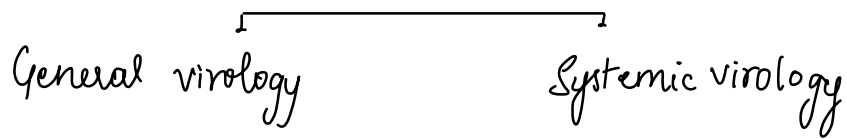
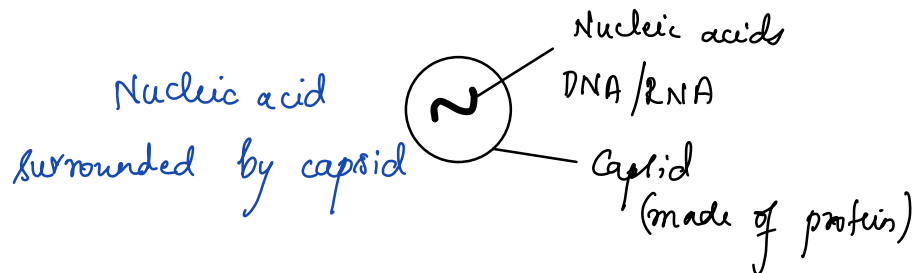


Virology



Viral Classification



arrangement of proteins - symmetry

↳ 3 types

• Icosahedral

• complex

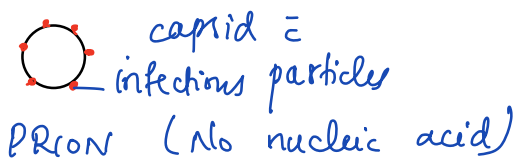
• Helical

↳ 20 faces & 12 vertices



VIRION

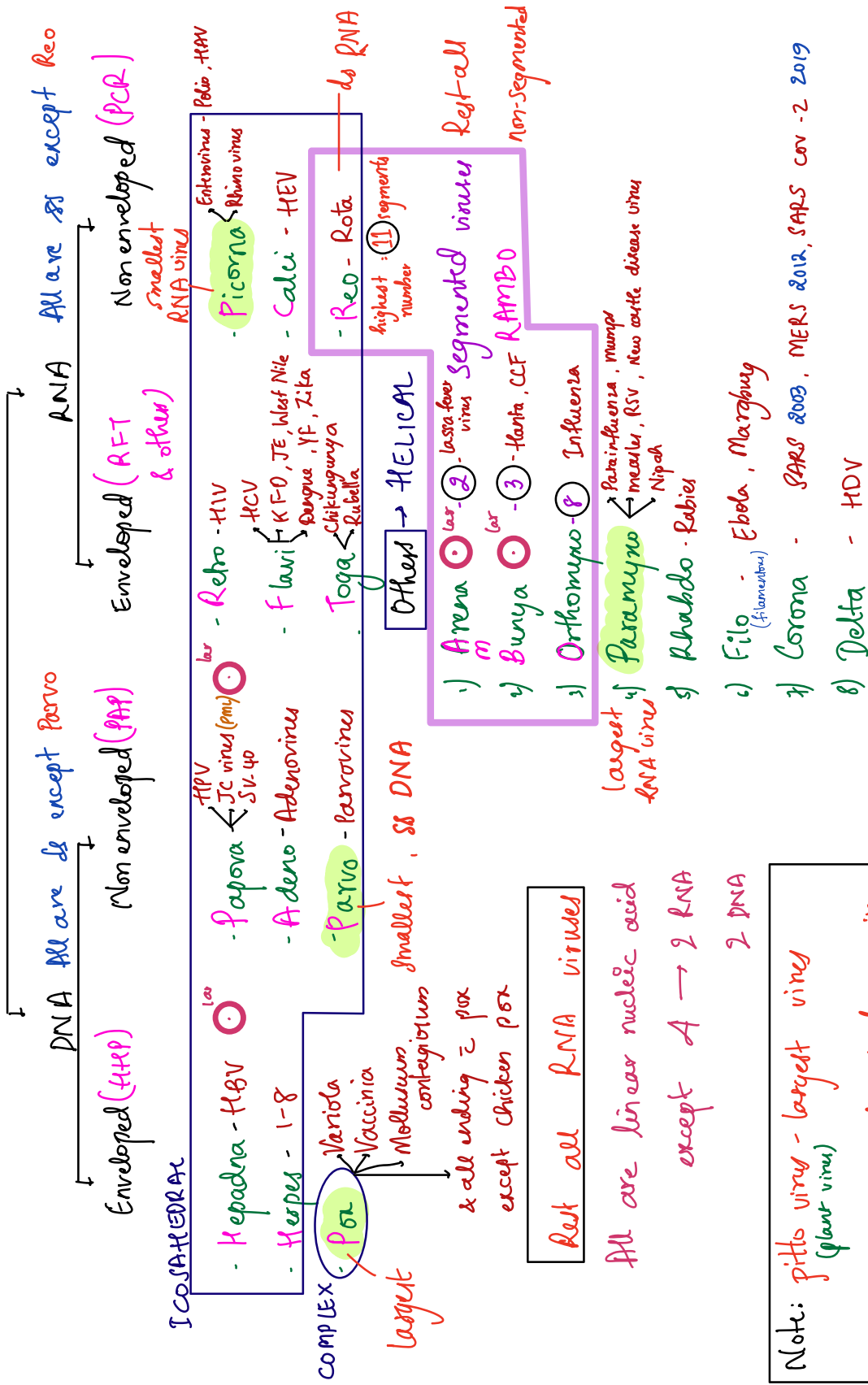
virus can be non-infectious



Classifications

- based on nucleic acid
- 1) Based on symmetry
 - 2) enveloped / non-enveloped
 - 3) DNA / RNA
 - 4) segmented / non segmented
 - 5) linear / circular
 - 6) ds / ss
 - 7) largest / smallest 'prion'

VIRUS



Notes: → DNA virus replication occurs in nucleus
