Introduction to **Virology**

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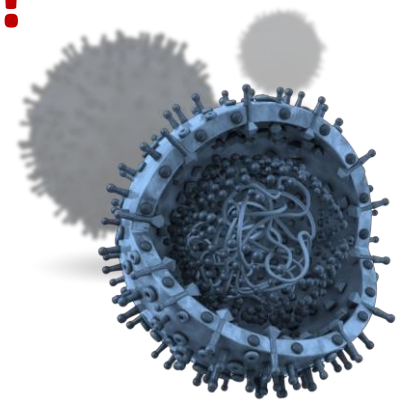
What is a virus?



Viruses are very different from the other microbial groups. They are so small (filterable) that most can be seen only with an **electron microscope**, and they are **acellular** (not cellular). Viruses can reproduce only by using the cellular machinery of other organisms **(obligatory intracellular parasites)**

TABLE 13.1 Viruses and Bacteria Compared

	Bacteria		
	Typical Bacteria	Rickettsias/ Chlamydias	Viruses
Intracellular Parasite	No	Yes	Yes
Plasma Membrane	Yes	Yes	No
Binary Fission	Yes	Yes	No
Pass through Bacteriological Filters	No	No/Yes	Yes
Possess Both DNA and RNA	Yes	Yes	No
ATP-Generating Metabolism	Yes	Yes/No	No
Ribosomes	Yes	Yes	No
Sensitive to Antibiotics	Yes	Yes	No
Sensitive to Interferon	No	No	Yes

Historical background

One hundred years ago, researchers couldn't imagine sub microscopic particles, so they described the infectious agent as *contagium vivum fluidum*—a contagious fluid

(١٧٩٨) Edward Jenner, introduced the term **virus** in microbiology. noticed that milk maids who infected with cowpox develop immunity against smallpox.

He inoculated a boy with the vesicle fluid taken from the hand of infected maid. The boy developed sustained immunity against smallpox.

(١٩٣٥) Wendell Stanley, isolated tobacco mosaic virus TMV, making it possible for the first time to carry out chemical and structural studies on a purified virus. At about the same time, the invention of the electron microscope made it possible to see viruses.

Figure ١. Edward Jenner inoculating a boy with the vesicle fluid taken from the hand of infected maid with cowpox. The boy developed sustained immunity against smallpox.

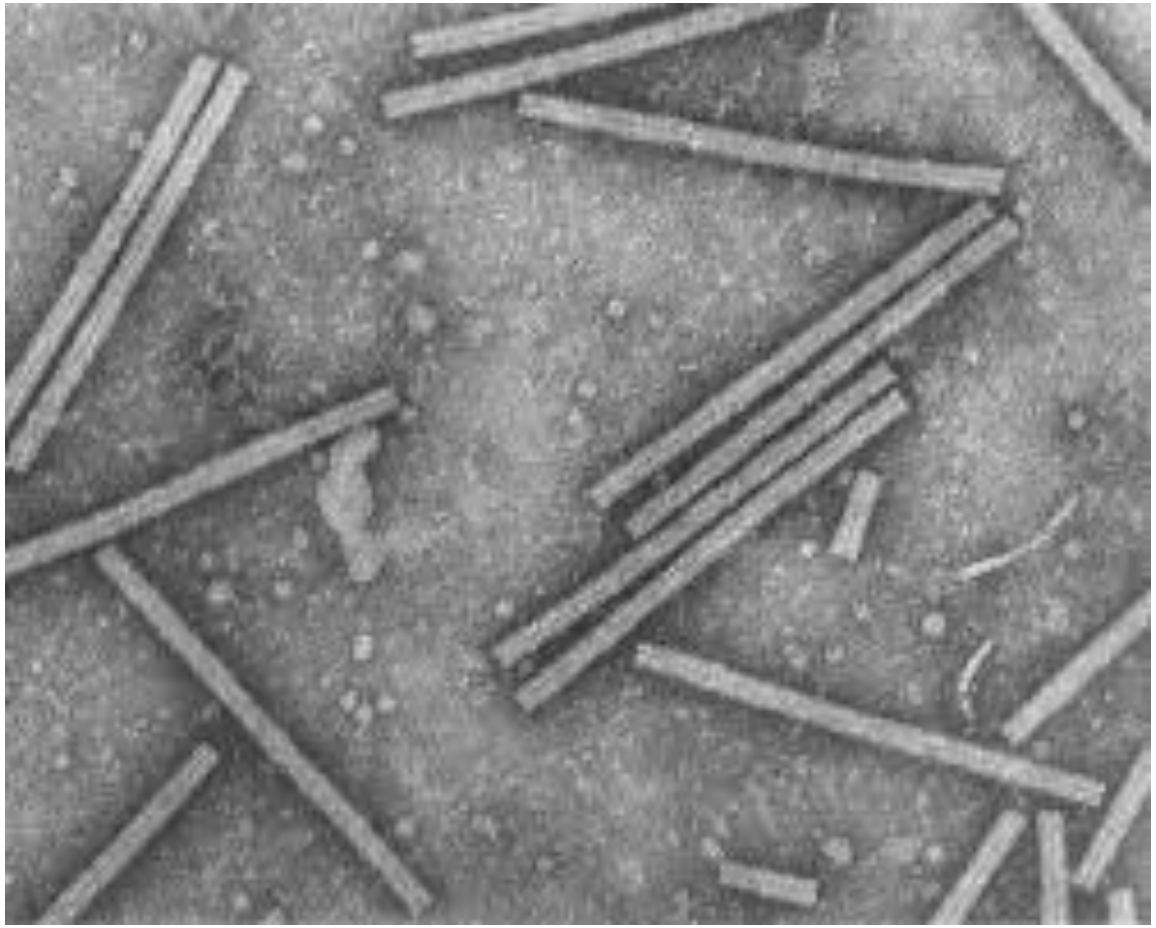


Figure 2. Tobacco mosaic virus (TMV(

Virus Host Range

The host range of a virus is → spectrum of host

the cells that virus can infect.

Viruses are able to infect specific types of cells of only one host species. (host specific)

In rare cases, viruses cross the host-species barrier, thus expanding their host range.

