

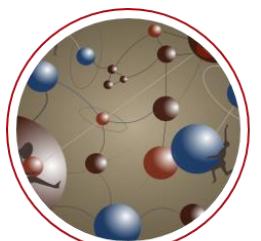
# On viruses and viral diseases

## + the case of COVID-19



Just One Giant Lab  
learning & solving together

Eugenia Covernton



Lecturers Without  
Borders

# On viruses and viral diseases

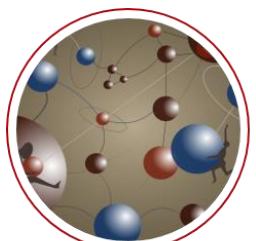
## + the case of COVID-19

### (20 FAQ)

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Q1·What is a virus? \_\_\_\_\_

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A virus is an *infectious agent*  
that replicates *only inside living cells*

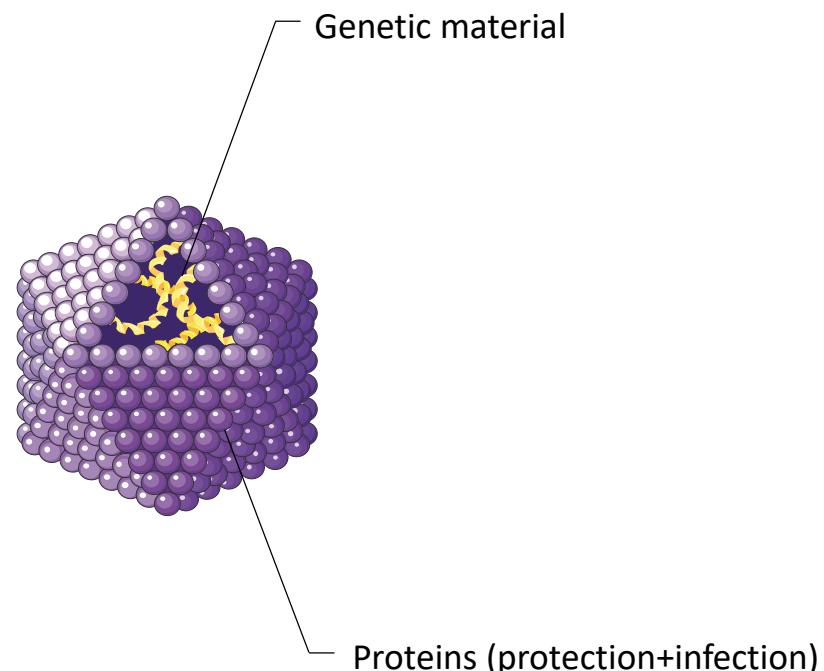
Q1·What is a virus? \_\_\_\_\_

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### Viral particle

Nucleic acids (DNA/RNA)

Proteins  
Protection  
Infection  
Replication



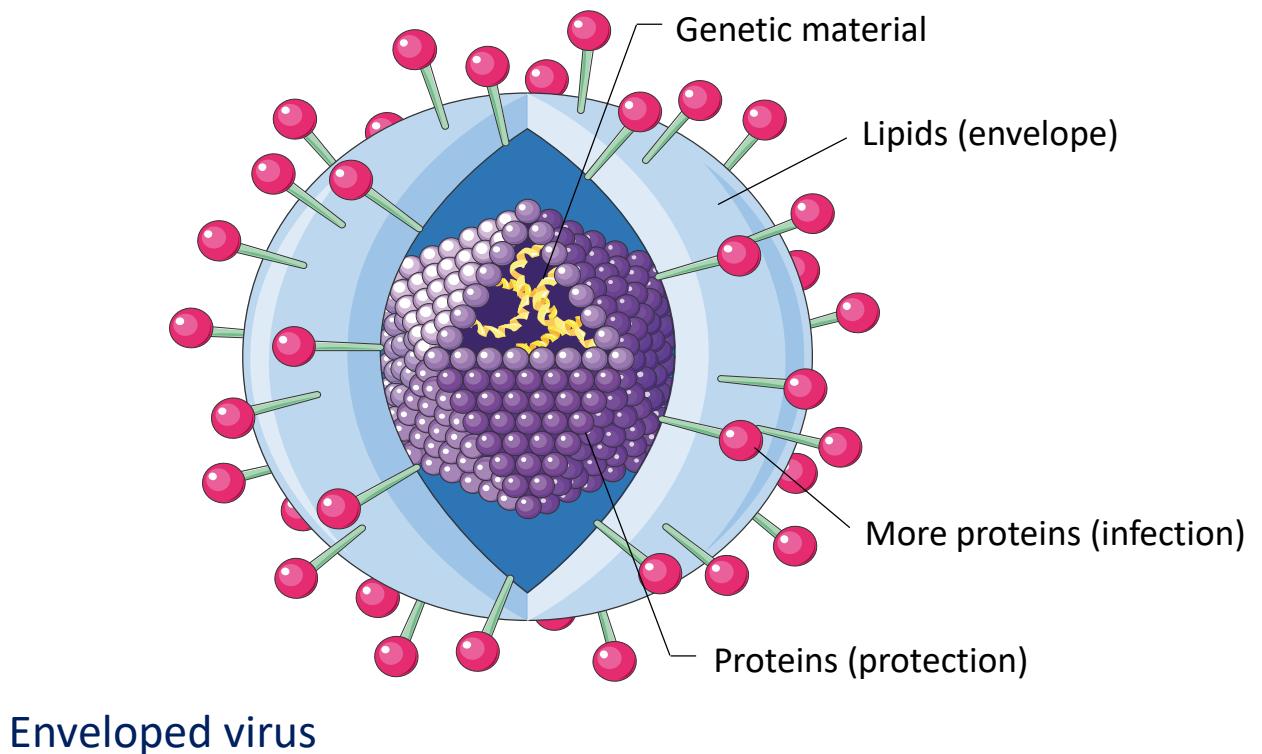
Non-enveloped virus

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### Viral particle

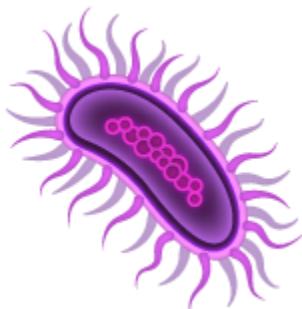
- Nucleic acids (DNA/RNA)
- Proteins
  - Protection
  - Infection
  - Replication
- Lipid envelope



Q1·What is a virus?

A virus is an **infectious agent** ?  
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Why not microorganism?

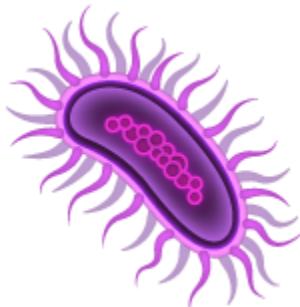


a common mistake

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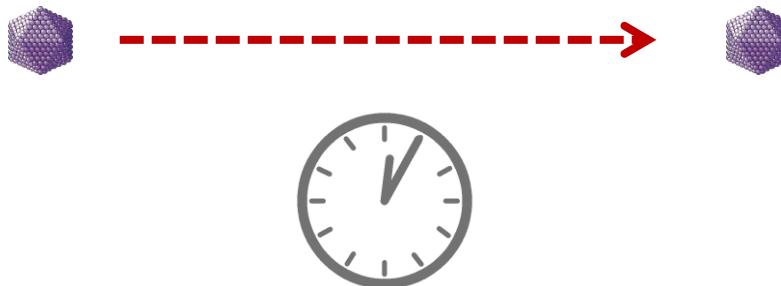
a common mistake

Any individual entity capable of reproduction,  
growth and development, maintenance, and  
some degree of response to stimuli.  
**(basically, a living entity)**

*Q2·Are viruses alive? \_\_\_\_\_*

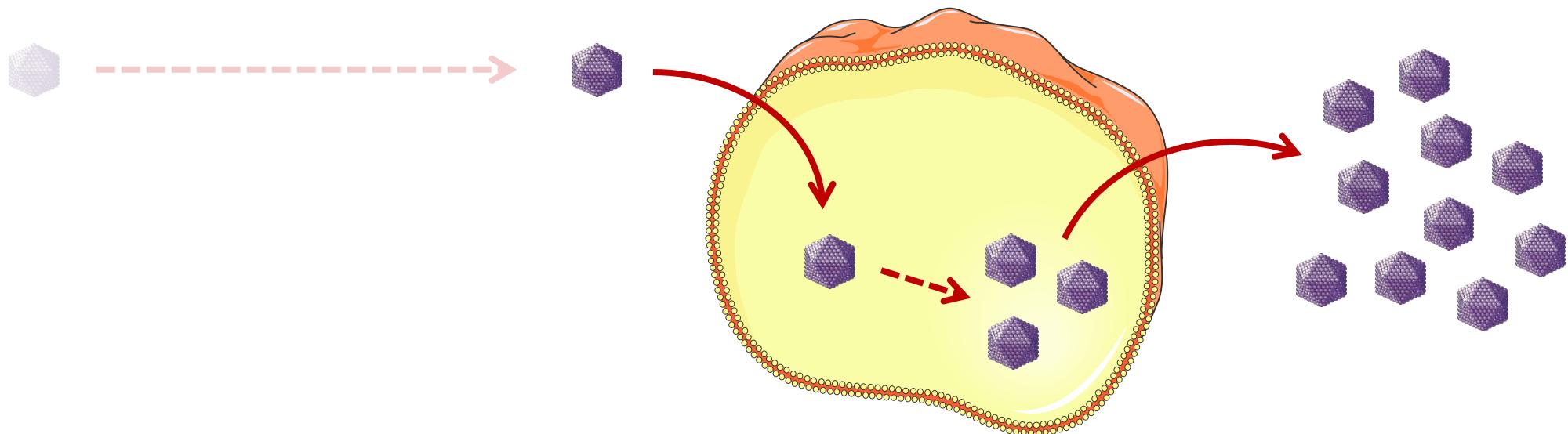
Q2 · Are viruses alive?

A virus is an *infectious agent*  
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Q2 · Are viruses alive?

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Q3. Do all virus look the same? \_\_\_\_\_

*Q3·Do all virus look the same? \_\_\_\_\_*

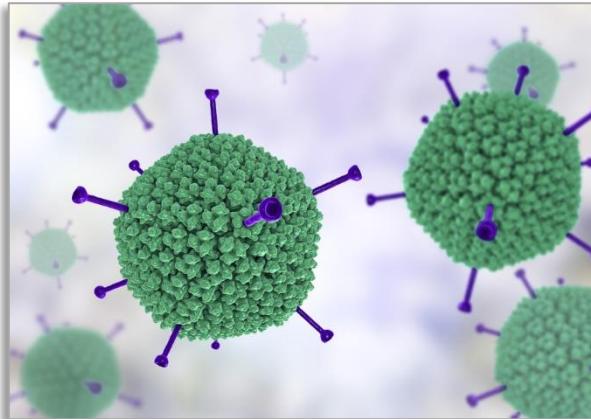
- Different shapes

*Q3·Do all virus look the same?*

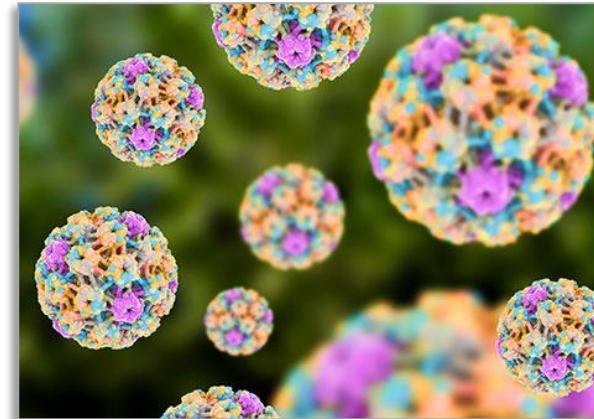
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► Different shapes

Non-enveloped



Adenovirus



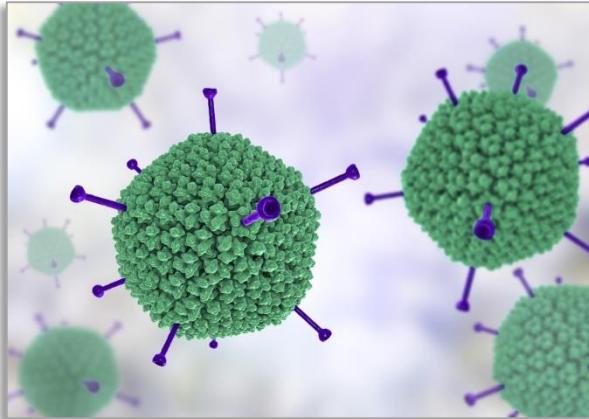
Papillomavirus

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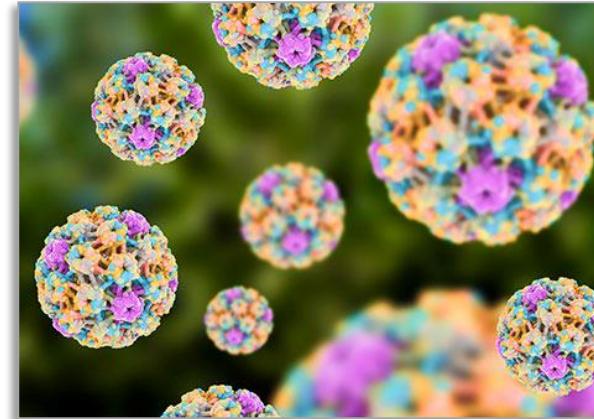
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► Different shapes