except Pox virus → occurs in cytoplasm

→ RNA virus replication occurs in cytoplasm
except measles → occurs in nucleus
orthomyxovirus
retrovirus

OTHERS — negative sense RNA dependent RNA polymerase

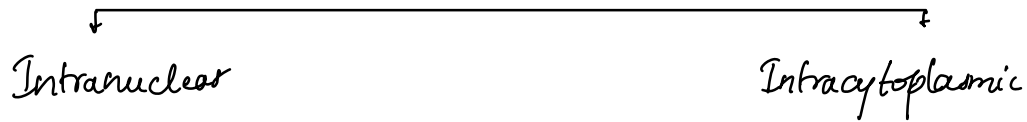
- 1) Arena
- 2) Bunya
- 3) Orthomyxo
- 4) Paramyxo
- 5) Rhabdo
- 6) Filo
- 7) Corona
- 8) Delta

Negative-stranded viruses

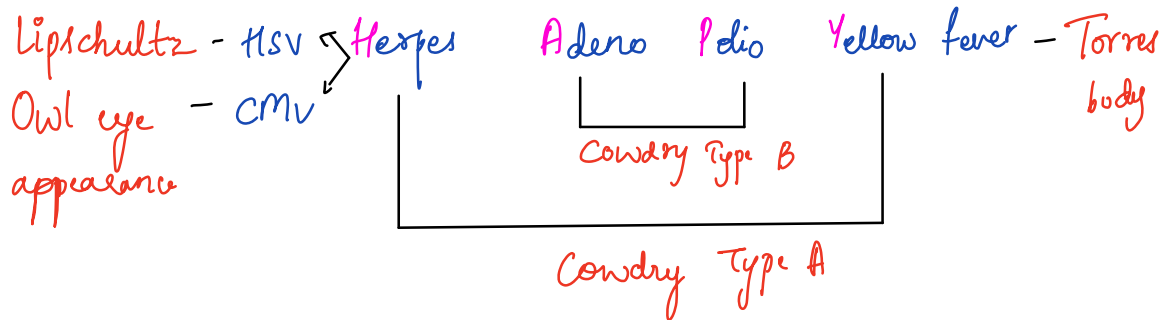
Must transcribe $\ominus$ strand to $\oplus$. Virion brings its own RNA-dependent RNA polymerase. They include **a**renaviruses, **b**unyaviruses, **p**aramyxoviruses, **o**rtomyxoviruses, **f**iloviruses, and rhabdoviruses.

