-stranded (ss) except Reoviruses.
- All Vs are haploid, except retroviruses are diploid
- DNA Always single molecule.
- RNA can be (+) or (-) polarity – more on this link (<http://youtu.be/ZGE4BLuAkuU>)

# Structure of viruses based on arrangement of capsomeres

## 2-Capsid

Rod-shaped

Cubic symmetry (Icosahedral).

Helical

Complex

It's a protein shell enclosing the viral genome.

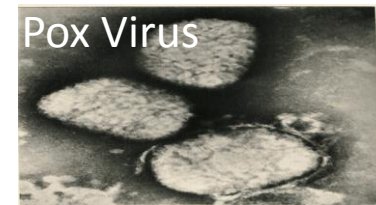
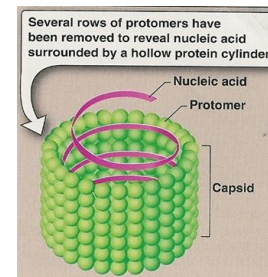
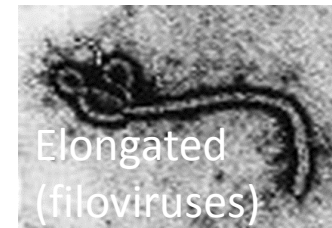
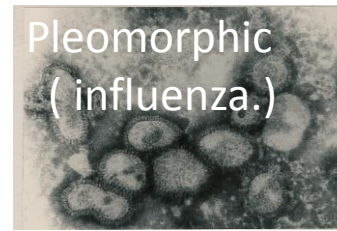
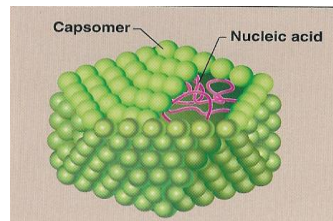
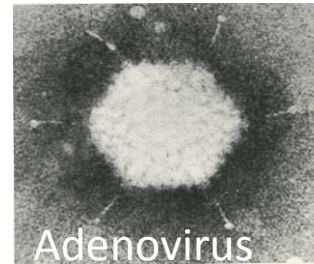
Capsids are build of a large Number of subunits called

Capsomeres

Function:.

Facilitates its entry into cell

Protect Nucleic Acid



Genome (NA)+capsid

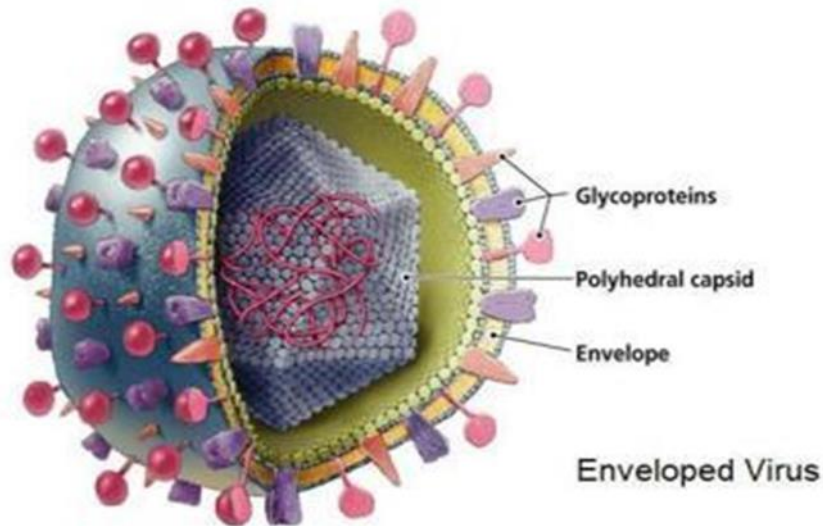
nucleocapsid

# Structure of viruses

## 3- Viral envelope (in some viruses)

It's a lipoprotein membrane envelope and surround the capsid.

It also contain protein and glycoprotein.