Virus Host Range

Viruses can infect:

- Invertebrates
- Vertebrates
- Plants

Human

Other vertebrates

- Pparasites
- Fungi
- Bacteria
- Bacteriophages

Viruses infect:

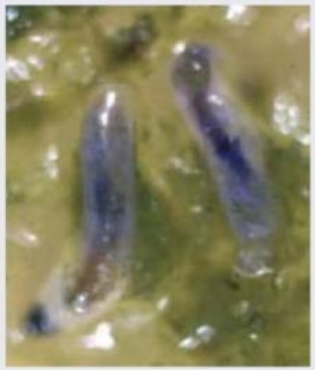
- **Humans**

Smallpox [1]

- **Other vertebrates**

Foot and mouth disease [2]

- **Invertebrates**



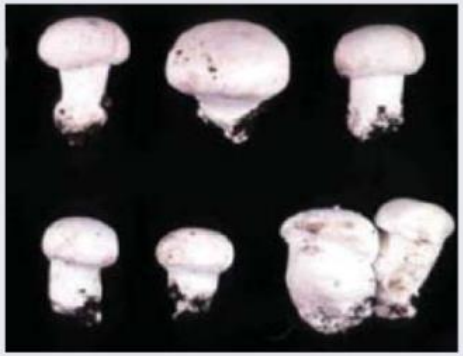
Leatherjackets infected with *Tipula* iridescent virus

- **Plants**

Delayed emergence of potato caused by tobacco rattle virus infection [3]

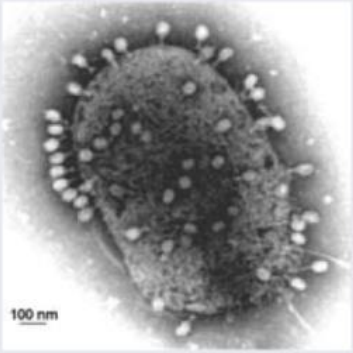
Damaged potato (spraing) caused by tobacco rattle virus infection [3]

- **Fungi**



Mushroom virus X [4]

- **Bacteria**



Escherichia coli cell with phage T4 attached [5]

)Virology Principles & Applications Book, p(1

Viral Size

Viral sizes are determined with the aid of electron microscopy. Different viruses vary considerably in size. Although most are quite a bit smaller than bacteria, some of the larger viruses (such as the vaccinia virus) are about the same size as some very small bacteria .Viruses range from **20 to 1000 nm** in length.