Always bring **p**olymerase or fail **r**eplication.

Viral Inclusion bodies



i) Intranuclear HAPY

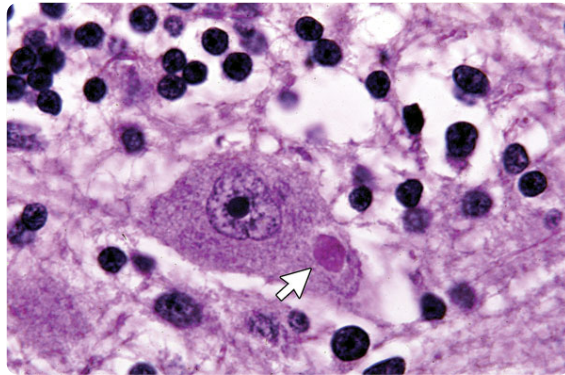


ii) Intracytoplasmic PCR

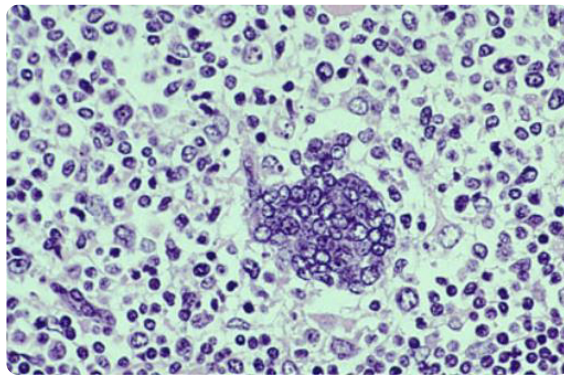
- | Pox | Chlamydia | Rabies - Negri bodies |
|-------------------------------------|------------------------------|-----------------------|
| - Variola - Paschen bodies | - C. trachomatis - HP bodies | |
| - Vaccinia - Guarnieri bodies | (Halberstaedter Prowazeki) | |
| - Molluscum contagiosum - HP bodies | - C. psittaci - LCL bodies | |
| (Henderson Patterson) | (Leventhal Collelly) | |
| - Cowpox - Bollinger | | |