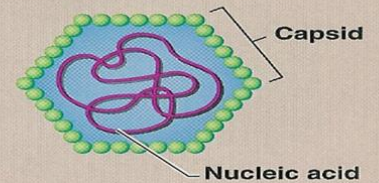


### -During viral budding:

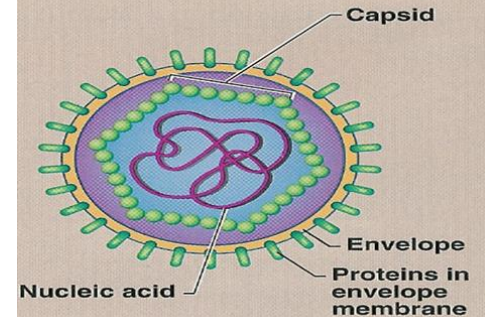
Envelope is derived from cell membrane except herpesviruses from nuclear membrane.

Enveloped viruses are more sensitive to heat, dry & other factors than nonenveloped Vs Glycoprotein attaches to host cell receptor.

### A Nonenveloped virus



### B Enveloped virus



# Viral proteins

## The outer viral proteins:

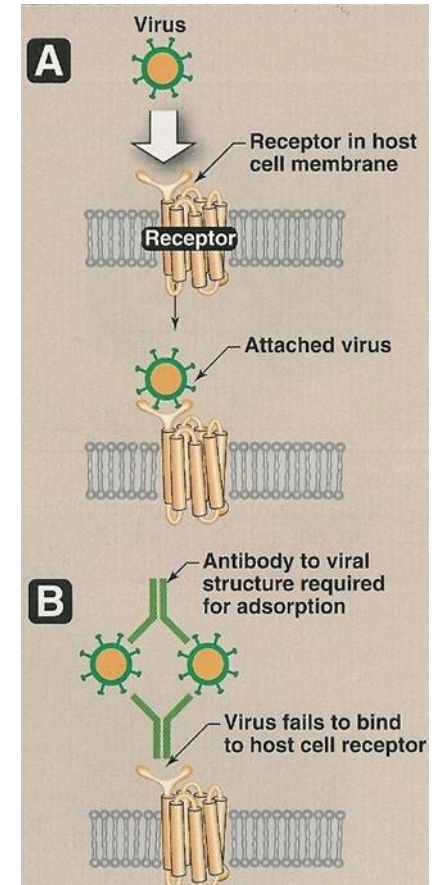
- Mediate attachment to specific receptors
- Induce neutralizing antibodies
- Target of antibodies

## -The internal viral proteins:

- Structural( capsid proteins of enveloped viruses)
- Nonstructural proteins(enzymes):

\*All ssRNA viruses(-) polarity have transcriptase ( RNA dependent RNA polymerase) inside virions.

\*RetroViruses & HBV contain reverse transcriptase.





## Classification of virus is based on:

- ❖ Chemical and physical properties of virions.
- ❖ Type of Nucleic Acid (**DNA** or **RNA**)
- ❖ The number of strand: **Double- vs/single-stranded**
- ❖ The polarity of viral genome: **Positive (+) or negative (-) stranded RNA**
- ❖ The presence or absence of envelope
- ❖ Type of symmetry

## Medically Important Viruses

1-DNA			
Single-stranded	Double-stranded		
Nonenveloped	enveloped		Nonenveloped
<u>Icosahedral</u>	<u>Complex</u>	<u>Icosahedral</u>	<u>Icosahedral</u>
Parvoviridae	Poxviridae	Herpesviridae Hepadnaviridae	Adenoviridae Papovaviridae

# Medically Important Viruses



2-RNA			
Single-stranded			Double-stranded
Neg-strand	Pos-strand		Nonenveloped
enveloped	enveloped	Nonenveloped	<u>Icosahedral</u>
<u>Helical</u> Orthomyxoviridae Paramyxoviridae Rhabdoviridae Filoviridae Bunyaviridae Arenaviridae	<u>Helical</u> Coronaviridae  <u>Icosahedral</u> Togaviridae Flaviviridae Retroviridae	<u>Icosahedral</u> Picornaviridae Hepeviridae Caliciviridae Astroviridae	Reoviridae

# Steps of Virus Replication

A microscopic image showing various types of viruses, including some with long, thin filaments and others with more rounded, spherical shapes. The image is in shades of blue and green, highlighting the intricate structures of the viral particles.