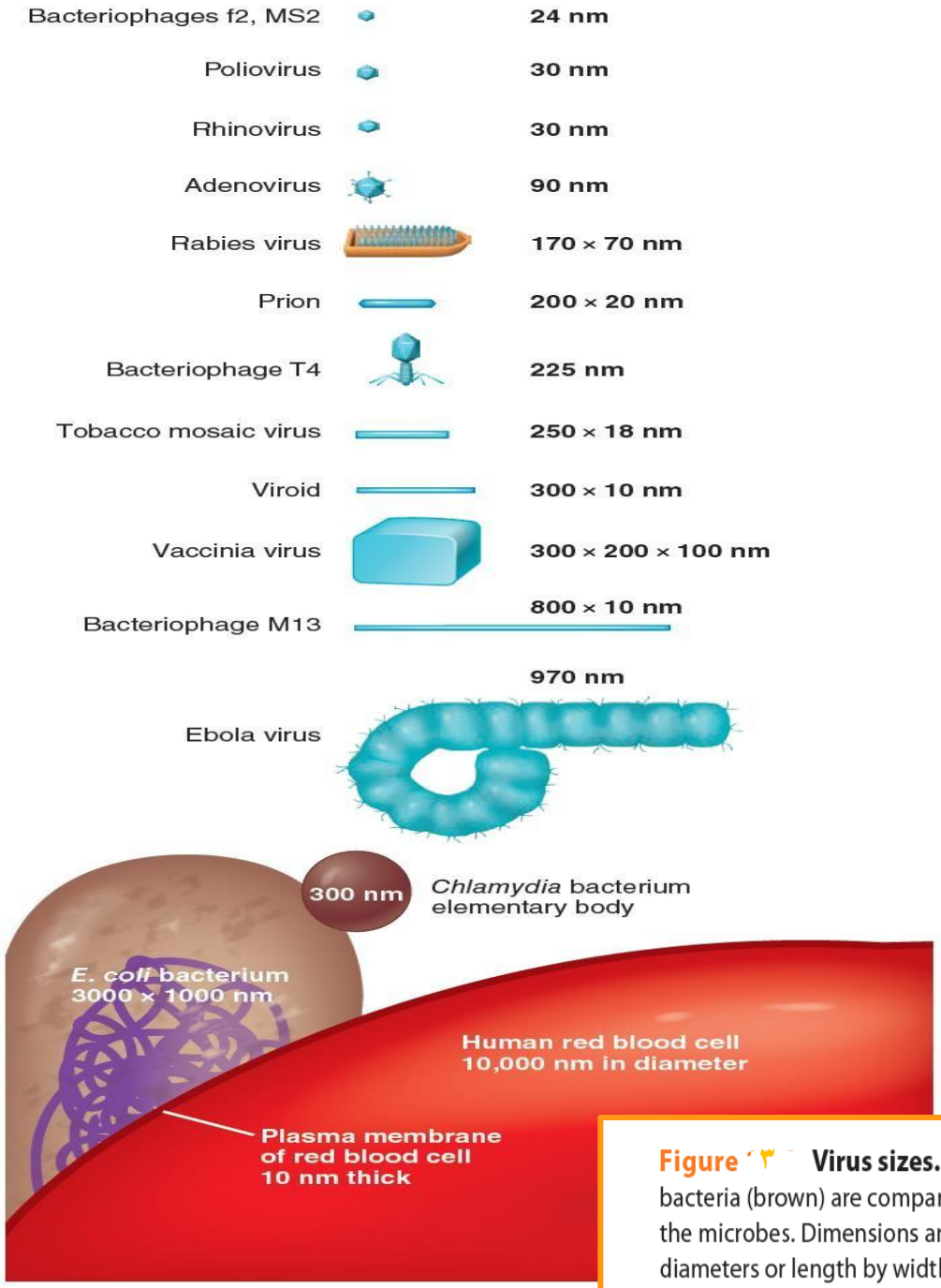
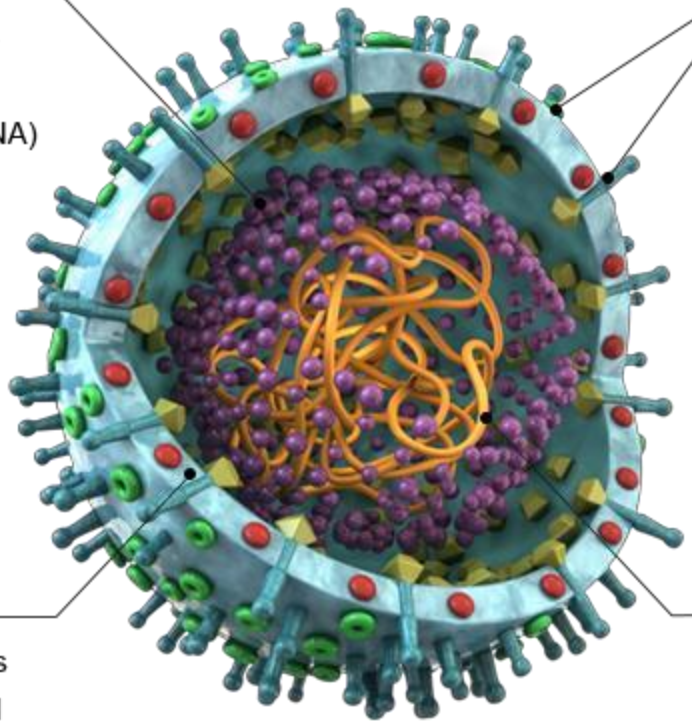
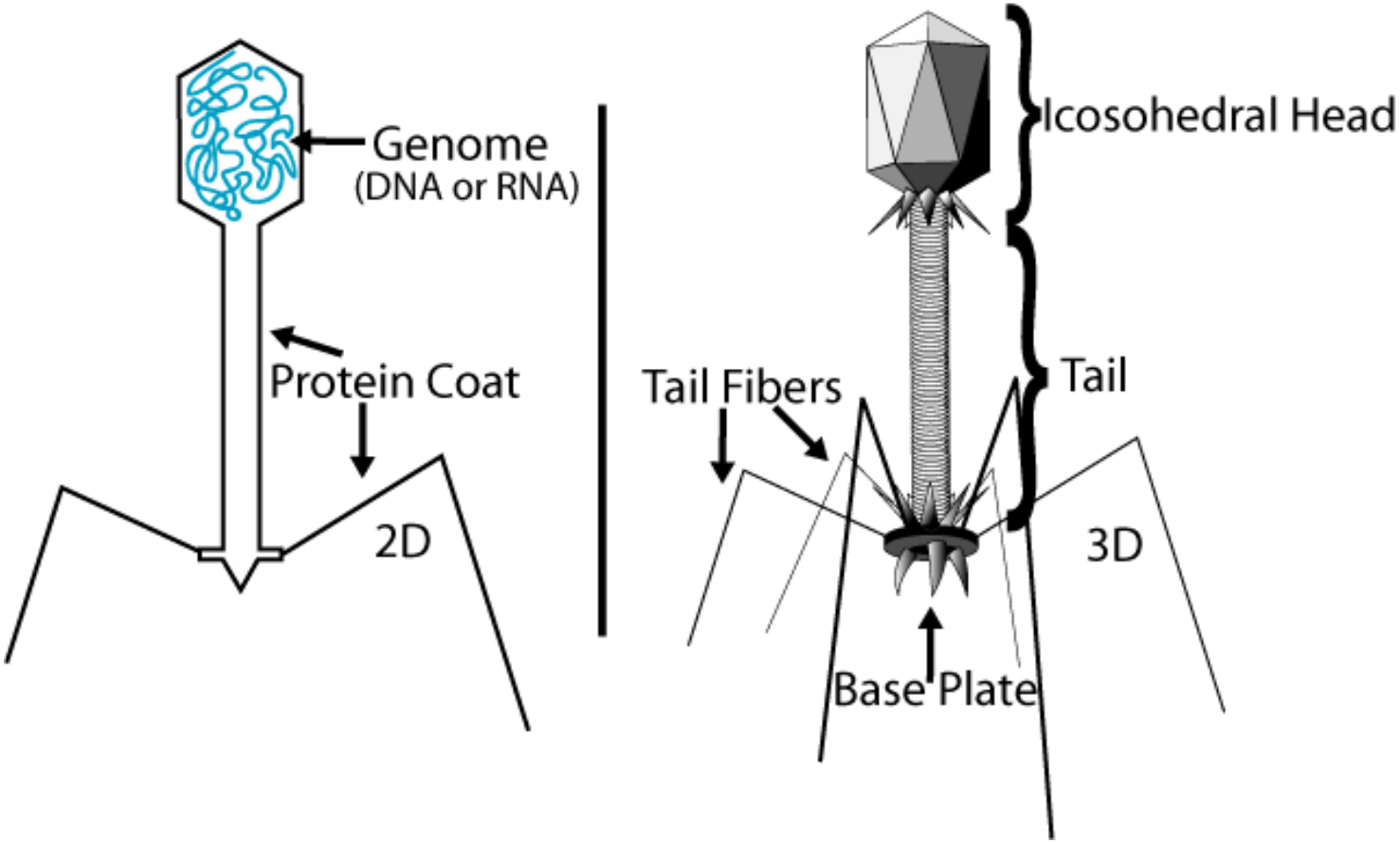


Figure ٣ Virus sizes. The sizes of several viruses (teal blue) and bacteria (brown) are compared with a human red blood cell, shown below the microbes. Dimensions are given in nanometers (nm) and are either diameters or length by width.