iii) Both intranuclear & intracytoplasmic

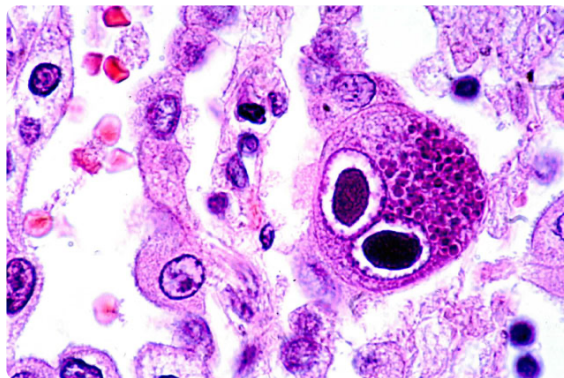
Measles - Warthin Finkeldey body



Negri bodies

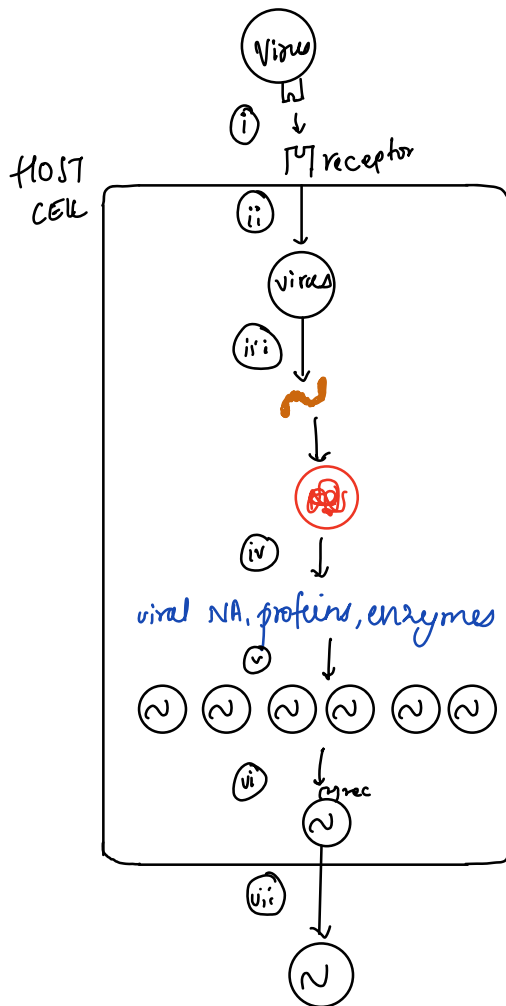


Warthin Finkeldey body



cmv (owl's eye)

Viral Replication



Ex: HIV { Virus-gp120 rec
Host-CD4 rec

i) Attachment
only cells which have the receptor for the virus can get infected

ii) Penetration
mostly by phagocytosis except
HIV - membrane fusion
Bacteriophage - injects its DNA

iii) Uncoating
Capsid removed to release viral nucleic acid

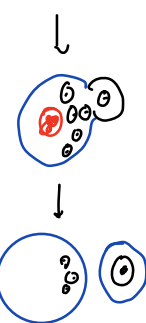
iv) Biosynthesis viral components

v) Assembly - daughter viruses

vi) maturation of proteins
receptor of virus

vii) Release by 2 mechanisms

Budding



All enveloped virus released by budding

lysis

All non-enveloped virus - released by lysis

Envelope -

- host cell derived
- made of lipid

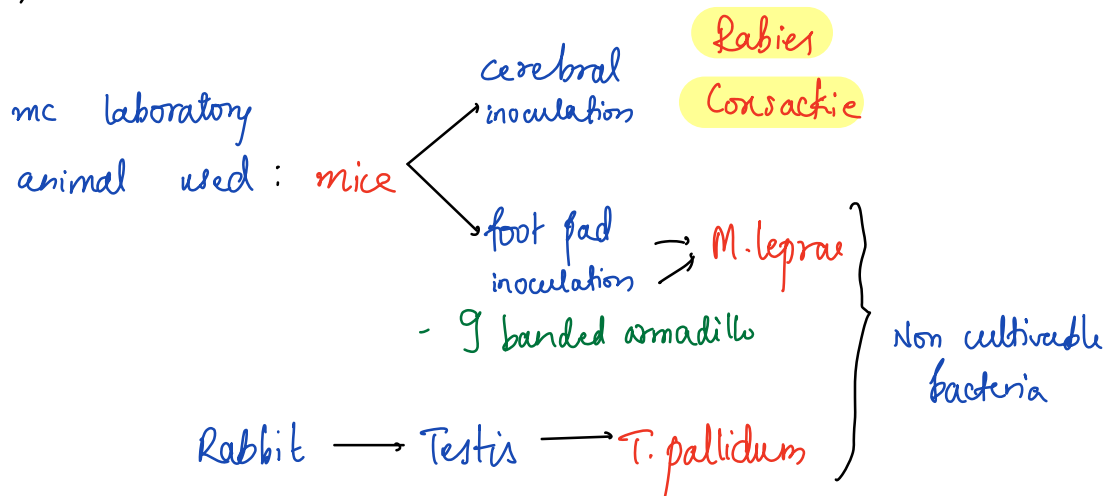
Receptor

- virus derived
- made of protein

Viral Cultivation

- 1) Animal inoculation
- 2) Embryonated egg culture
- 3) Tissue culture (mc used)