## 1-Adsorption

- Glycoprotein (IF ENVELOPED)
- Folding proteins in capsid (NON-ENVELOPED)

## 2-Penetration

- Fusion: of the cell membrane and the viral envelope (ONLY ENVELOPED CAN FUSE) • Endocytosis: Virus is consumed by the endocytotic vesicle. Cell wraps around the Virus.

## 3-Uncoating

- Release of Viral Genome to Cytoplasm in **Direct** Synthesize of Protein or to Nucleus in **indirect** Synthesize of protein.

## 4-Synthesis of viral components mRNA

- mRNA: This Step for (-) RNAs Viruses, it will use the genome to produce mRNA, and that's why it is indirect.
- Viral proteins: This Step for (+) RNAs, they have mRNA, it will begin the synthesise by the Ribosomes Directly.
- Replication of viral genome: The mechanism will continue for the replication, one virus will produce in one cell millions of viruses.



## 5-Assembly

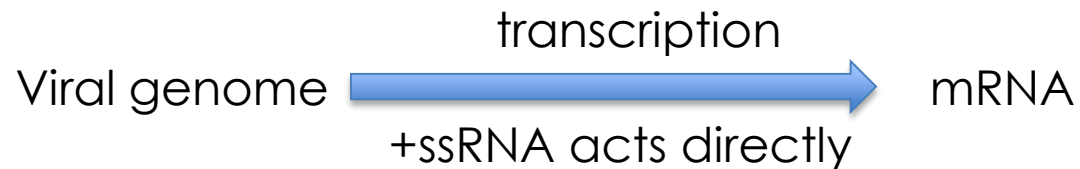
- NA + V. Proteins = Virions

## 6-Release

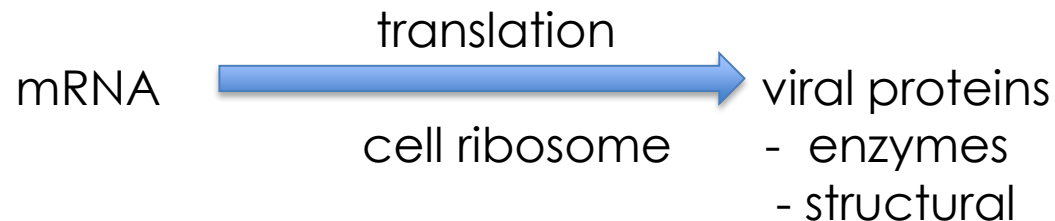
- **Enveloped Viruses:** Viruses leaves the cell and create their Envelopes from the cell membrane OR from the nuclear mb ex: **herpes Vs.** (This process is called **Budding**)
- **non-Enveloped** Viruses: Cell lysis or rupture of the cell membrane