Structure of Virus



Bacteriophage Structure

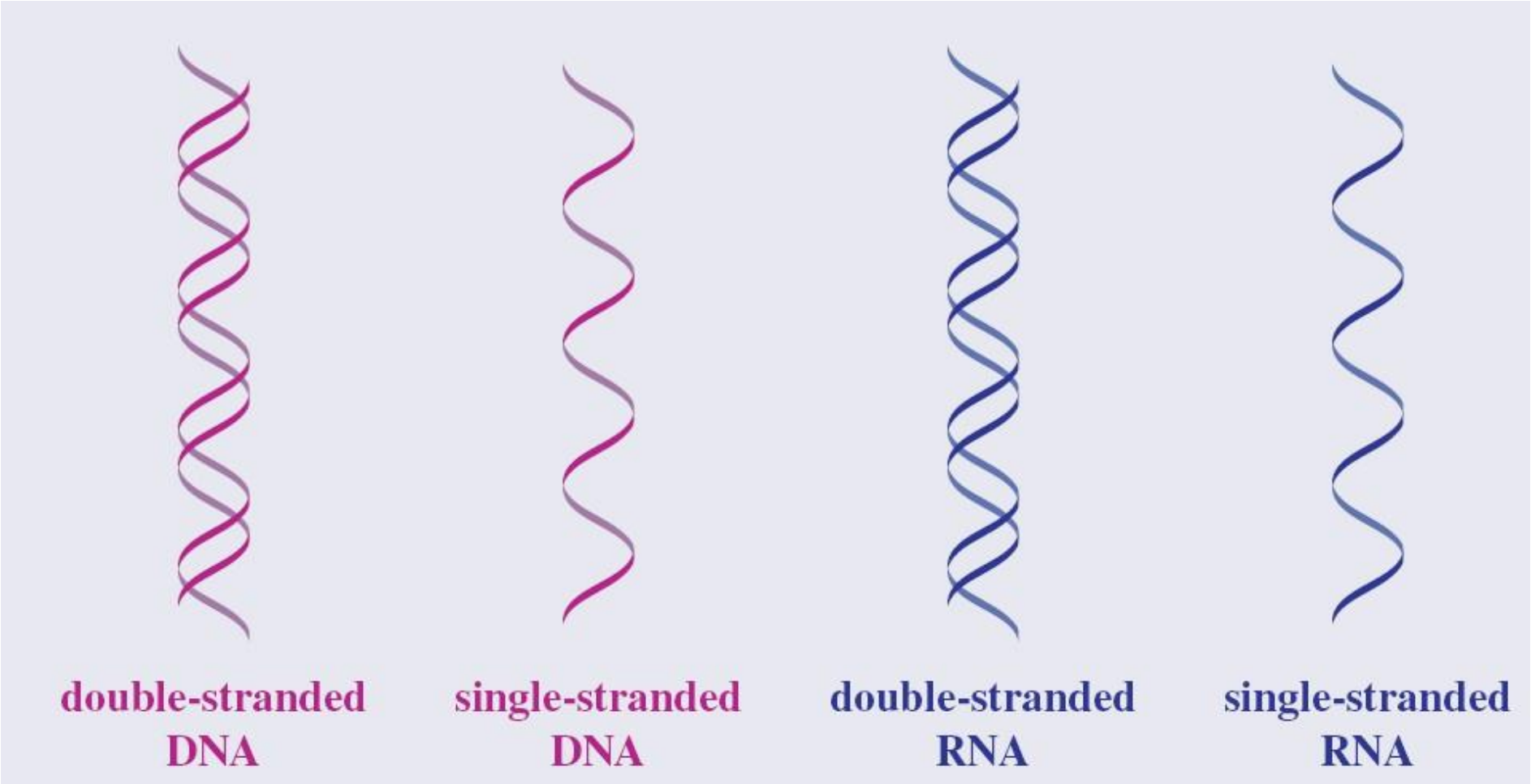


Virus Genomes

In contrast to prokaryotic and eukaryotic cells, in which DNA is always the primary genetic material (and RNA plays an auxiliary role), a virus can have either) **DNA** or **RNA** but never both.

The nucleic acid of a virus can be → single-stranded / double-stranded.

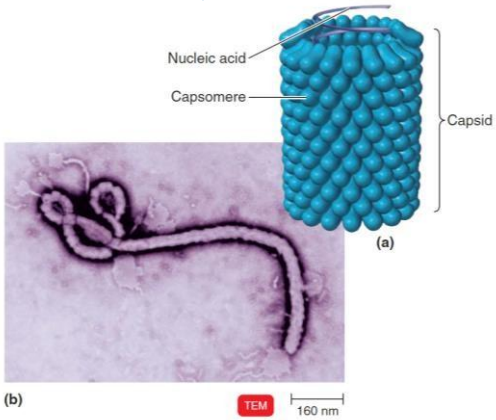
Virus Nucleicacid



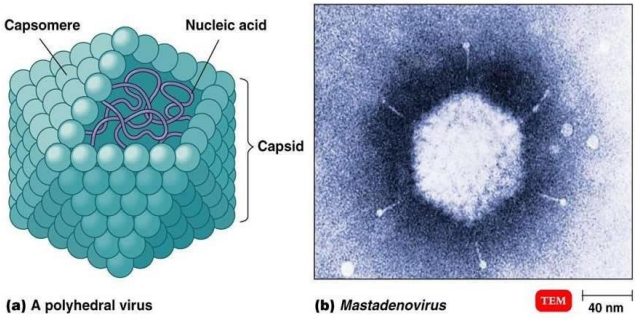
General Morphology

)basis of their capsid architecture(.

- **Helical Viruses:**
  - Example: **Ebola** viruses

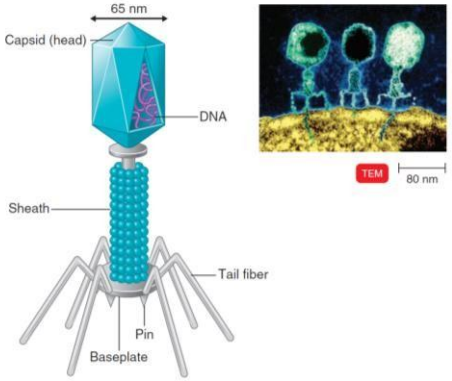


- **Polyhedral Viruses:**
  - Example: **poliovirus.**



- **Complex Viruses:**

example :**bacteriophage.**



Nomenclature of Viruses

- Various approaches, (do not obey the binomial nomenclature) derived from:

Named after the diseases
eg. Measles virus, smallpox virus

Name after the places where the disease first reported
eg. Newcastle disease virus, Ebola virus، Norwalk virus, Bunyaviridae