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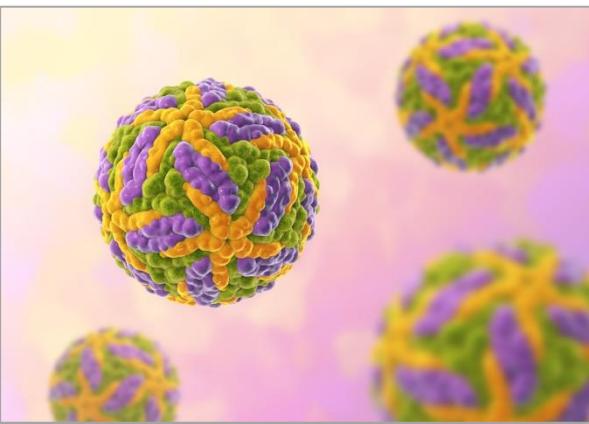


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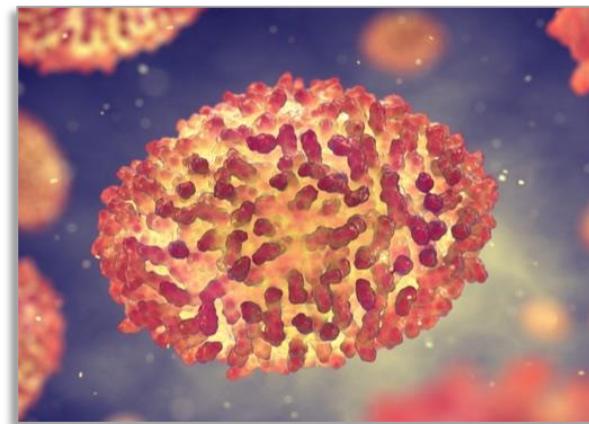


Papillomavirus

Enveloped



Yellow fever virus



Smallpox virus



Ebola virus

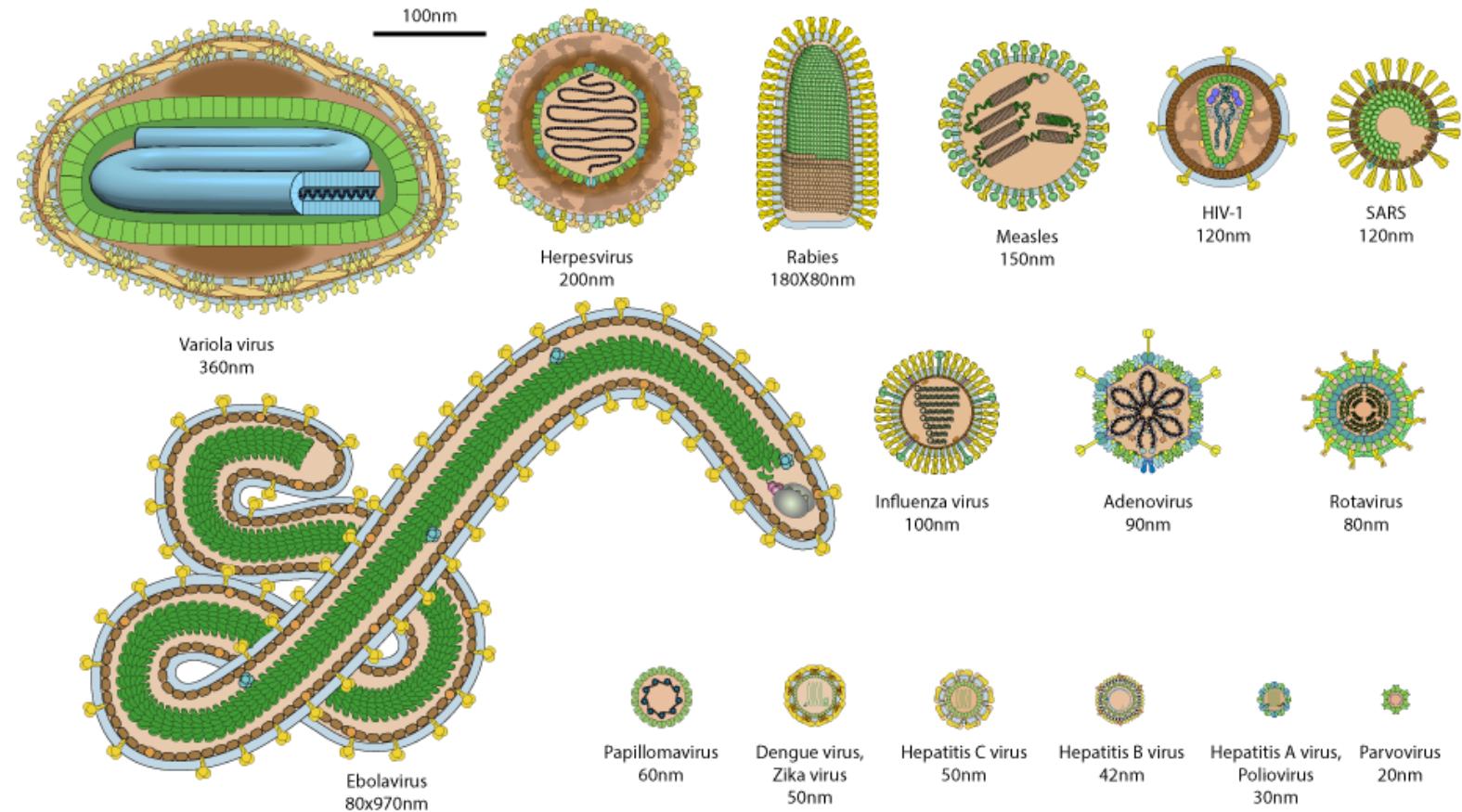
*Q3·Do all virus look the same? \_\_\_\_\_*

- Different sizes

*Q3·Do all virus look the same?*

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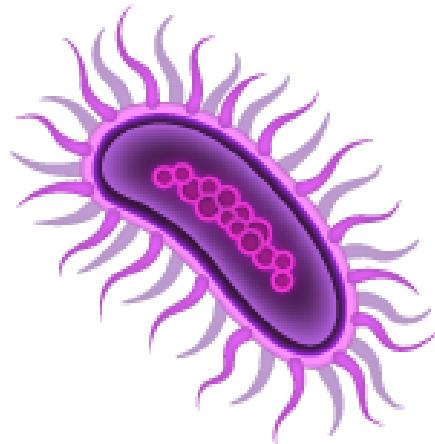
► Different sizes



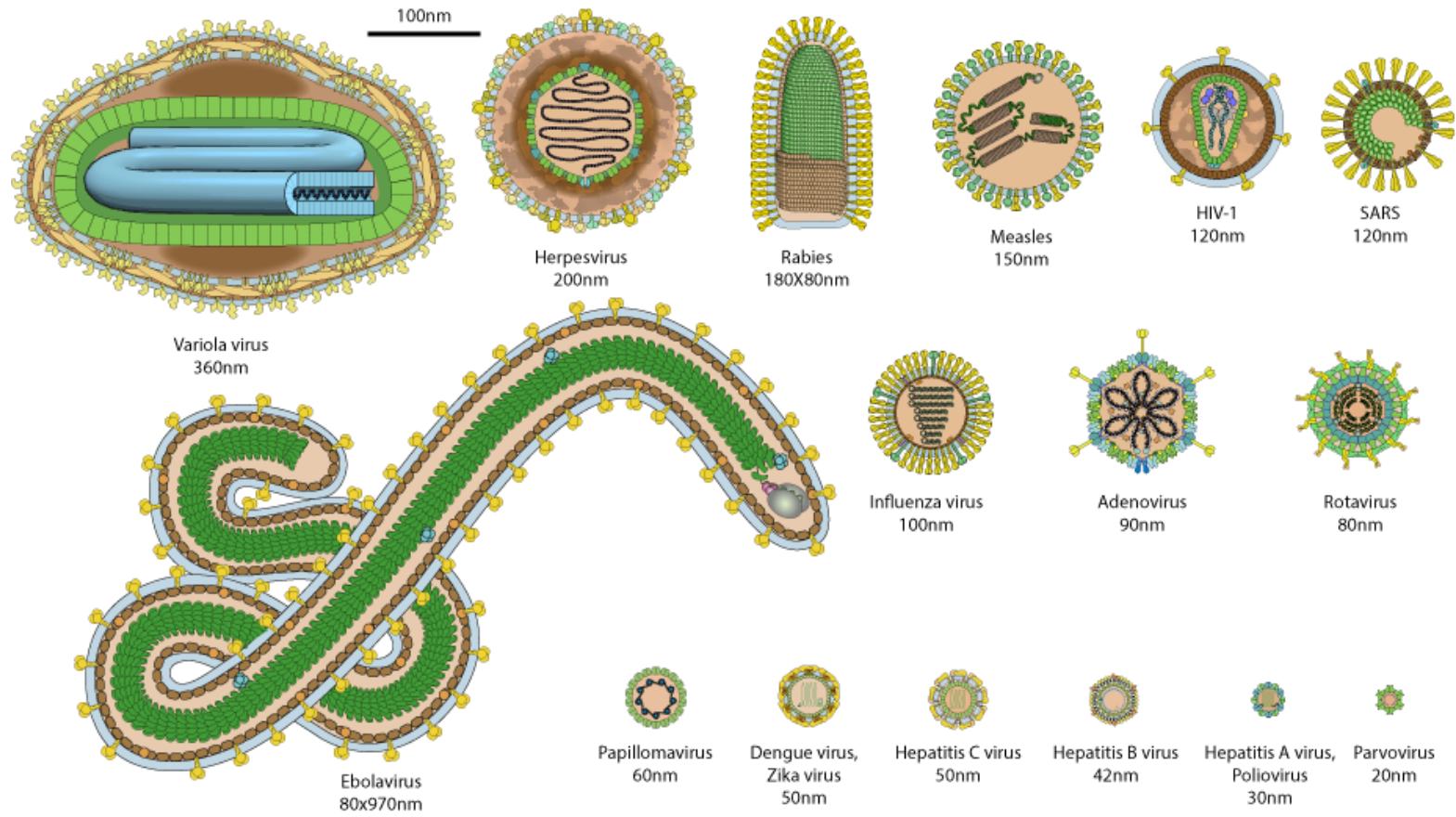
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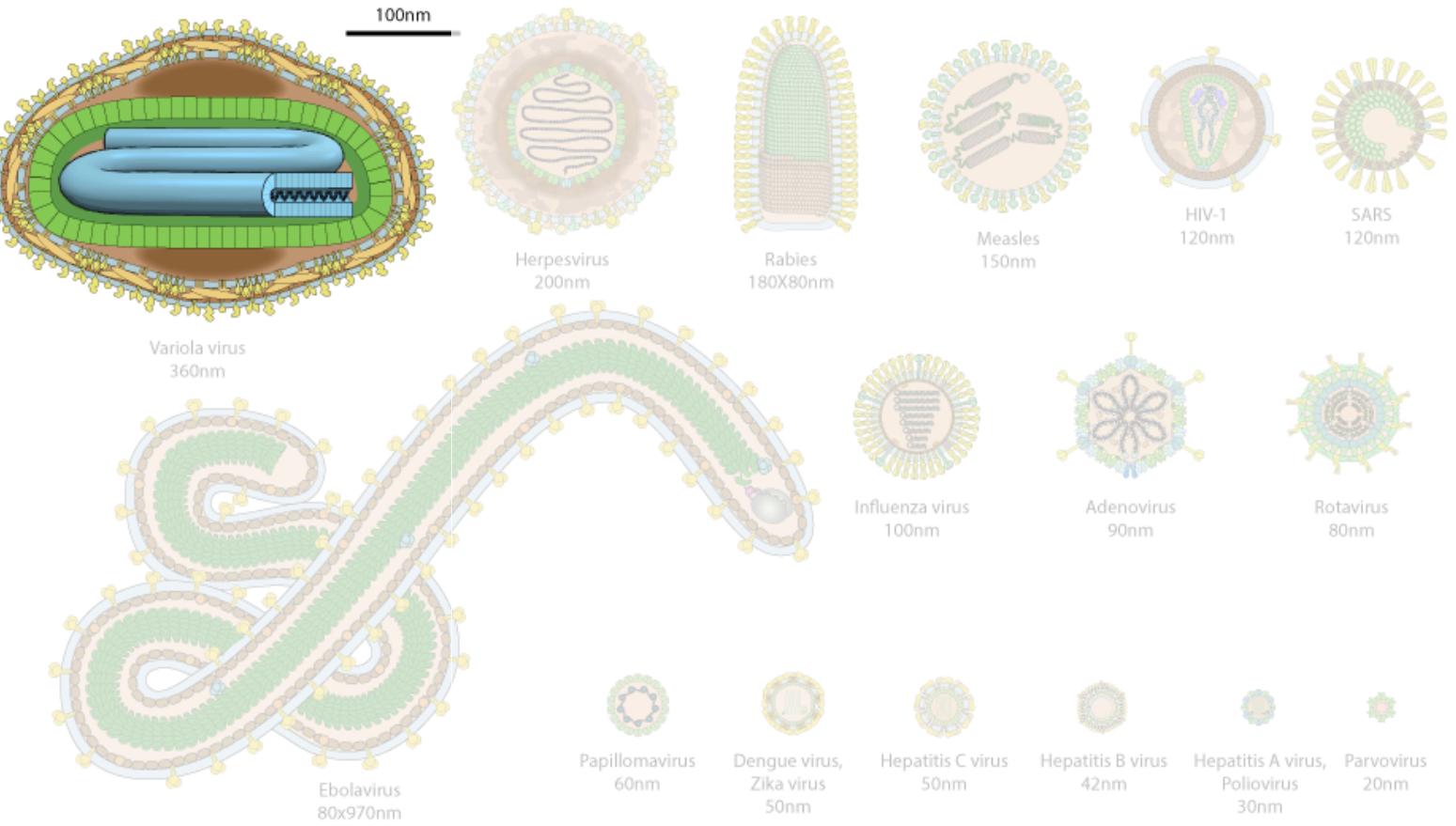
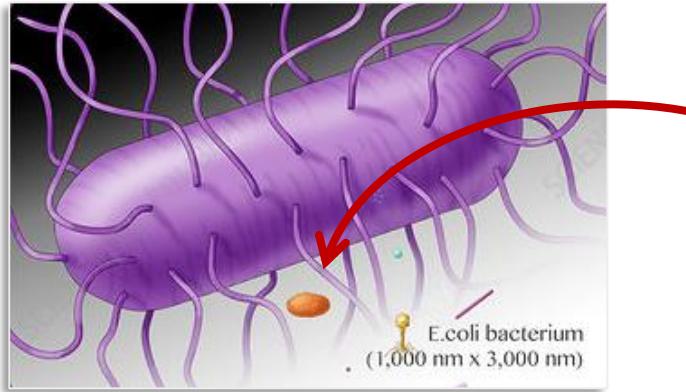
a common mistake