## Synthesis of viral components

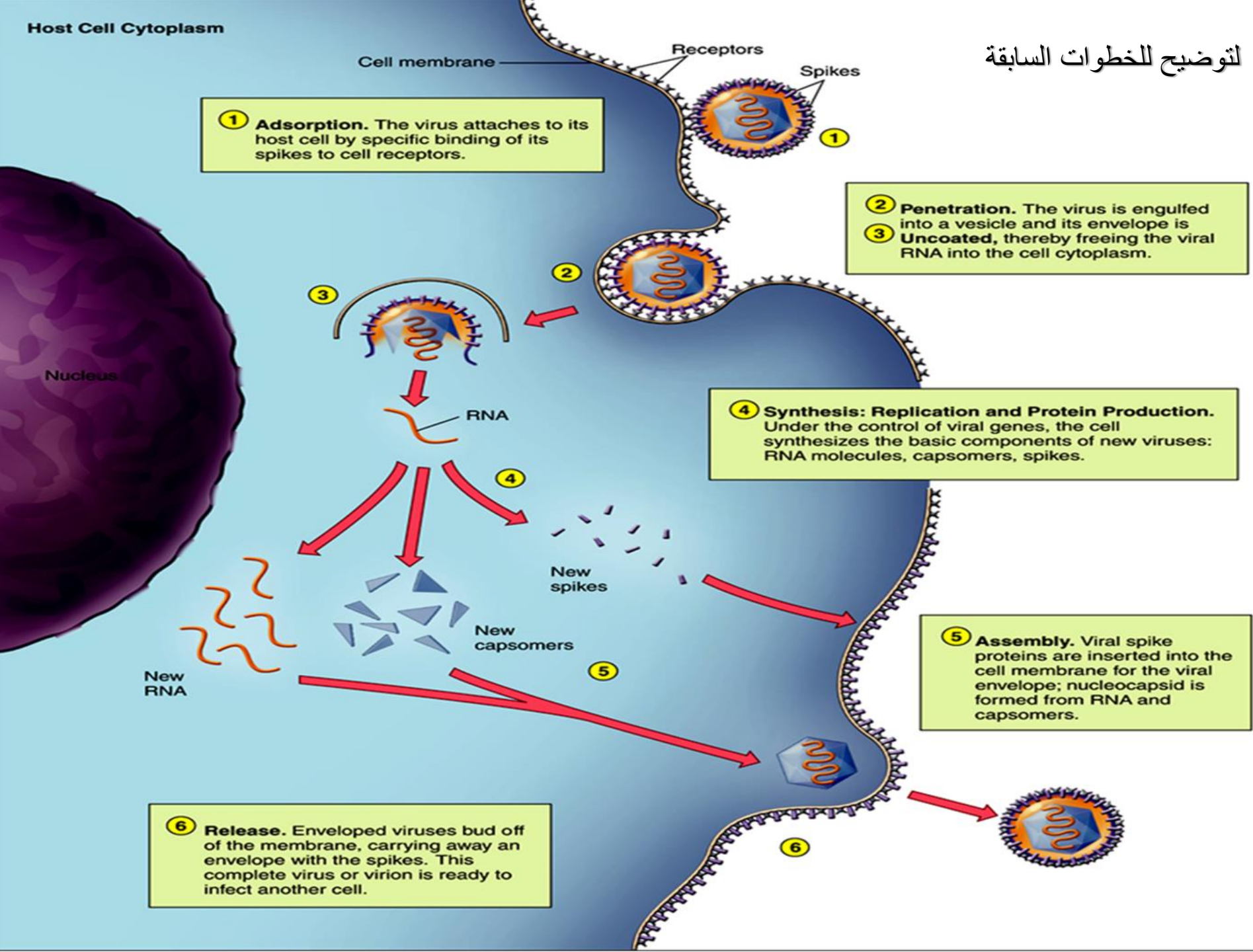
### -mRNA



### - Viral proteins



-replication of viral genome



# laboratory diagnosis of viral infections

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

## 1-Microscopic Examination

### Light microscope

- Replicating virus often produce histological changes in infected cells which can be seen by light microscope.

\*Take note that virions (complete virus particles) **CANNOT** be seen by light microscope.

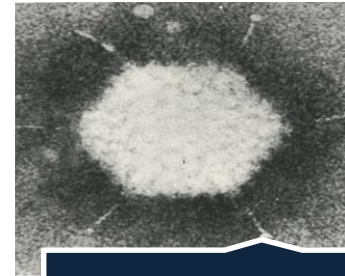
Ex. Inclusion bodies

### Electron microscope

- To study form, size and structure of the virions.