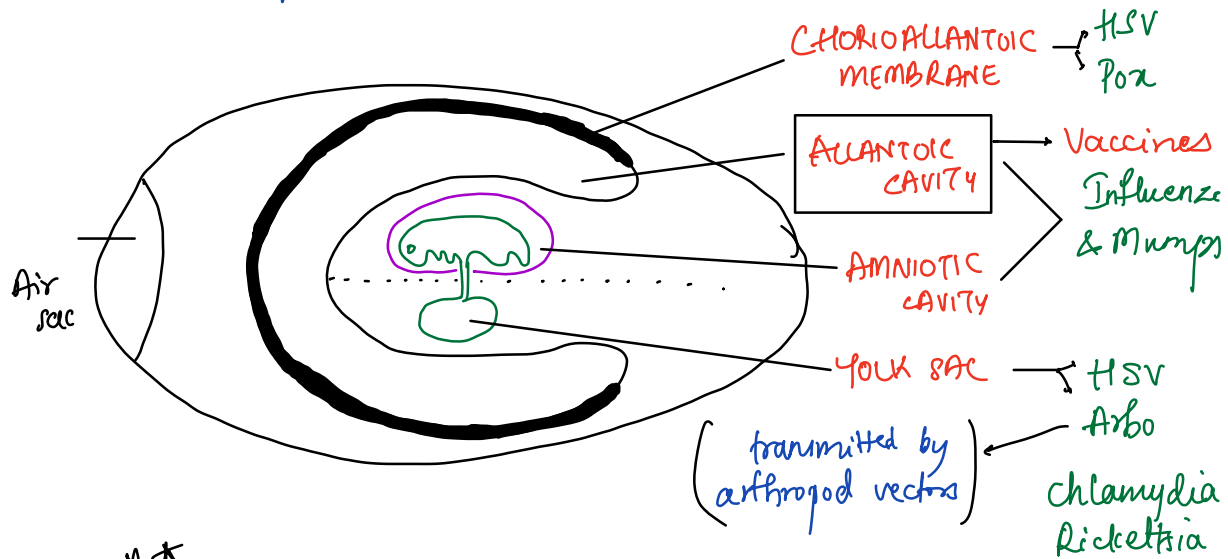
1) Animal inoculation



9 banded armadillo

2) Embryonated Egg Culture

process of inoculation → **candling**



pk

Vaccines produced in Allantoic cavity **YIR**
Yellow fever
Influenza
Rabies

3) Tissue culture

Not done anymore { a) Organ - Tracheal ring culture - Coronovirus
b) Explant (part of organ) - Adenoid gland culture - Adenovirus

c) Cell culture - fibroblasts (mc used)
Epithelial cells (kidney)

Primary
cell culture

subculture - upto
5 times

- 1) chick embryo
fibroblast
- 2) Rhesus monkey
kidney
- 3) Human embryonic
kidney

Diploid
cell culture

subculture upto
50 times

- 1) Human lung diploid
fibroblast
WI 38
MRC-5

Continuous
cell culture
(mc)

subculture can be
done indefinitely

- HeLa
- Hep 2
- McCoy
- BHK
- Vero (mc)

African green monkey
kidney



T - FLASK
Tissue culture flask

Viral growth medium

add virus cells

cells form monolayer sheet

aka - Monolayer

Viral Identification

- only for few specific
- i) Cytopathogenic Effect (CPE) - morphological changes in cell due to infection
 - ii) Viral Interference - Growth of 1st virus inhibits growth of 2nd virus
 - iii) Haemagglutination - adsorption of RBC by virus on its surface

- iv) Electron microscope
 - v) Direct Immunofluorescence Assay (mc)
 - vi) PCR
- can be applied for detection of all viruses