*Q3·Do all virus look the same?*

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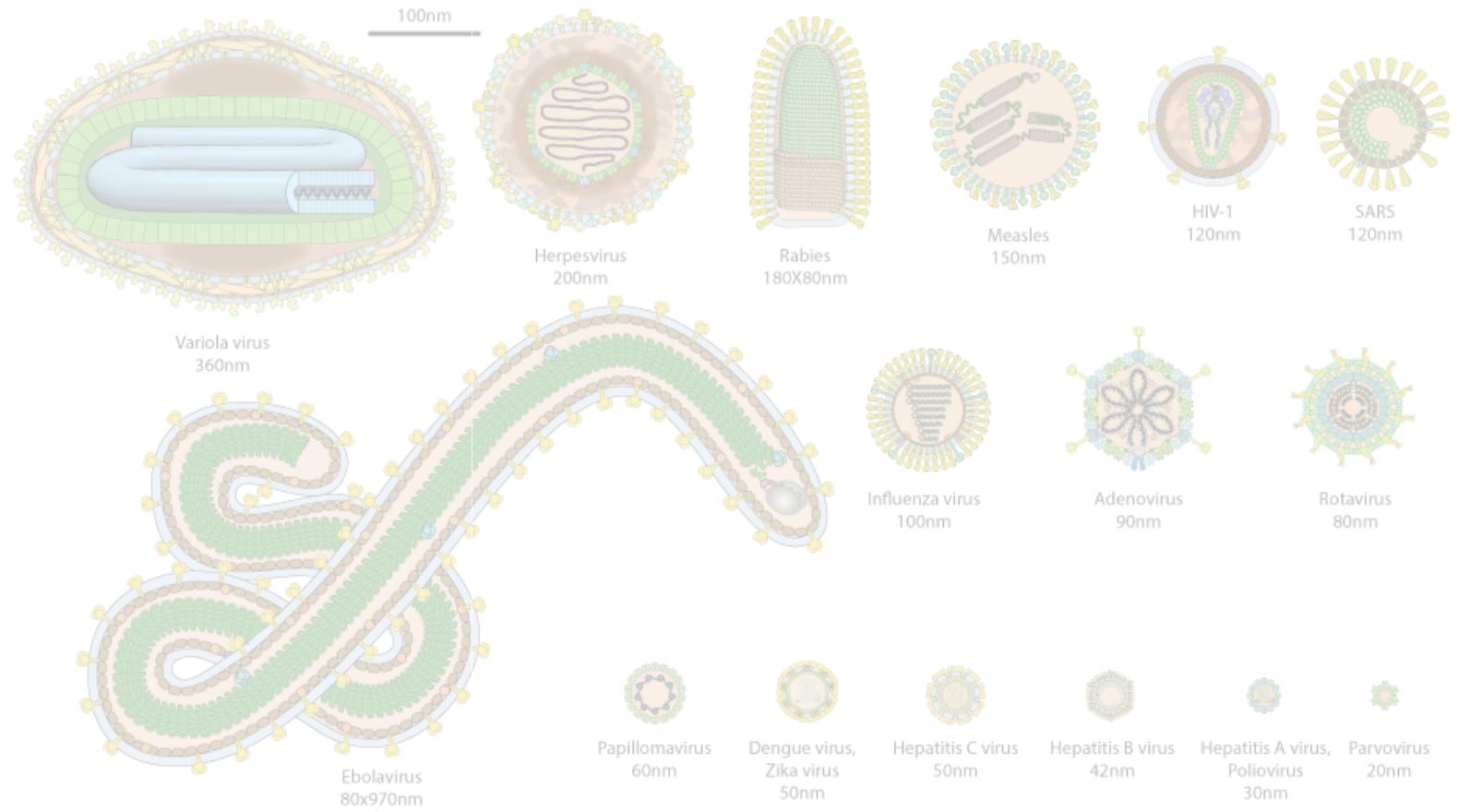
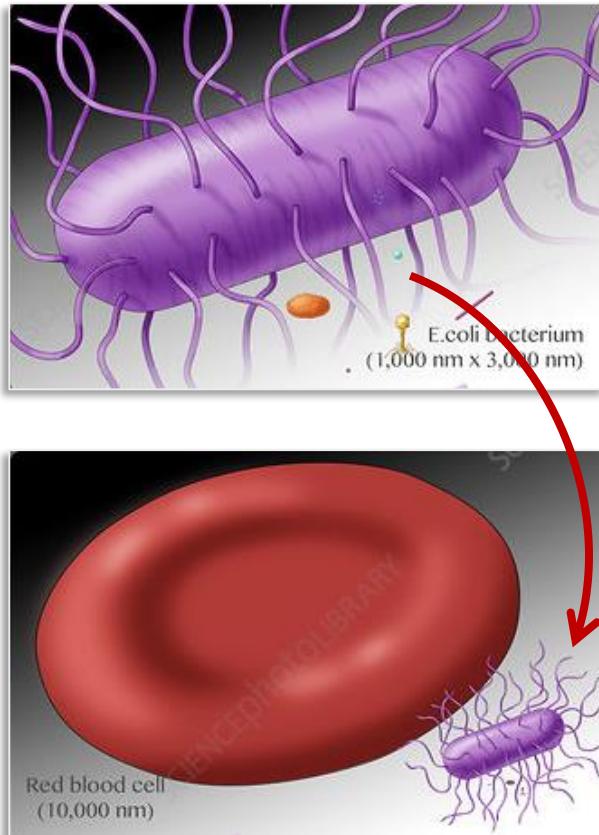
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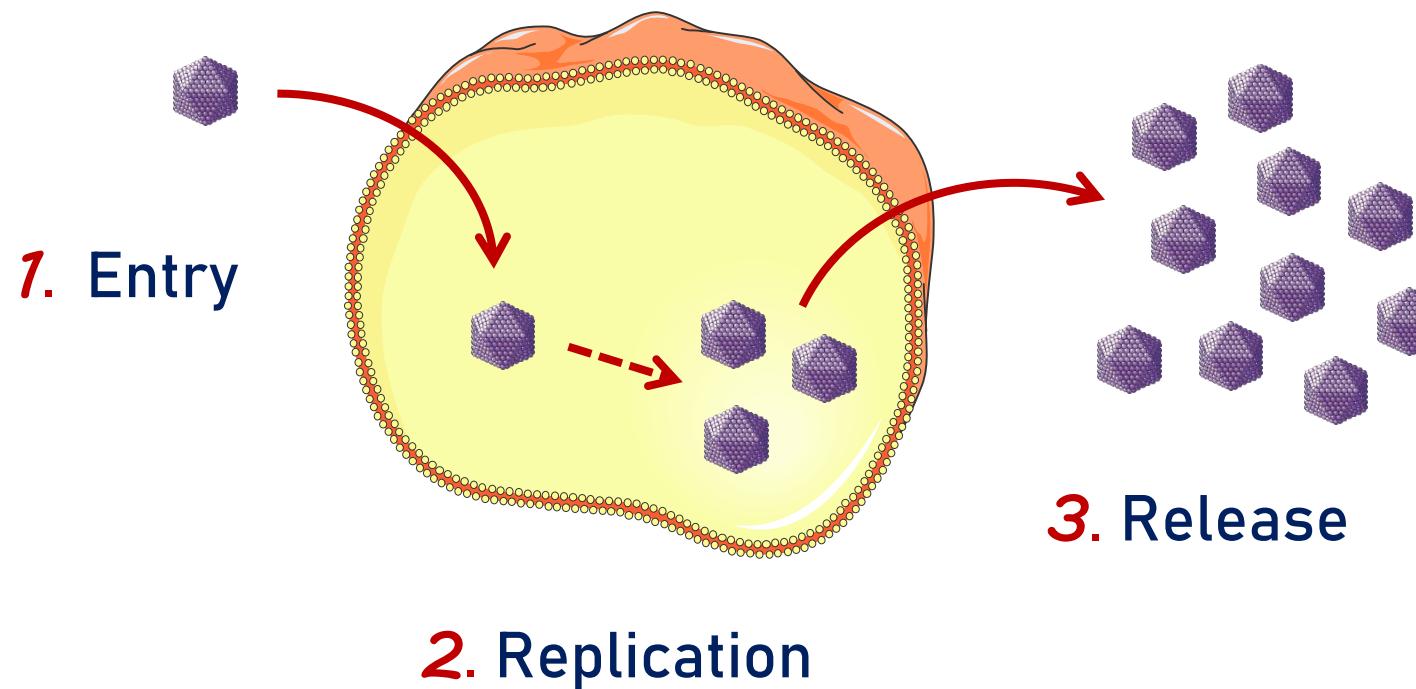


VIRAL  
INFECTION

Q4·What is a viral infection? \_\_\_\_\_

Q4. What is a viral infection? \_\_\_\_\_

**Viral infection** is the process through which the virus **replicates inside cells**



*Q4·What is a viral infection? \_\_\_\_\_*

## **1. Viral entry**

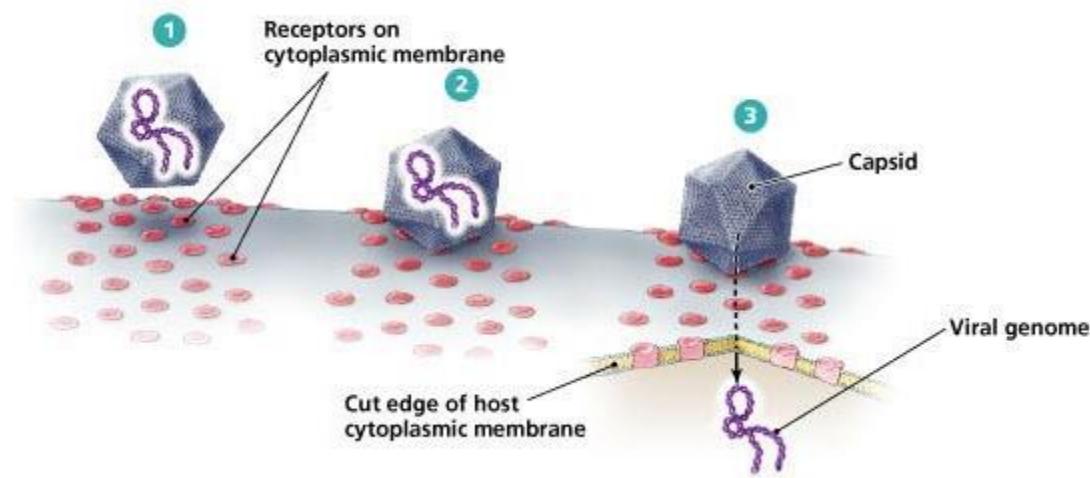
*Q4·What is a viral infection? \_\_\_\_\_*