Host and signs of disease
e.g. Tobacco mosaic virus, cauliflower mosaic virus brome mosaic virus

Latin and Greek words
e.g. Coronaviridae – "crown"
Parvoviridae – "small

Virus discovers
e.g. Epstein-Barr virus

How they were originally thought to be contracted
e.g. dengue virus ("evil spirit"), influenza virus
)the "influence" of bad air(

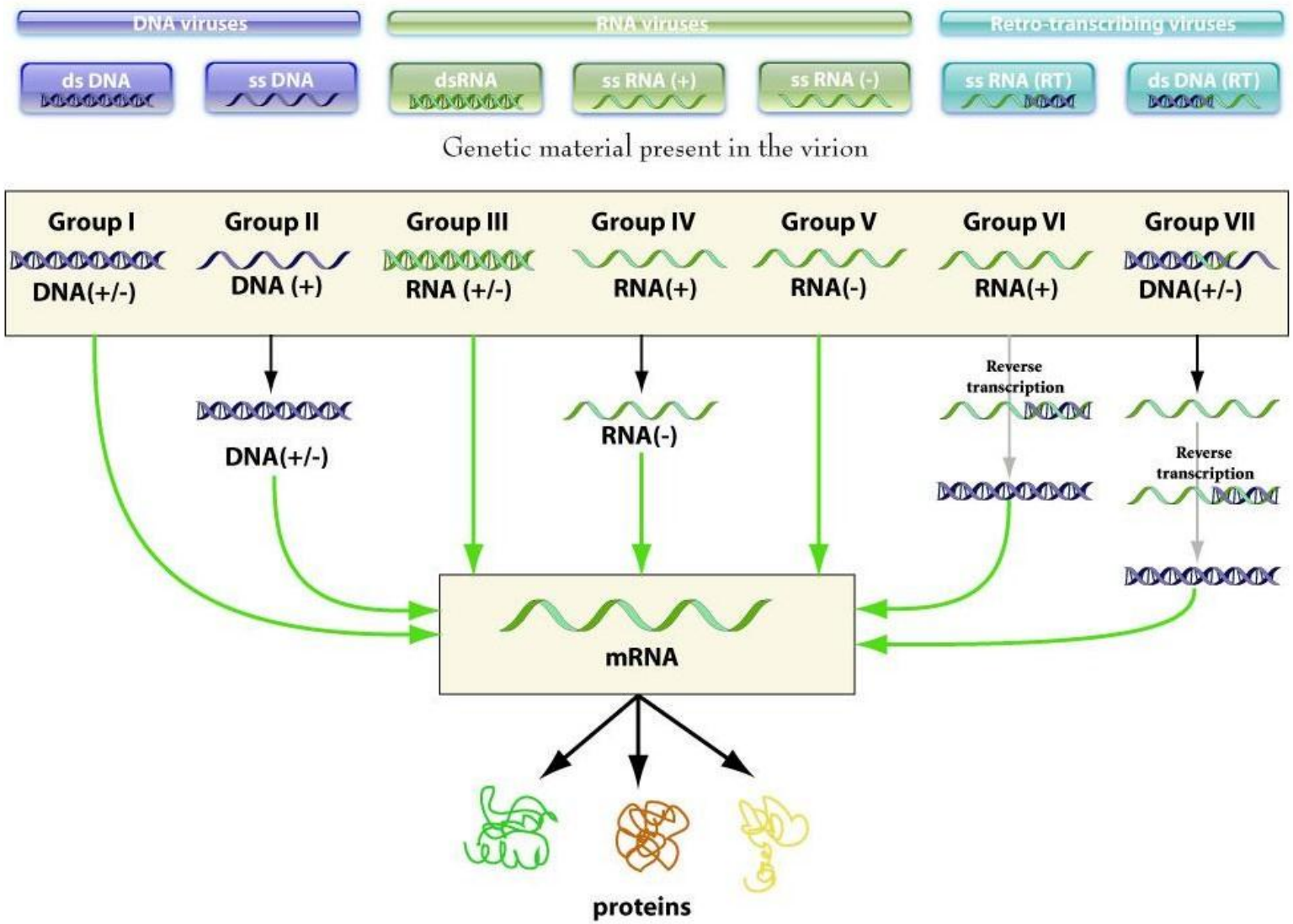
Classification of Virus

Using International Committee on Taxonomy of Viruses (ICTV) to classify the viruses

Classification of Virus

- **-1Classical system**
  - -eg. animal, plant, bacterial virus
  - -eg. naked or enveloped
- **-2Based on Genomics**
  - Baltimore classification
- **-3Based on Serology**
  - Classification based on Diagnostic virology

Baltimore classification



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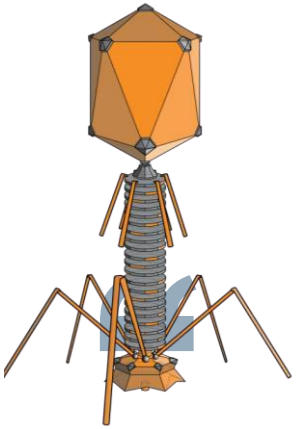
How do we Detect and Measure Viruses؟

)Isolation, Cultivation, and Identification of Viruses(

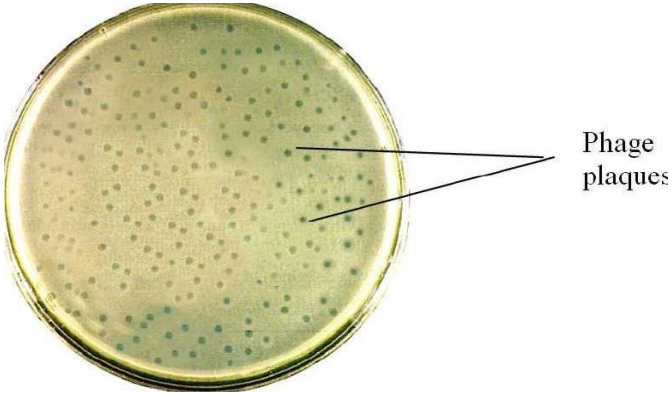
They can **not** be cultivated on artificial culture media.

The fact that viruses **can't** multiply outside a living host cell complicates their detection, enumeration, and identification.