- Haemagglutination
- Influenza
 - Mumps
- have haemagglutinin proteins



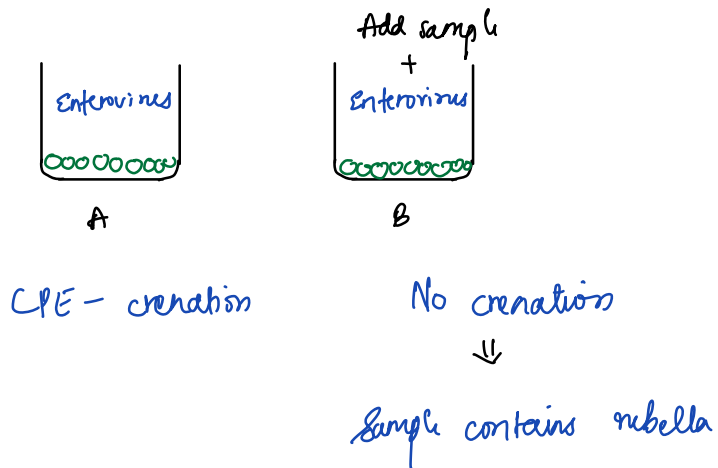
→ Cytopathic effect

- 1) Enteroviruses - crenation of cells
- 2) Measles - Syncytium formation
- 3) HSV - ballooning
- 4) SV-40 (Simian vacuolating) - Vacuolation
non pathogenic
- 5) Adenoviruses - granular clump
(bunch of grapes)

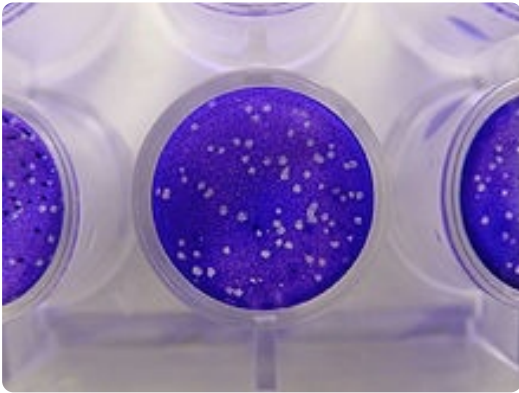
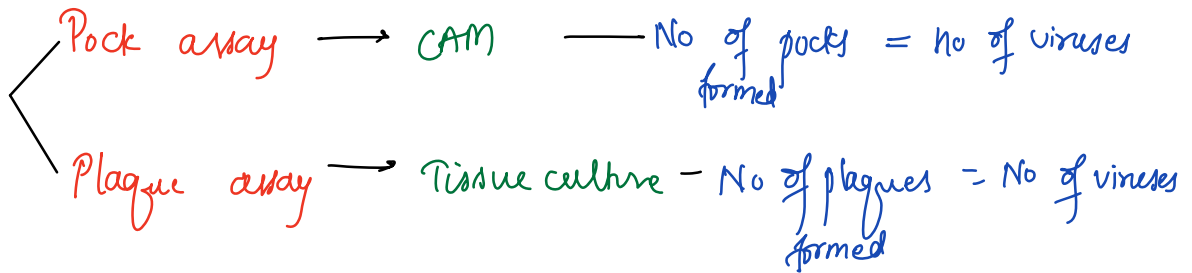
→ Viral interference

E.g.: Rubella & Enterovirus
↓ ↓
grows does not grow
inhibits

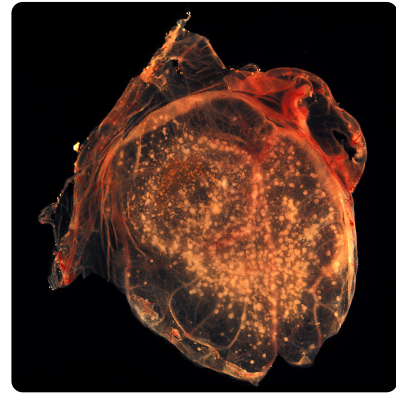
```
graph LR; R[Rubella] -- inhibits --> E[Enterovirus]; R -- grows --> G1[grows]; E -- does not grow --> G2[does not grow]
```



* Viral Assay - Quantification (viral load)