- 1. Viral entry**        The virus delivers its genetic material into the cell

Q4·What is a viral infection? \_\_\_\_\_

1. Viral entry → The virus delivers its genetic material into the cell

Non-enveloped viruses

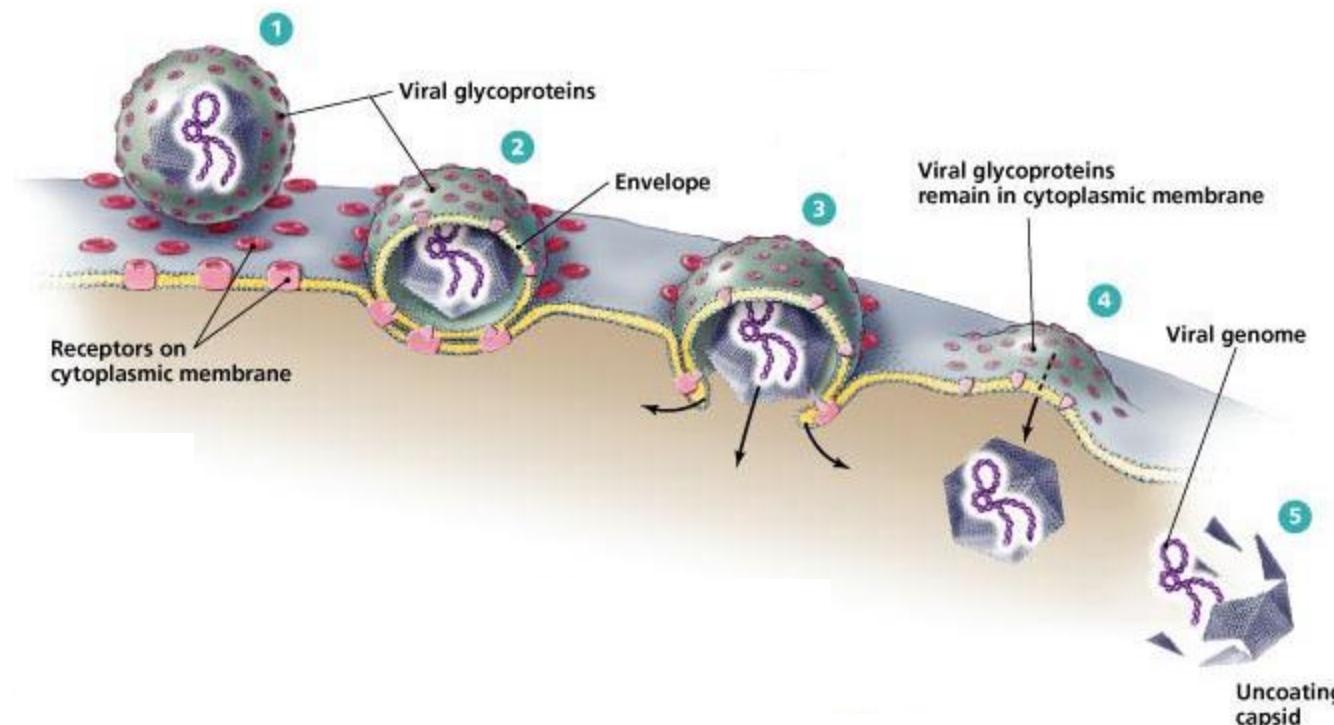


The capsid remains outside the cell and only the genome is delivered

*Q4·What is a viral infection? \_\_\_\_\_*

**1. Viral entry** → The virus delivers its genetic material into the cell

Enveloped viruses



The viral membrane fuses to the cell and the capsid is delivered

*Q4·What is a viral infection? \_\_\_\_\_*

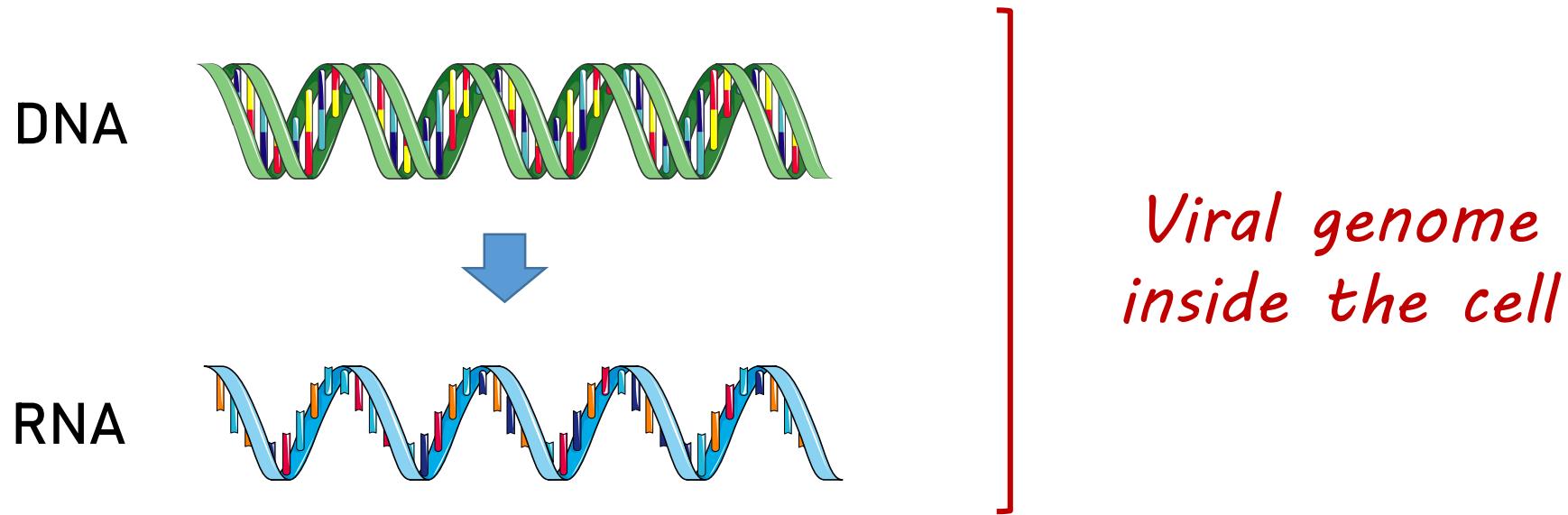
## **2. Viral replication**

*Q4·What is a viral infection? \_\_\_\_\_*

**2. Viral replication** ➔ The virus makes copies of itself inside the cell

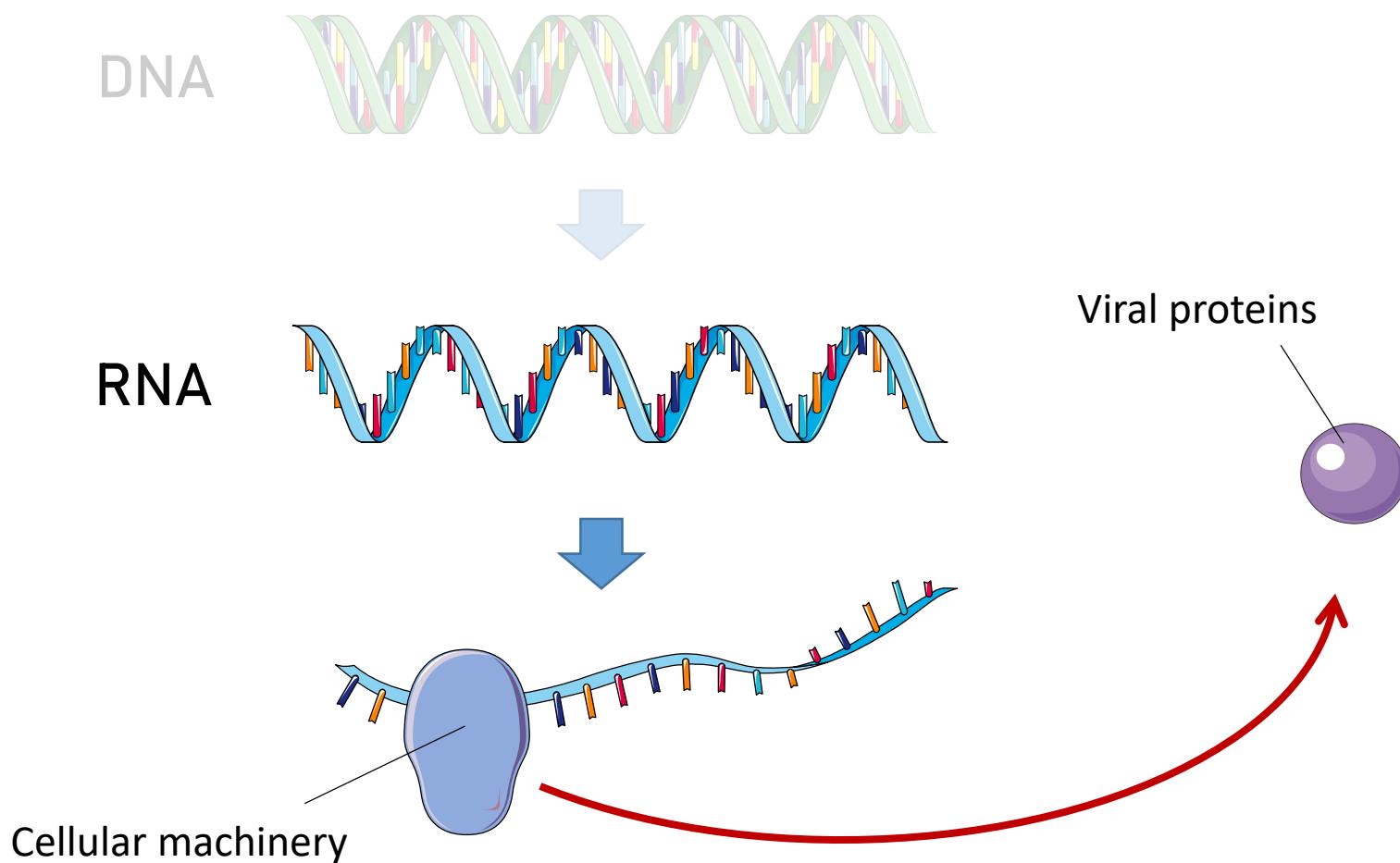
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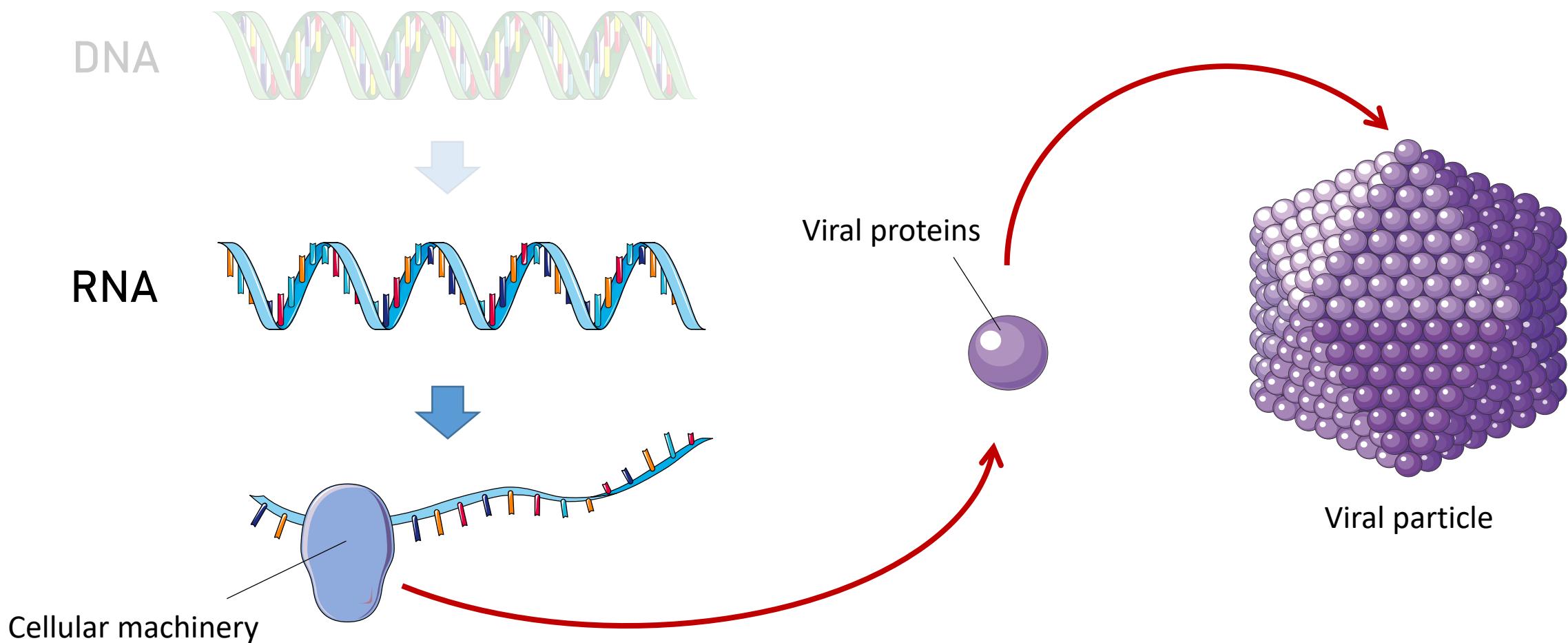
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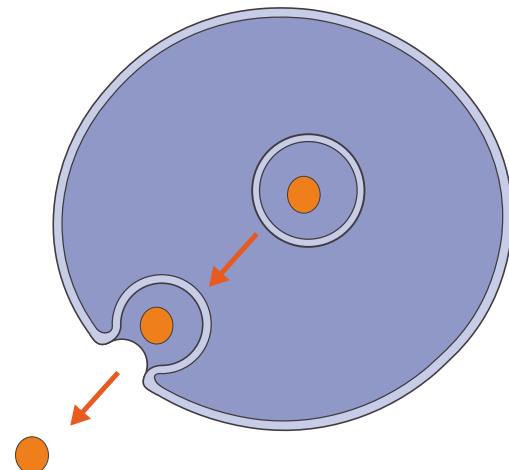
### **3. Viral release**

*Q4·What is a viral infection? \_\_\_\_\_*

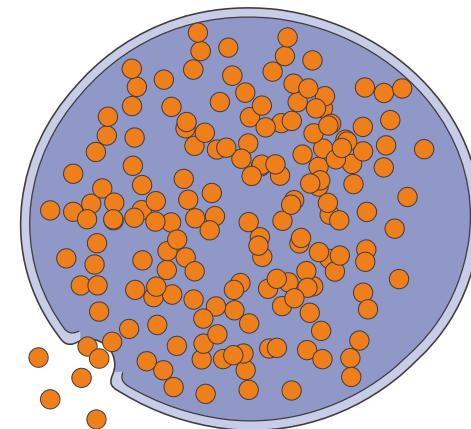
### 3. Viral release



Non-enveloped viruses



Signal to be released



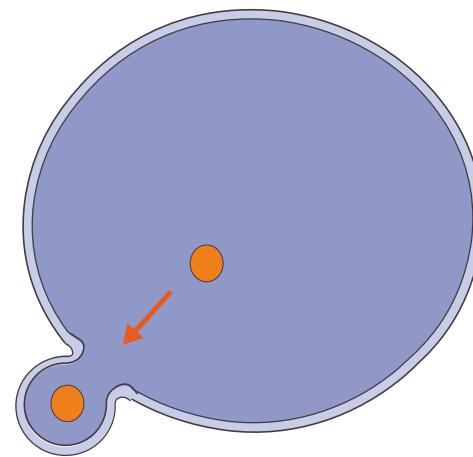
Fill up the cell until it explodes

*Q4·What is a viral infection? \_\_\_\_\_*

### 3. Viral release



Enveloped viruses



Budding: the virus takes part of the cell membrane with it!