It has been replaced by Antigen detection and molecular tests.

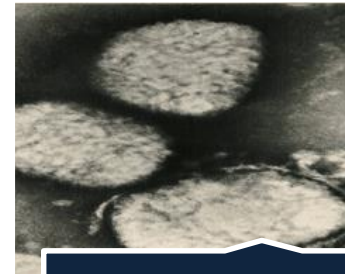
### Electron Micrographs:



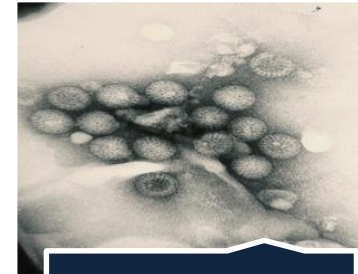
AdenoVirus



HerpesVirus



PoxVirus



RotaVirus

# laboratory diagnosis of viral infections

## 2-Serological tests

-Virus cultivation:  
Laboratory animals  
Embryonated eggs  
Cell culture

### Antigen detection

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

### Antibody detection

e.g. of techniques :

- Complement fixation test (CFT)
- Immunofluorescence (IF) Enzyme- linked
- immunosorbent assay (ELISA)

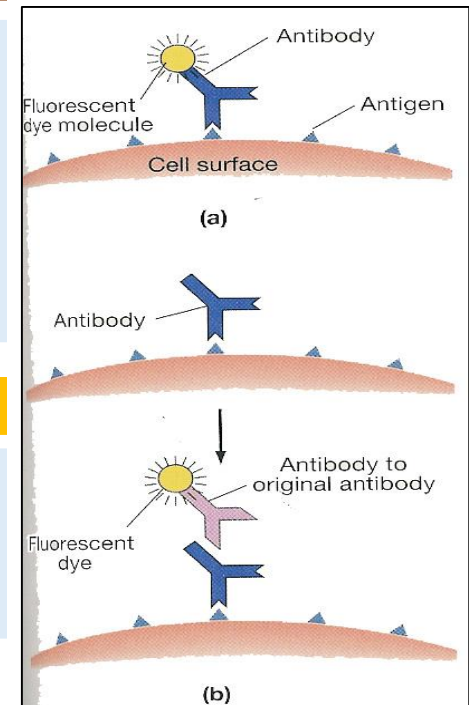
### Immunofluorescence (IF)

A-Direct: antigen detection by using an antigen sample.

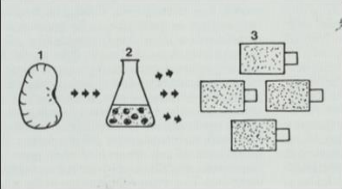
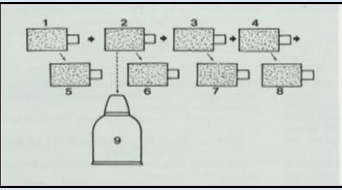
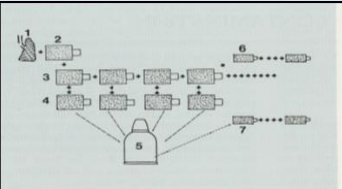
B-Indirect: antibody detection by using an antibody sample Uses florescent dye

### Enzyme-linked immunosorbent assay (ELISA)

Direct: antigen detection or specific IgM,IgG  
Indirect: antibody detection, Uses an enzyme that reacts with an enzymatic substrate to show color, colored wells indicate reactivity.



## 3-Cell culture

Cell Culture	No of sub passages (the number of times the cells have been subcultured)	illustrating Pictures
Primary c/c	1 to 2	
Diploid c/c (semi continuous)	20 to 50	
Continuous cell line	Indefinite	

**-Problems with cell culture:**  
 Long incubation (up to 5 days).  
 "Because one of the problems with cell culture is long incubation, they came up with a modified cell culture: a Rapid culture technique:

Shell vial assay (this technique detects viral antigens in cell culture, and takes 1-3 days)".