Plaque assay



Pock assay

Viral Immunity

single imp immune factor $\longrightarrow$ **INF**
that act against virus

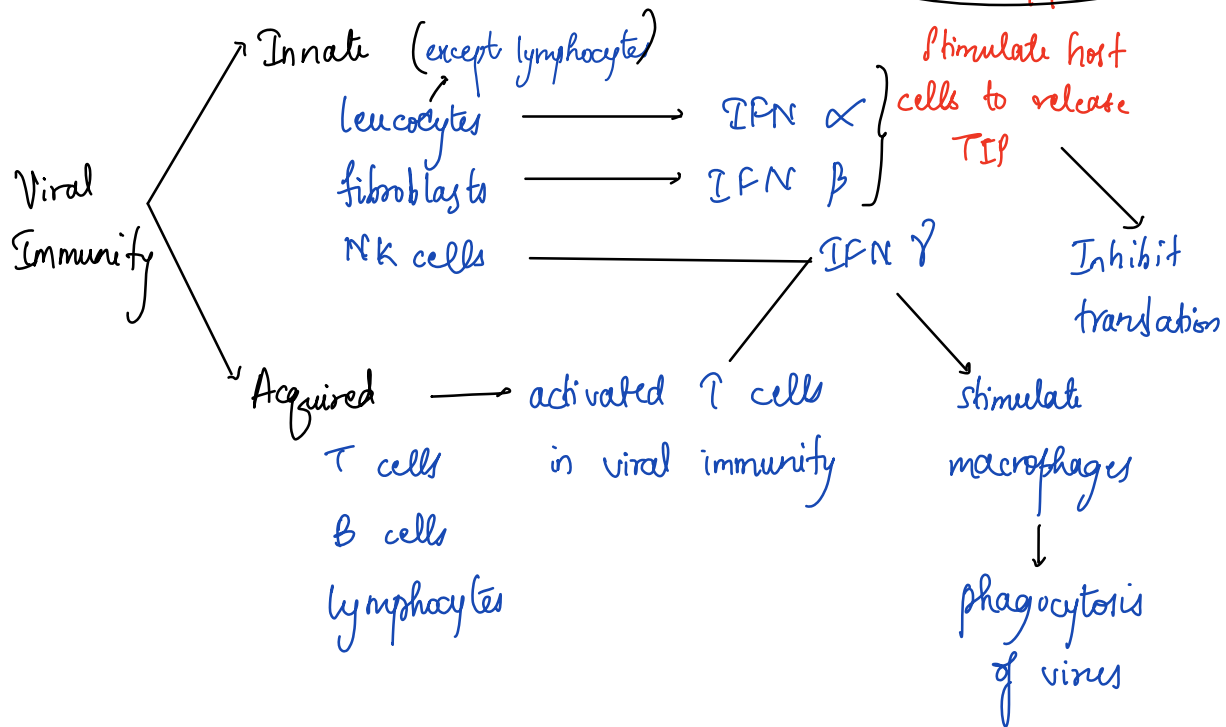
- cytokine (protein)
- host specific

Types of INF

Type I - INF α , INF β

Type II - INF γ

Type III - New



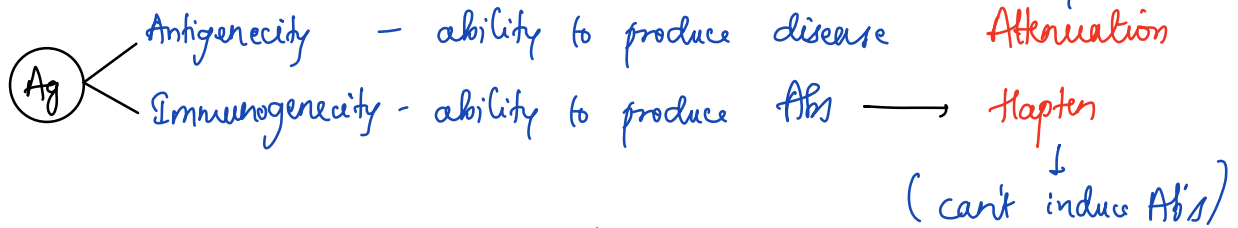
Viral vaccines

live vaccines - 15

	Birth	6, 10, 14 wks	1.5-2yrs & 4.5 to 6y
↑	BCG, OPV	Rota	mme
↑	Smallpox,	Chickengon, Typhoid, Cholera	
↑	JE	Dengue, YF, Influenza (nasal spray)*	
		Hep. A	

live (attenuation)