Signal to be released

*Q5·What can viruses infect? \_\_\_\_\_*

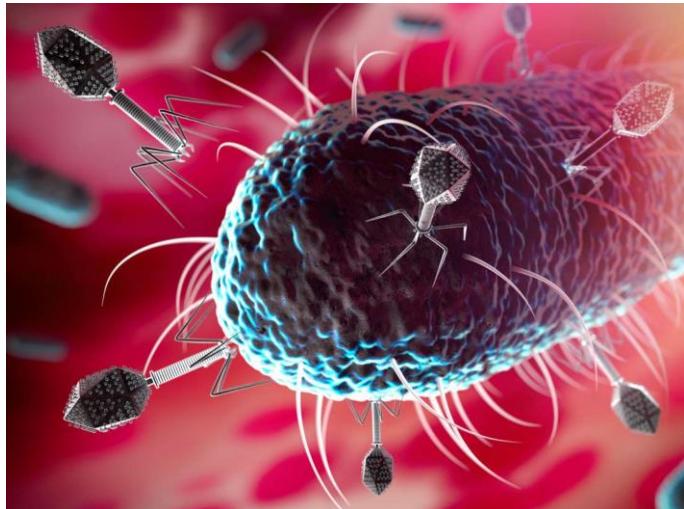
## Q5·What can viruses infect?

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Living cells



Viruses don't infect only humans and other animals, they can infect every type of living cell, from microorganisms to giant trees.



Bacteria



Fungi

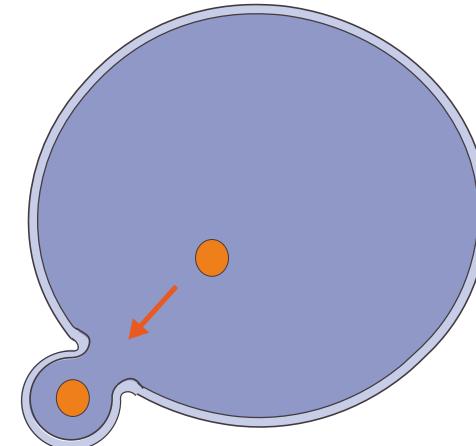
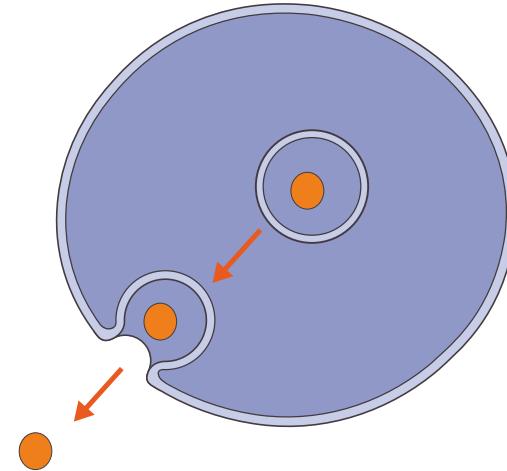


Plants

Q6·What's the difference between infection and disease? —

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Viruses that don't kill the host cell can produce **chronic infection**

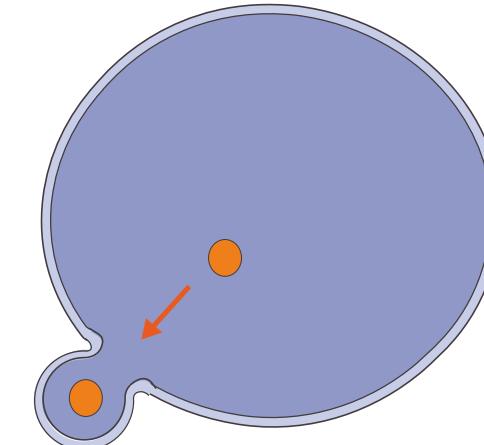
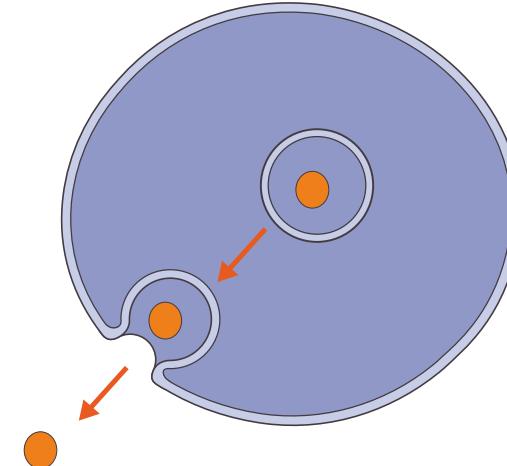


## Q6·What's the difference between infection and disease? —

Viruses that don't kill the host cell can produce **chronic infection**

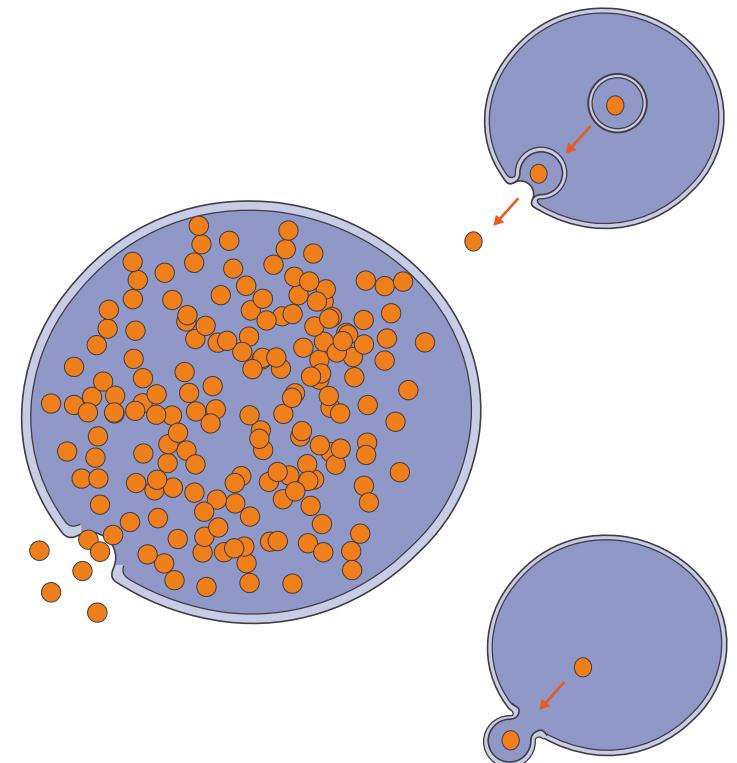


If the replication of the virus doesn't exhaust the cell, the cell barely notices it is infected



## *Q6·What's the difference between infection and disease? —*

If the virus replicates too fast and/or destroys the cell to exit, **cells start failing to perform their normal duties**



*Q6·What's the difference between infection and disease? —*

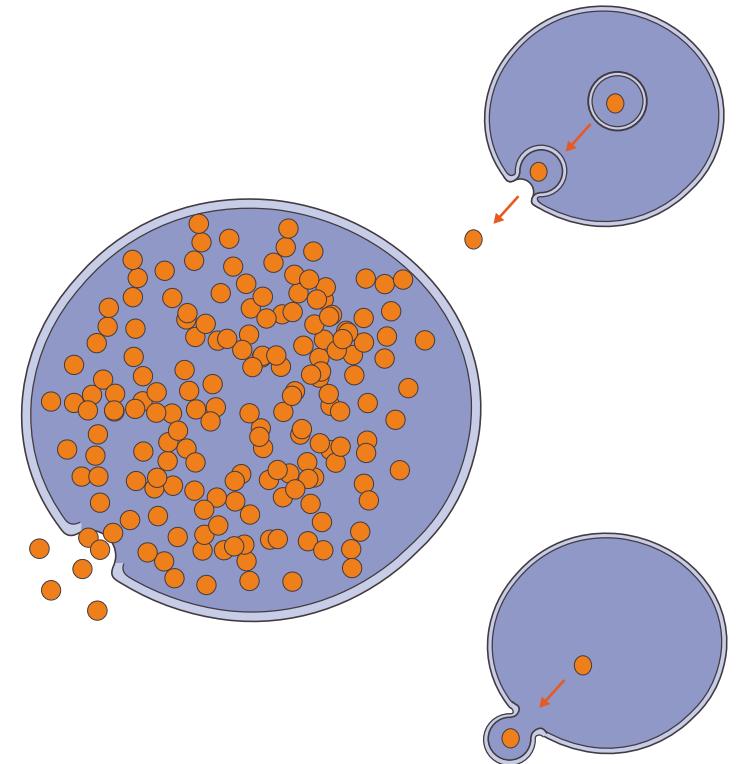
If the virus replicates too fast and/or  
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**perform their normal duties**



Tissue dysfunction



*Disease*



*Q7. Why do ≠ viral diseases have ≠ symptoms? \_\_\_\_\_*

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Not all virus can infect all types of cells

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Not all virus can infect all types of cells

Different types of cells form different tissues in an organism

*Q7. Why do ≠ viral diseases have ≠ symptoms? \_\_\_\_\_*

Not all virus can infect all types of cells

Different types of cells form different tissues in an organism

*Disease*



Tissue dysfunction

Symptoms depend on the types of tissue that are affected the most by the virus

*Q7·Why do ≠ viral diseases have ≠ symptoms? \_\_\_\_\_*



Respiratory tract infection



Skin infection

*Q7·Why do ≠ viral diseases have ≠ symptoms? \_\_\_\_\_*



Respiratory tract infection



Skin infection

**In general, each virus infect a number of different tissues, creating a collection of symptoms that helps doctors identify the agent**

Q8. Can we treat a viral disease? \_\_\_\_\_

## *Q8·Can we treat a viral disease?*

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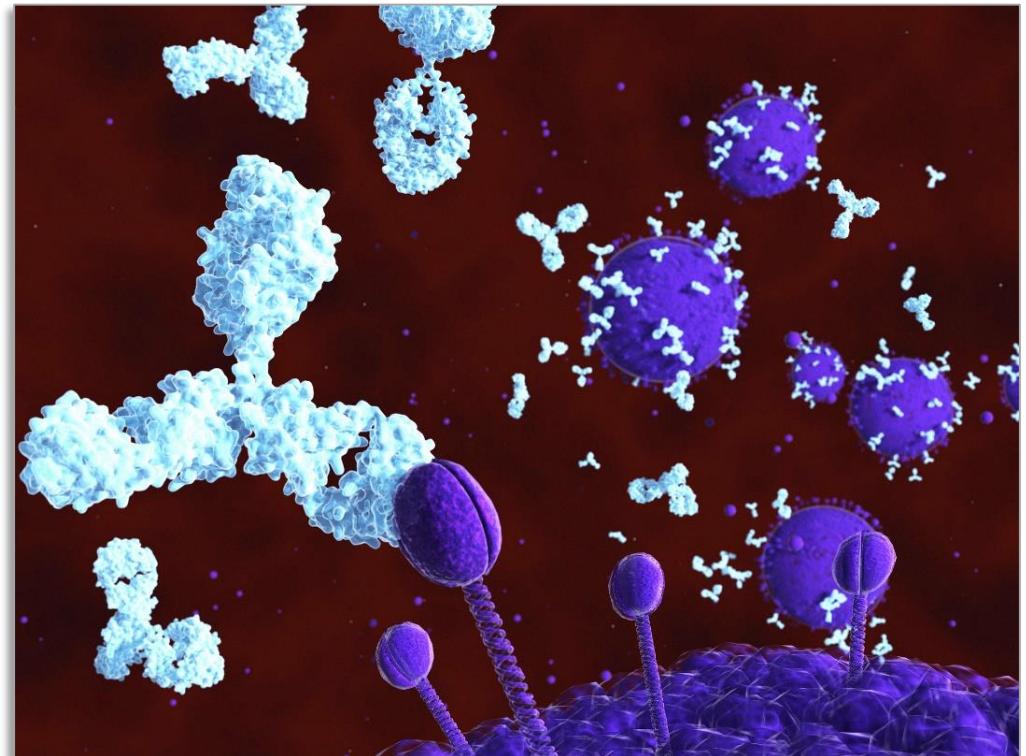
Natural defenses  
(immune system)



Viral infection  
detected



Virus neutralization  
and clearance



*Most acute viral diseases last  
3-10 days*

Q8.