✓Viruses **must** be provided with **living cells** instead of a fairly simple chemical medium (.()



▷However, viruses that use bacterial cells as a host (**bacteriophages**) are rather **easily** grown on **bacterial cultures.**



Methods for growing viruses in the laboratory

(1)Growing Bacteriophages

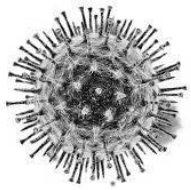
solid media

plaque method

)detect and count viruses(

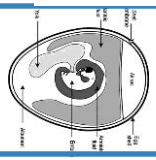
liquid media

(٢)Growing Animal Viruses



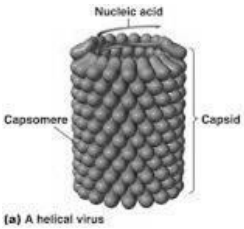
Living Animals

Embryonated Eggs



Cell Cultures

(٣)Growing plant Viruses



(١)Growing Bacteriophages in the Laboratory

The Number of Plaques

=

Plaque-forming Units (PFU.(

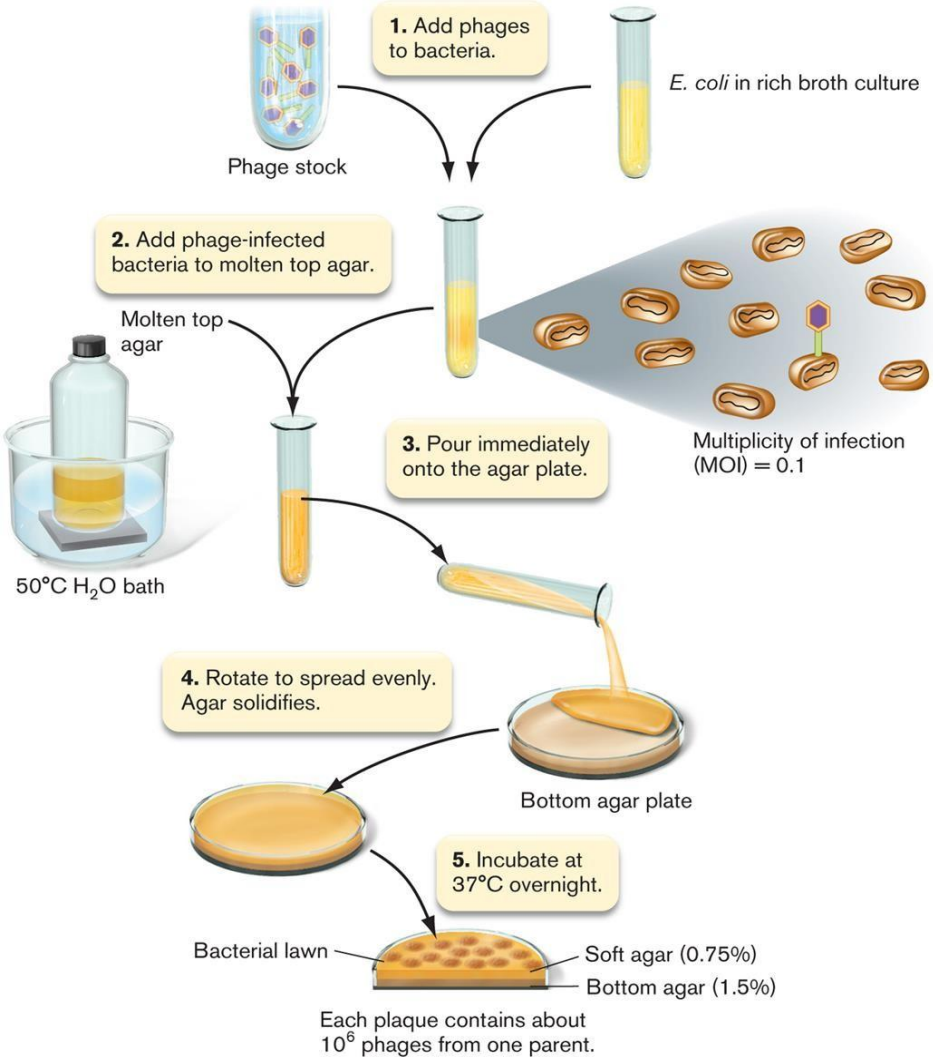


Figure 4. *plaque method.*

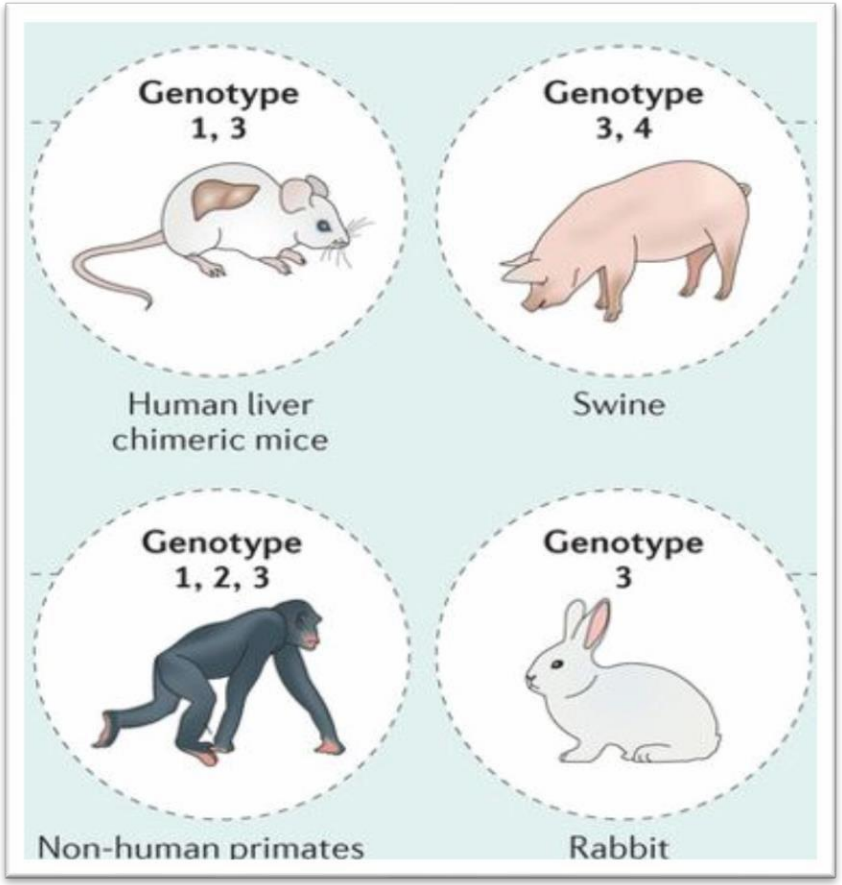
(2)Growing Animal Viruses

A- **In Living Animals**:

▹Some animal viruses can be cultured **only** in living animals, such as mice, rabbits, and guinea pigs.