- Sensitivity is variable.
- Susceptible to bacterial contamination.
- Some viruses do not grow in cell culture e.g. HCV.



# Cell culture

## - Detection of viral growth:

Cytopathic effects.

“Rounding, shrinkage, aggregation, and lose of adherence.

Giant Cell formation. Inclusion bodies formation: The site of viral replication and protein synthesis.”

-Other effects.

## Rapid culture technique

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

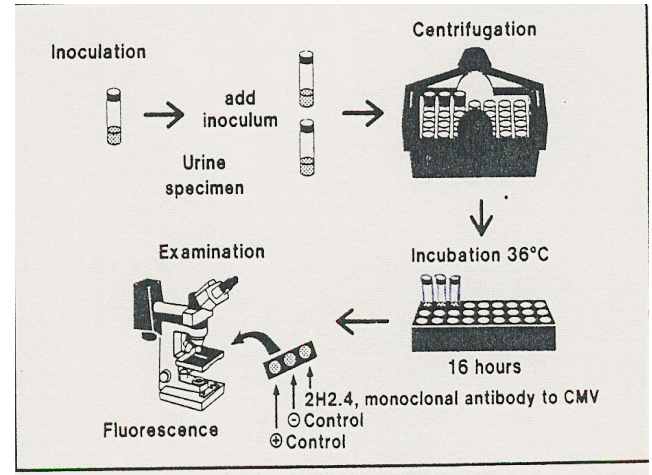
## Molecular test:

-Polymerase chain reaction (PCR)

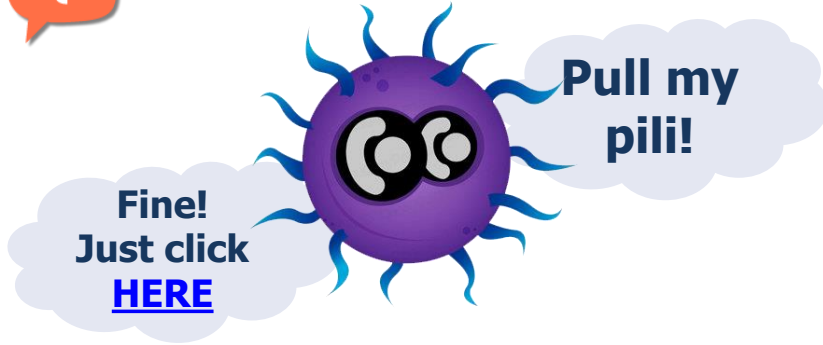
- NA amplification technique.
- Viral genome.

- Uses of molecular test:

- Diagnosis.
- Monitoring response to treatment.



# Online Quiz



## Videos

Viruses (Structure, Types and Bacteriophage Replication):

<https://www.youtube.com/watch?v=s8jhJXgC-bk>

shapes of viruses:

<https://www.youtube.com/watch?v=05bwTTWlGA>

Classifying DNA & RNA Viruses

<https://www.youtube.com/watch?v=lgrsdajGes0>

## Books that could help you

- ❖ Microbiology made ridiculously simple
- ❖ Sherris Medical Microbiology



# MI**CR**Obiology TEAM 435

We do things better

## Boys Team

- Ali Alzahrani
- Khalid Sharahily
- Ahmad Alzahrani
- Zeyad Alsalem
- Muhammad Dossary
- Meshal Alhazmy
- Hamzah Alfiar

## Girls Team

- Lamyia Alsaghan
- Nojood Alhaidri
- Monera Alayuni
- Alanoud AlOmair
- Shahad Alenezi
- Aisha Al-Sabbagh
- Bodour Julaidan
- Noura AlTawil
- Deema AlFaris
- Sara Al-Hussein
- Suha Alenezy
- Latifah Alsukait
- Dalal Alhuzaimi
- Reema Allhaidan

Girls power!



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Contact us!