Can we treat a viral disease?

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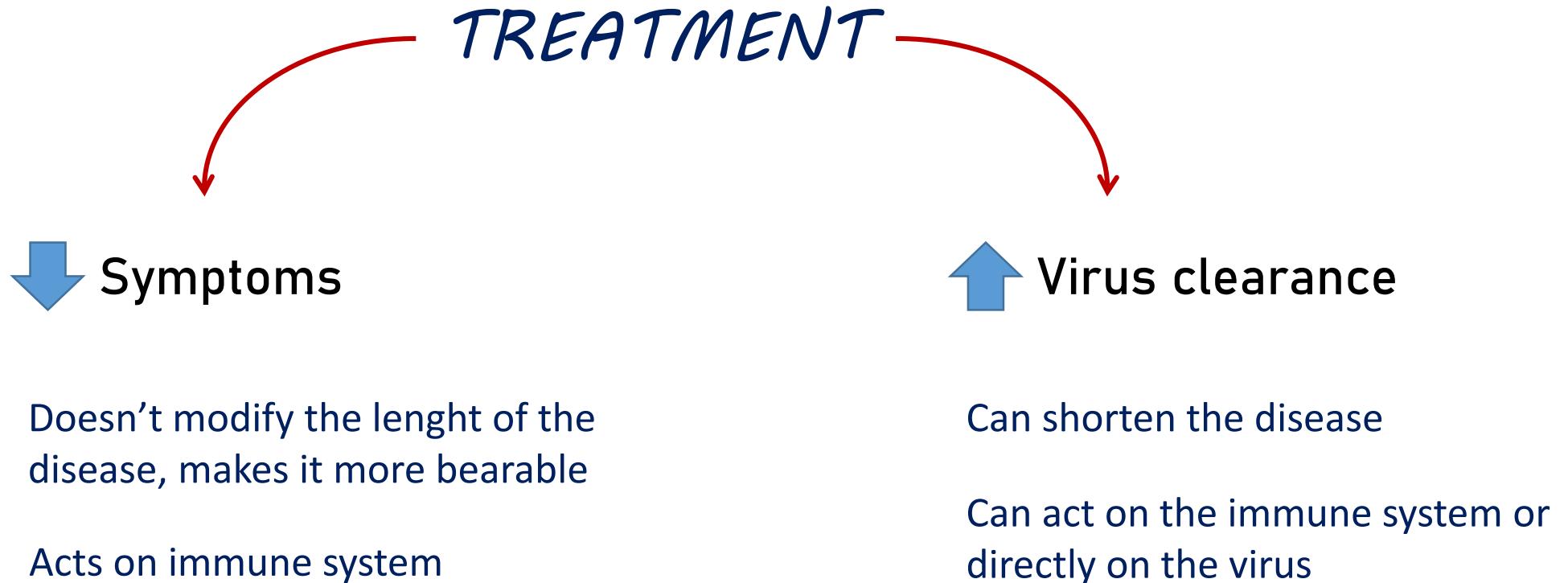
*Q8·Can we treat a viral disease?*



Doesn't modify the length of the disease, makes it more bearable

Acts on immune system

*Q8·Can we treat a viral disease?* \_\_\_\_\_



*Q9·Can we cure a viral disease?*



*Q9·Can we cure a viral disease?*

---

Most viruses can be cleared completely at least in some patients  
(including “incurable” diseases like AIDS)

## *Q9·Can we cure a viral disease?*

---

Most viruses can be cleared completely at least in some patients  
(including “incurable” diseases like AIDS)

Some viruses produce lifelong immunity against future infections,  
but not all (and not in all patients)

## *Q9·Can we cure a viral disease?*

---

Most viruses can be cleared completely at least in some patients  
(including “incurable” diseases like AIDS)

Some viruses produce lifelong immunity against future infections,  
but not all (and not in all patients)

**So yes, most viral diseases can eventually be cured, yet not  
always... and the cure may not prevent re-infection**

Q10·Can we prevent a viral disease? \_\_\_\_\_

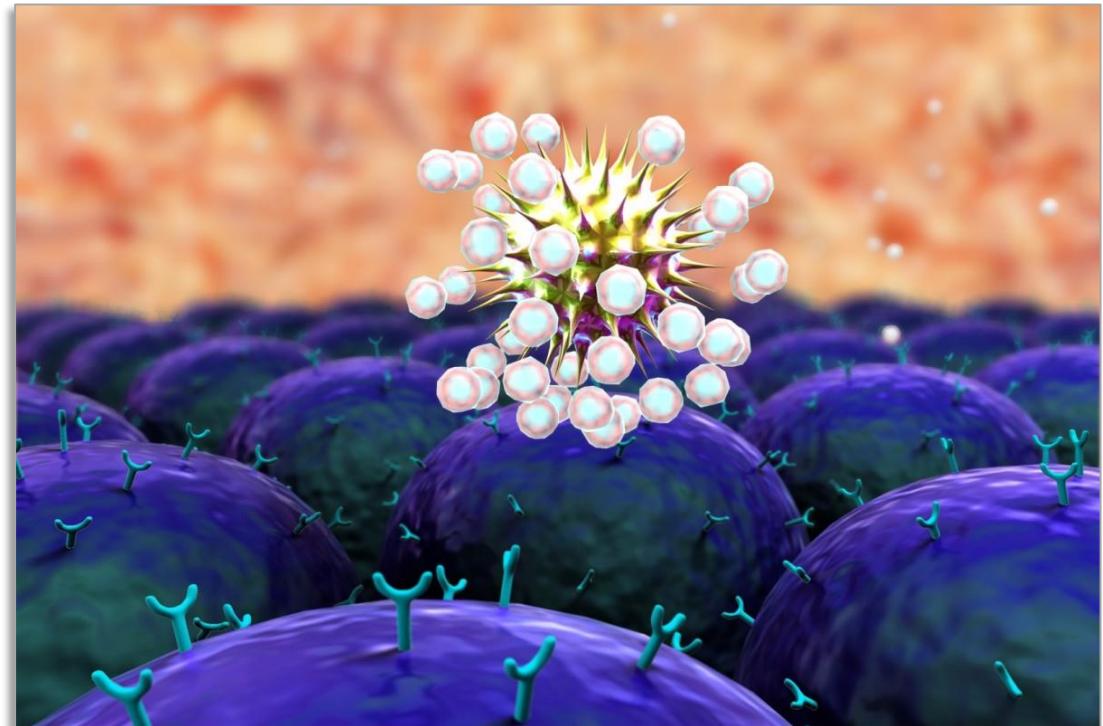
## *Q10·Can we prevent a viral disease?*

---

Several molecules can block  
the entry, the replication or the  
release of virus from cells

↓  
Prevent viral infection

*Viral disease*

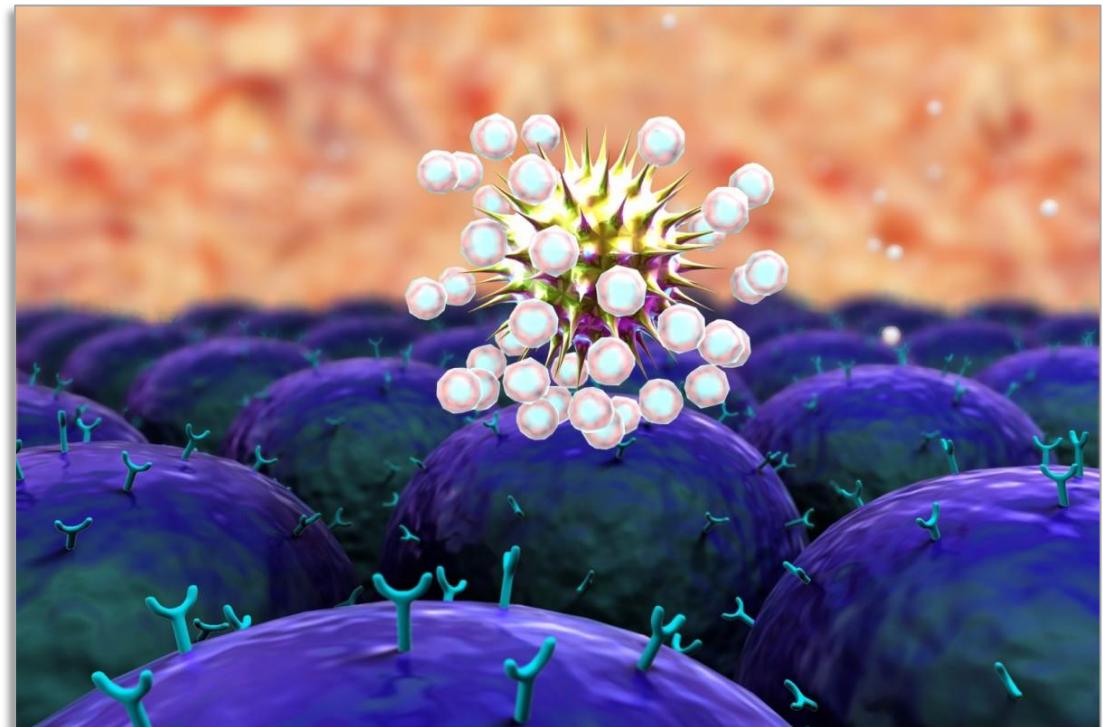


## *Q10·Can we prevent a viral disease?*

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Several **molecules** can block  
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*Antiviral drugs  
and  
Vaccines*