▹Most experiments to study the **immune system's response** to viral infections.

▹ Animal inoculation may be used as a diagnostic procedure for **identifying** and **isolating** a virus from a clinical specimen.



(2)Growing Animal Viruses

B- **In Embryonated Eggs**:

Viral growth is signalled by:

1. The death of the embryo.
2. Embryo cell damage.
3. By the formation of typical pocks or lesions on the egg membranes.

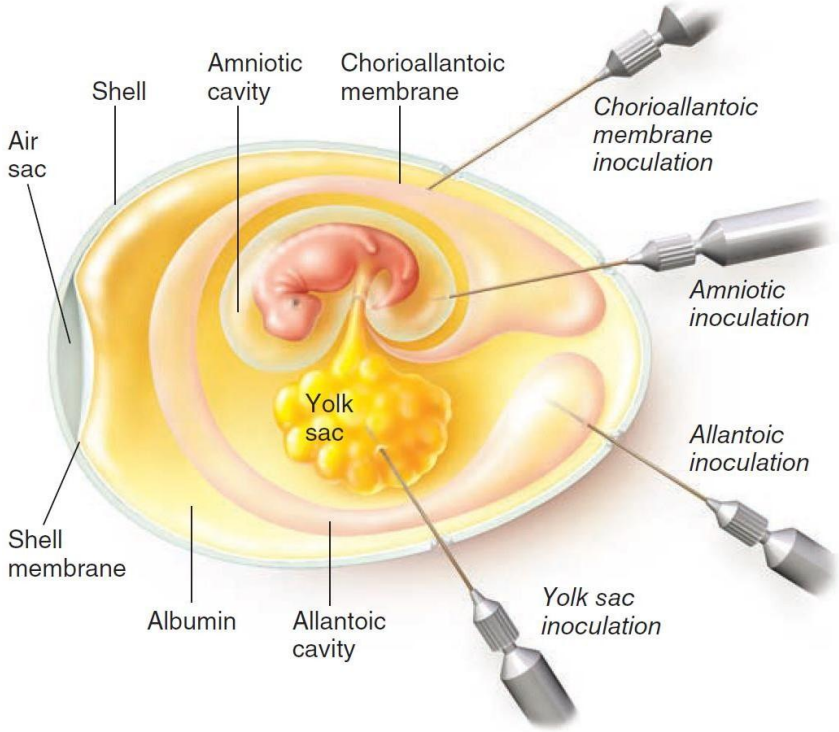


Figure .5 Inoculation of an embryonated egg. The viruses will grow on the membrane at the inoculation site.

(2)Growing Animal Viruses

B- In Embryonated Eggs:

The different sites of viral inoculation in embryonated eggs are:

1. Chorioallantoic membrane(CAM)
2. Amniotic Cavity
3. Allantoic Cavity
4. Yolk sac

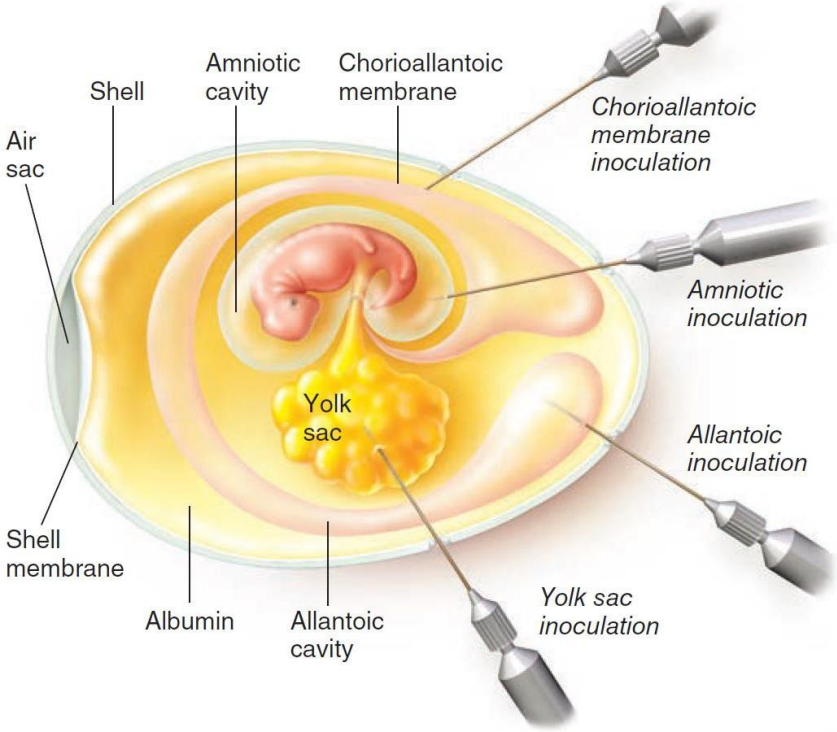


Figure .5 Inoculation of an embryonated egg. The viruses will grow on the membrane at the inoculation site.