(Antigenicity removed)



Killed — inactivated (phenol, BPL)

Live



Local immunity
not safe ∵ attenuation is reversible

CfI in immunocompromised & pregnancy

Killed



No local immunity
Safe

can be given

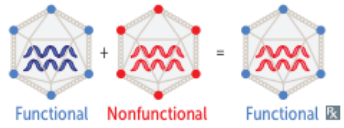
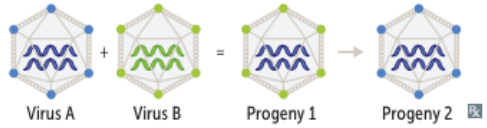
Note:

- 2 live vaccines can be given if given @
different sites
- can't be given @ same site
- repeat dose: min gap of 4 weeks

Note: Enveloped → made of lipid → dissolved by solvent
i.e. alcohol, bile, soap
Non enveloped - not applicable
detergent
∴ loses envelope &
loses infectivity

Group	Definition	Bacteria	Virus	Fungi
Group -1	Biological agents that are unlikely to cause human disease	- No pathogenic organisms	-	-
Group - 2	Biological agents that can cause human disease and may be hazard to workers: but are unlikely to spread to community: effective treatment or prophylaxis is usually available	Bacillus species (except B. anthracis) clostridium species Corynebacterium diphtheria Enterobacteriaceae Staphylococcus streptococcus Mycobacterium (except M. tuberculosis)	Adenovirus Calicivirus Coronavirus (not SARS Co. V) Herpesvirus influenza virus	Cryptococcus Candida Dermatophyte: Aspergillus
Group - 3	Biological agents that can cause severe human disease and are a serious hazard to workers; they may spread to the community; but effective treatment or prophylaxis is usually available	B. anthracis Brucella species Coxiella burnetii Francisella tularensis M. tuberculosis	Prion LCM virus (Lymphocytic choriomeningitis)) Hantavirus SARS Co. V Encephalitis virus such as- St. Louis Japanese West Nile Western equine	
Group -4	Same as group 3 except that effective treatment or prophylaxis is usually not available		Lassa virus Ebola virus Marburg virus Herpes simiae virus	

Viral genetics

Recombination	Exchange of genes between 2 chromosomes by crossing over within regions of significant base sequence homology.	
Reassortment	When viruses with segmented genomes (eg, influenza virus) exchange genetic material. For example, the 2009 novel H1N1 influenza A pandemic emerged via complex viral reassortment of genes from human, swine, and avian viruses. Has potential to cause antigenic shift.	
Complementation	When 1 of 2 viruses that infect the cell has a mutation that results in a nonfunctional protein, the nonmutated virus “complements” the mutated one by making a functional protein that serves both viruses. For example, hepatitis D virus requires the presence of replicating hepatitis B virus to supply HBsAg, the envelope protein for HDV.	
Phenotypic mixing	Occurs with simultaneous infection of a cell with 2 viruses. For progeny 1, genome of virus A can be partially or completely coated (forming pseudovirion) with the surface proteins of virus B. Type B protein coat determines the tropism (infectivity) of the hybrid virus. Progeny from subsequent infection of a cell by progeny 1 will have a type A coat that is encoded by its type A genetic material.	

Receptors used by viruses

VIRUS	RECEPTORS
CMV , <i>Adenoviruses</i>	Integrins (heparan sulfate)
EBV	CD21
HIV	CD4, CXCR4, CCR5
P arvovirus B19	P antigen on RBCs
Rabies	Nicotinic AChR
R hinovirus	ICAM-1 (I CAM e to see the rhino)