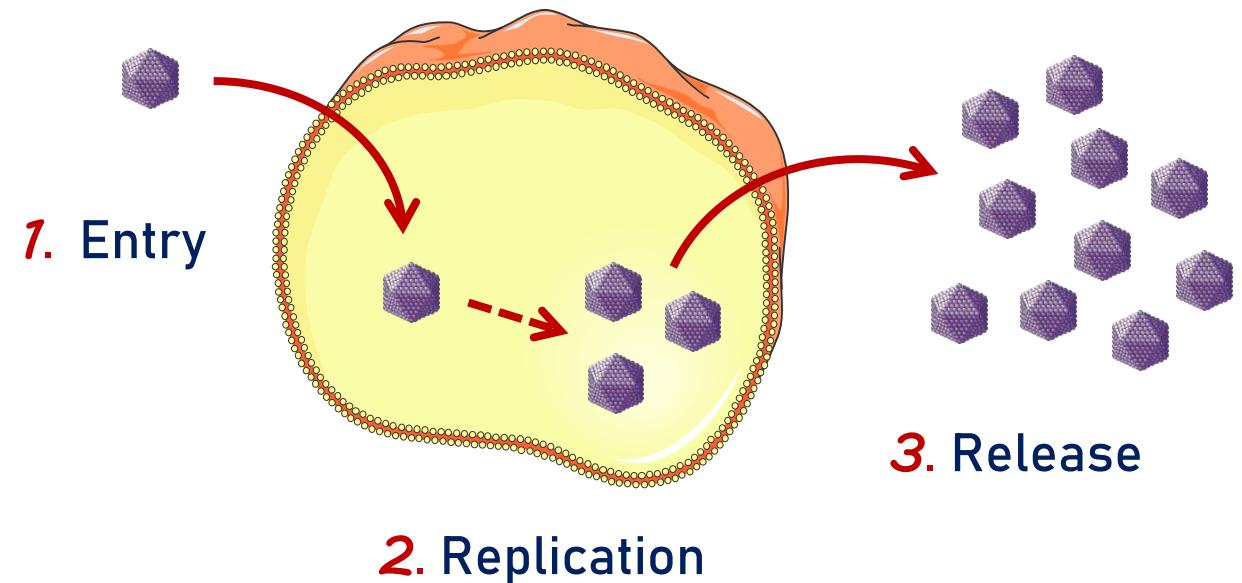


Q11·What are antiviral drugs & how do they work? \_\_\_\_\_

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## Antiviral drugs

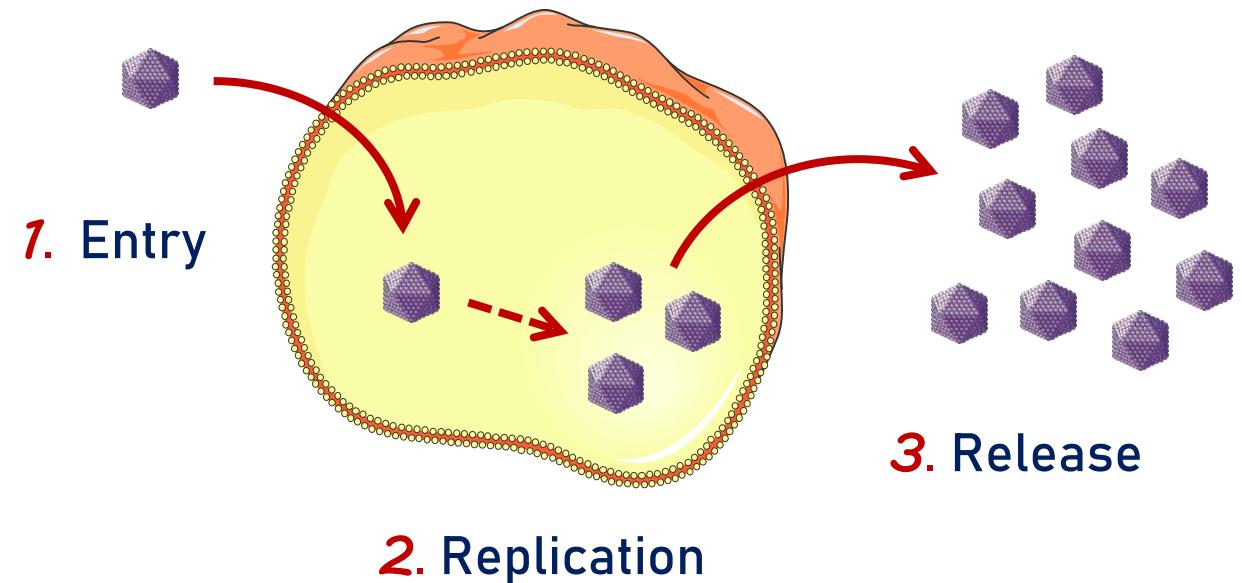
- After initial infection



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## Antiviral drugs

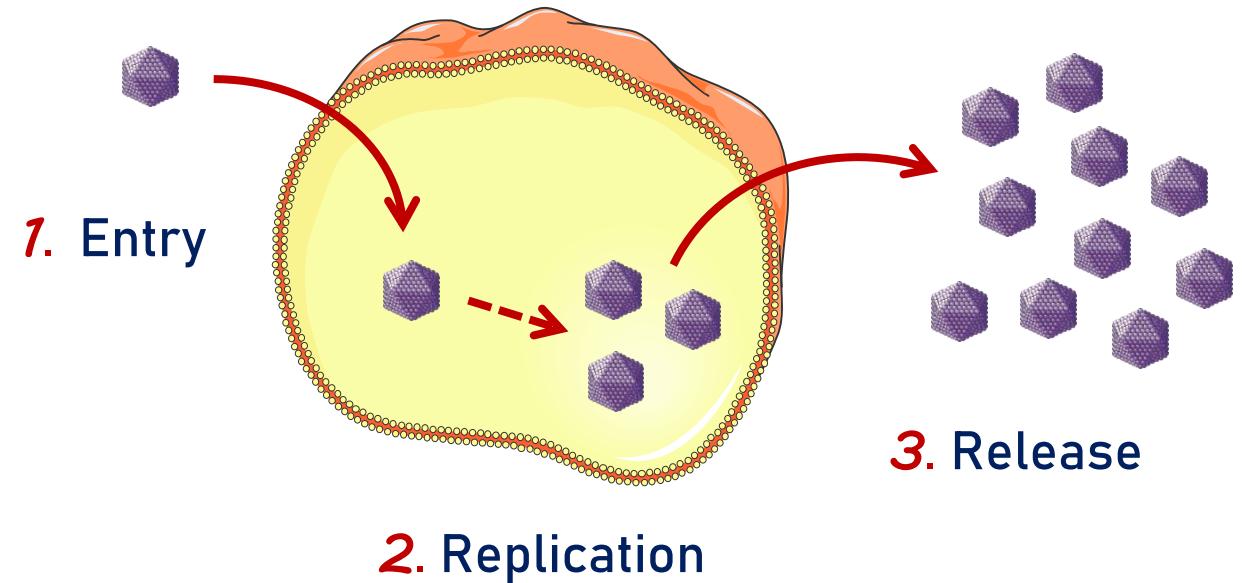
- ▶ After initial infection
- ▶ Prevent **spreading** of the virus



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## Antiviral drugs

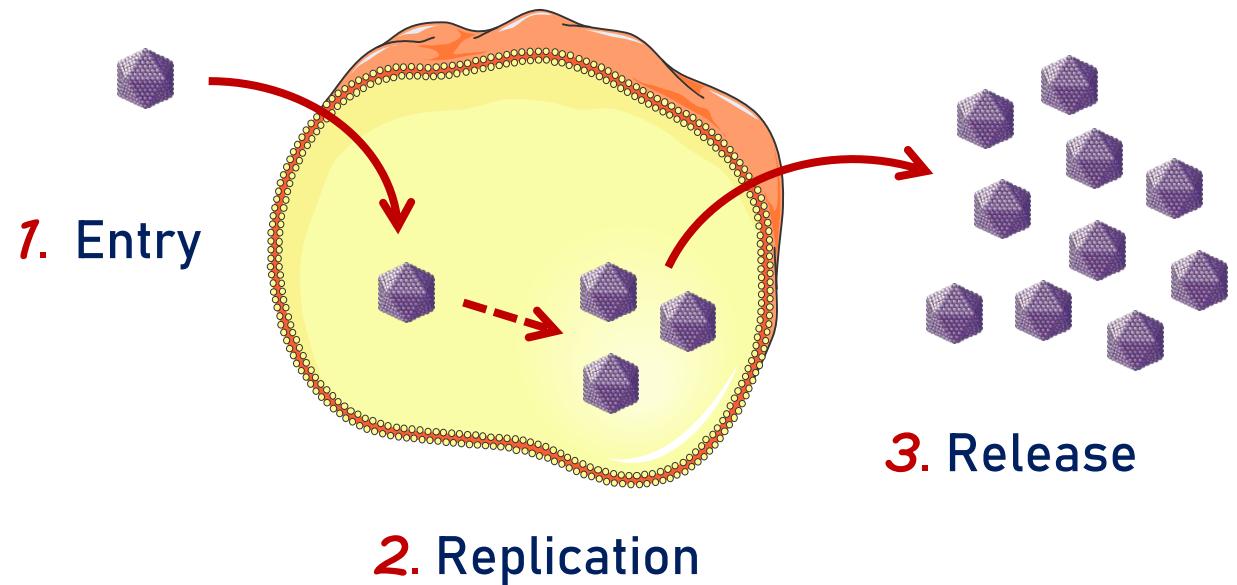
- ▶ After initial infection
- ▶ Prevent **spreading** of the virus
- ▶ Can target any step of the infection



Q11. What are antiviral drugs & how do they work? \_\_\_\_\_

## Antiviral drugs

- ▶ After initial infection
- ▶ Prevent **spreading** of the virus
- ▶ Can target any step of the infection
- ▶ Can target virus directly or act on the immune system

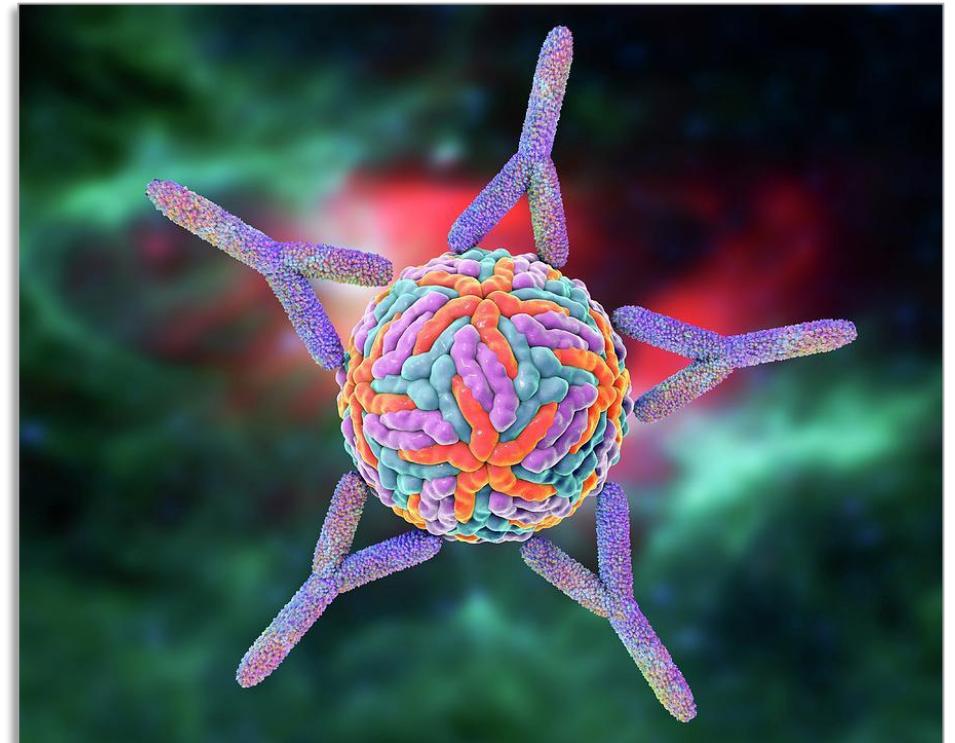


Q12·What is a vaccine? \_\_\_\_\_

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## Vaccines

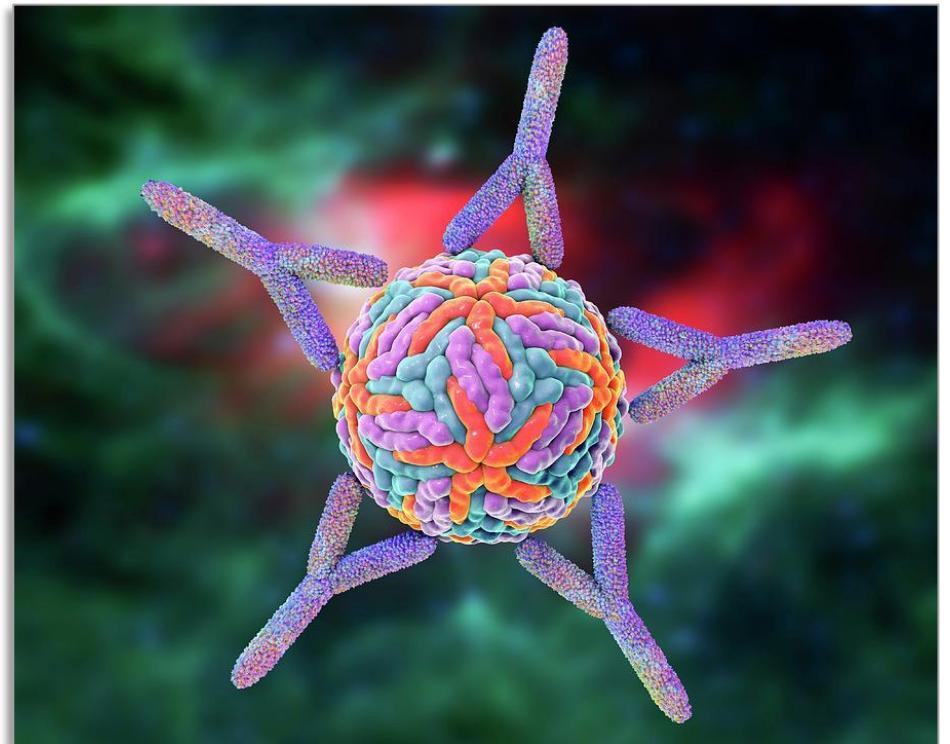
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## Vaccines

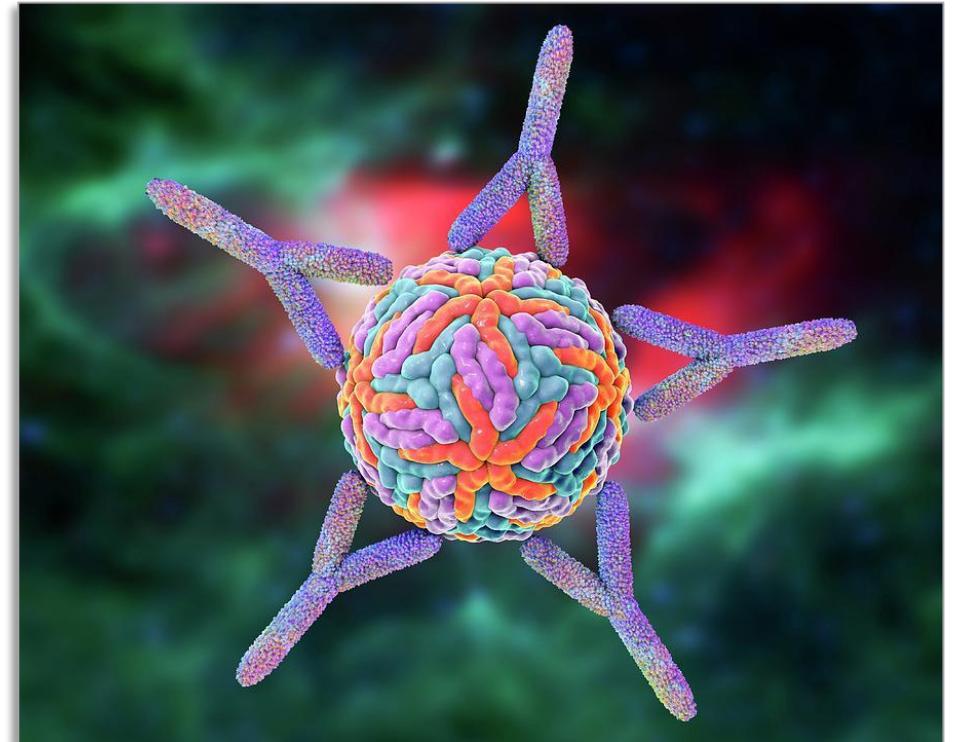
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## Vaccines