(2)Growing Animal Viruses

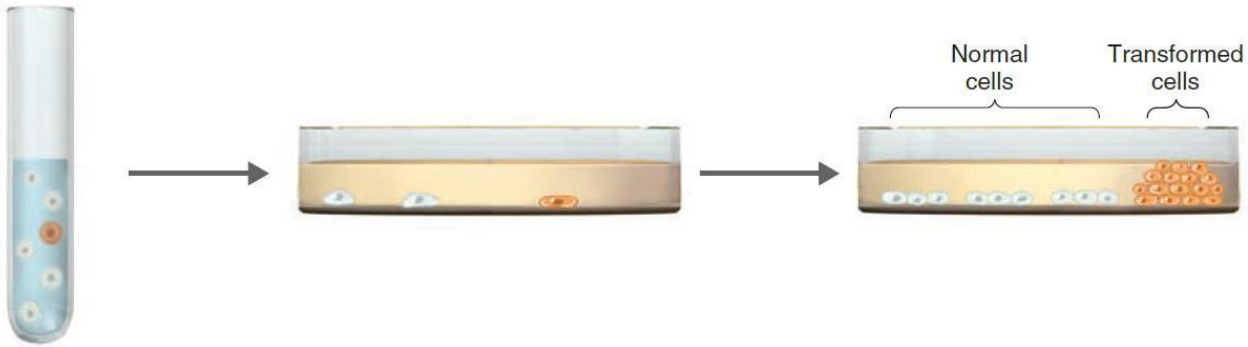
C - In Cell Cultures:

Cell cultures have replaced **embryonated eggs** as the preferred type of growth medium for many viruses. **Cell cultures consist of cells grown in culture media in the laboratory.**

(2)Growing Animal Viruses

C - In Cell Cultures:

Cell culture lines are started by treating a slice of animal tissue with enzymes that separate the individual cells (Figure ٥). These cells are suspended in a solution that provides the osmotic pressure, nutrients, and growth factors needed for the cells to grow.



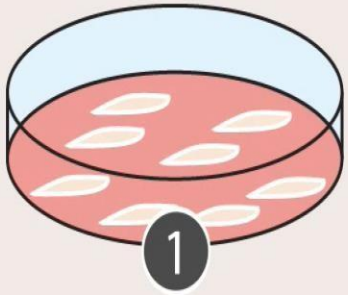
1 A tissue is treated with enzymes to separate the cells.

2 Cells are suspended in culture medium.

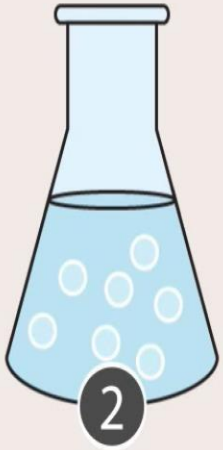
3 Normal cells or primary cells grow in a monolayer across the glass or plastic container. Transformed cells or continuous cell cultures do not grow in a monolayer.

Figure **Cell cultures.** Transformed cells can be grown indefinitely in laboratory culture.

Two main growth conditions



Monolayers
(Adherent cultures)



Free-floating
(Suspension cultures)

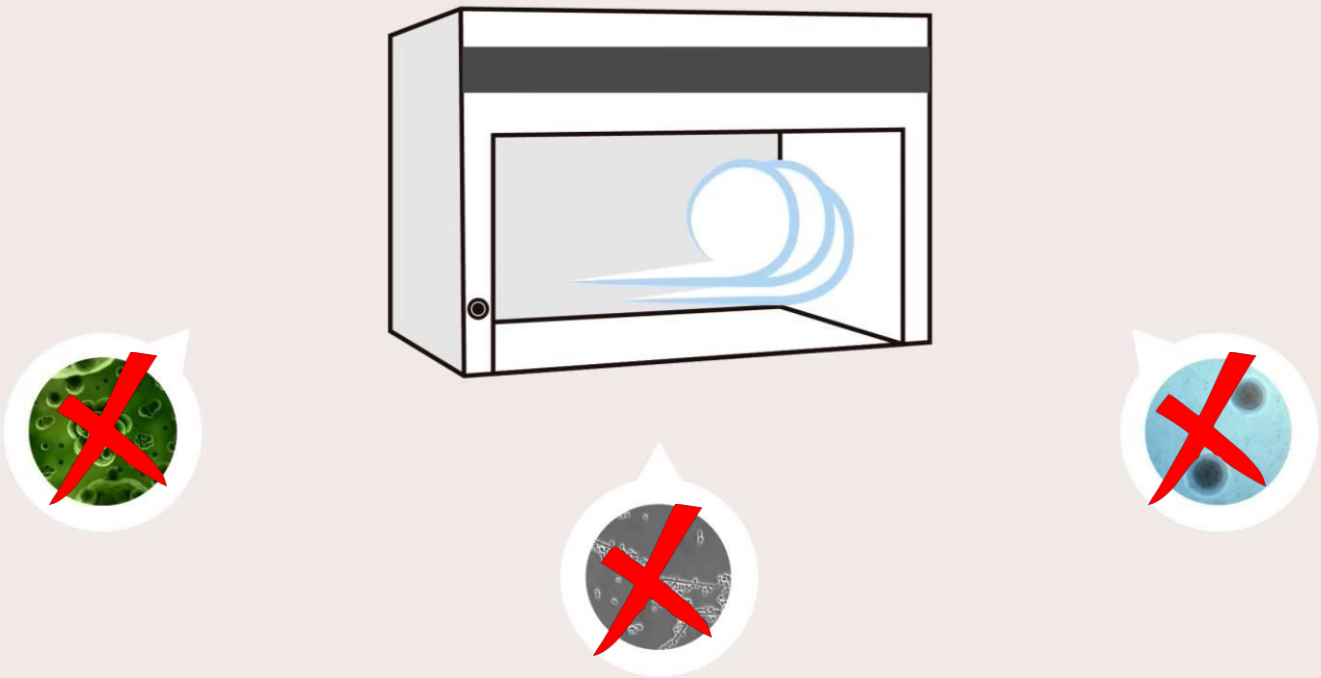
Examples of Cultureware

Flasks

Plates

Roller Bottles

Laminar Flow Hood



Commonly Used Commercial Media

1. Dulbecco's Modified Eagle Medium (DMEM)
2. Roswell Park Memorial Institute-1640 (RPMI)
3. Ham's F12 Nutrient Mixture (F12)

(١)Growing plant Viruses in the Laboratory

Plant viruses = similar in morphology and nucleic acid types to animal viruses

Common crop viruses:

- Bean mosaic virus
- Wound tumor virus
  - corn and sugarcane
- Potato yellow dwarf virus

Must penetrate cell wall by:

- Wounds
- Parasites
  - Ex) aphids that eat sap

Result = color change, deformed/stunted growth, wilting

(١) Growing plant Viruses in the Laboratory