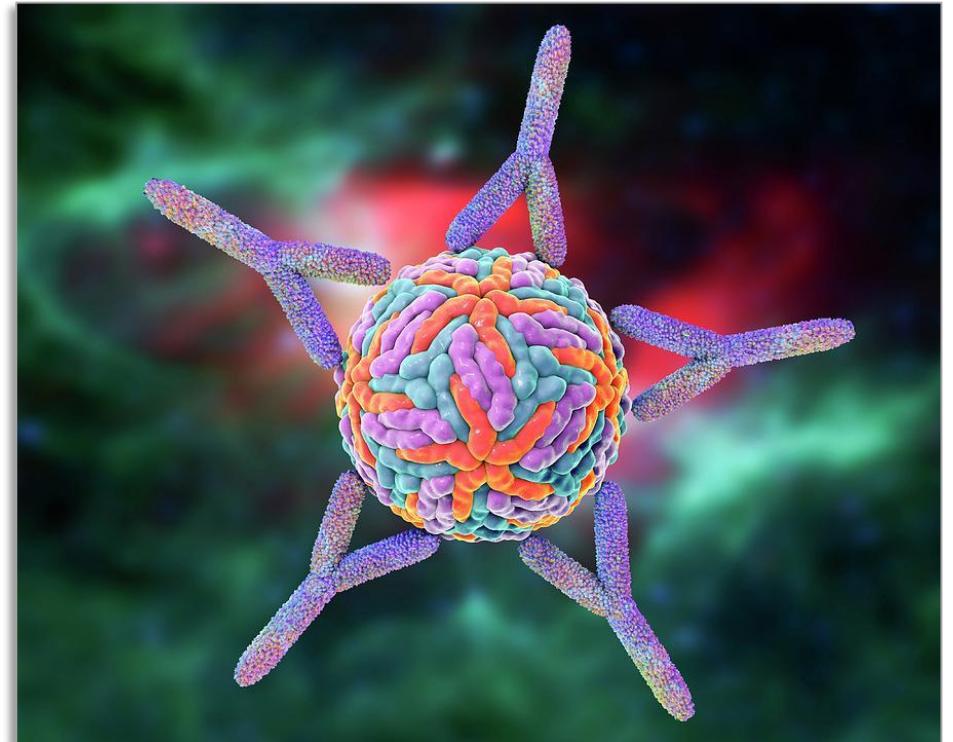
- ▶ Before any infection
- ▶ Prevent **initial infection**
- ▶ Normally target virus entry



*Q12·What is a vaccine?* \_\_\_\_\_

## Vaccines

- ▶ Before any infection
- ▶ Prevent **initial infection**
- ▶ Normally target virus entry
- ▶ Act on the immune system,  
preparing it to recognize the virus



*Q12·What is a vaccine? \_\_\_\_\_*

## *Vaccines*

The immune system recognizes viruses because it detects  
the “clothes” that a virus wears

*Q12·What is a vaccine?* \_\_\_\_\_

## *Vaccines*

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Vaccines train the immune system to recognize those  
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## Vaccines

The immune system recognizes viruses because it detects  
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Vaccines train the immune system to recognize those  
clothes faster



*We need one vaccine per virus... except when  
families of virus share clothes!*

Q13·How are vaccines developed? \_\_\_\_\_

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- 2.** Identify the clothes that the immune system detects better
- 3.** Create “fake clothes” to trick the immune system
- 4.** Try if they work in the lab, then in animals, then in humans
- 5.** Evaluate SAFETY and EFFICACY
- 6.** Produce in large quantities and make available

Q14. Can a vaccine eliminate the virus completely? \_\_\_\_\_

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A vaccine *doesn't* eliminate the virus from the environment, but can potentially eradicate the disease.

Q14. Can a vaccine eliminate the virus completely? \_\_\_\_\_

A vaccine *doesn't eliminate the virus from the environment, but can* **potentially** eradicate the disease.



**ONLY IF USED CORRECTLY  
AND SUSTAINED OVER TIME!**



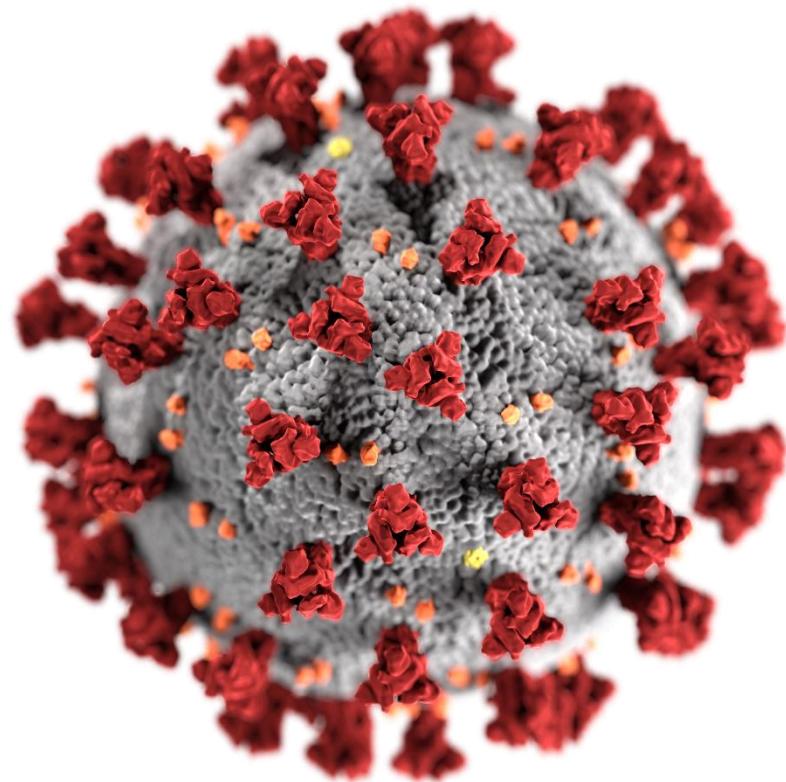
# *The case of COVID-19*

Applying all this to real life

*Q15·COVID-19: A disease or a virus? \_\_\_\_\_*

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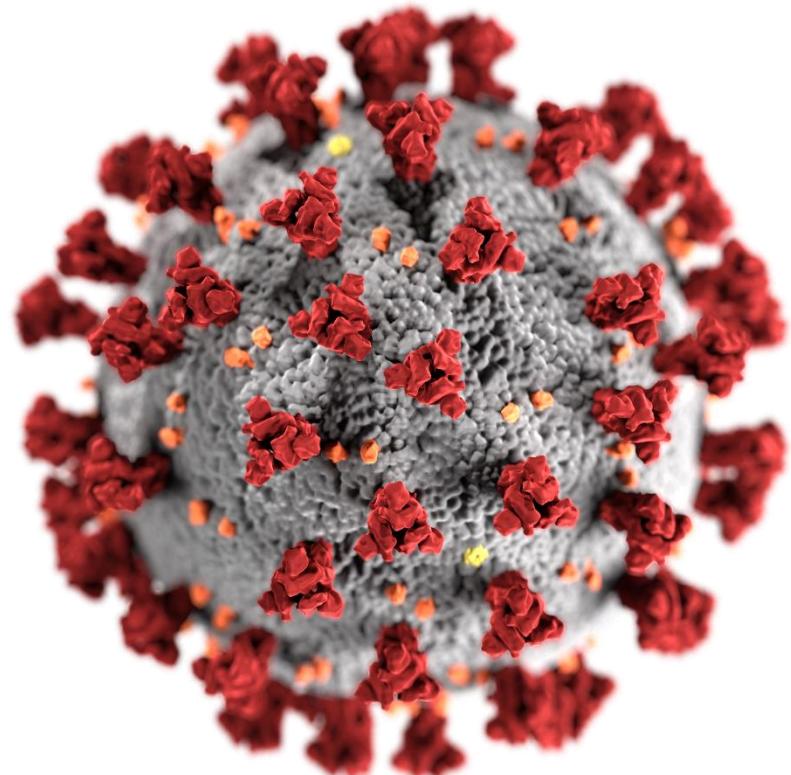
## SARS-CoV-2: the virus behind the disease



*Q15·COVID-19: A disease or a virus?* \_\_\_\_\_

## SARS-CoV-2: the virus behind the disease

Not the only human coronavirus!



Scientists have already characterized 6 other types of human coronaviruses, 2 of which caused big epidemics very recently: **MERS-CoV** and **SARS-CoV(1)**



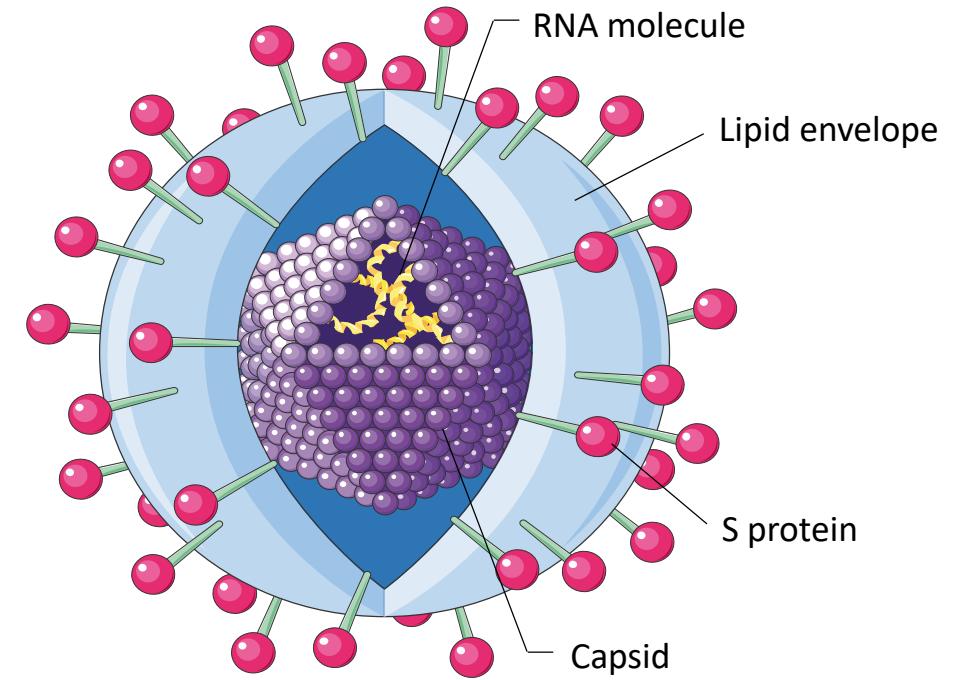
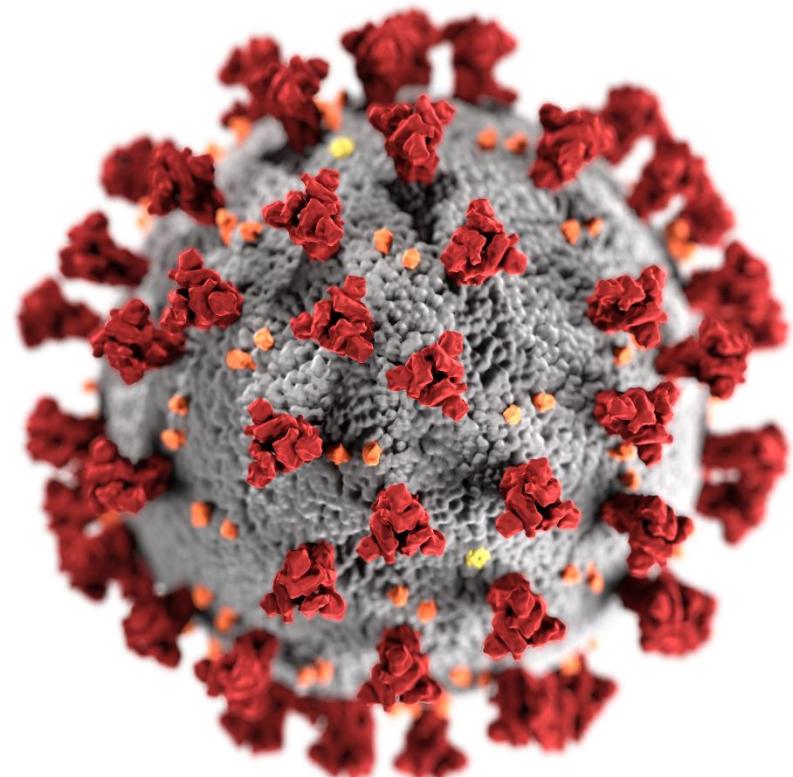
*We can use that knowledge to study their “cousin”!*

*Q16·COVID-19: What do we know about SARS-CoV-2? \_\_\_\_\_*

*Q16·COVID-19: What do we know about SARS-CoV-2? \_\_\_\_\_*

## SARS-CoV-2: the virus behind the disease

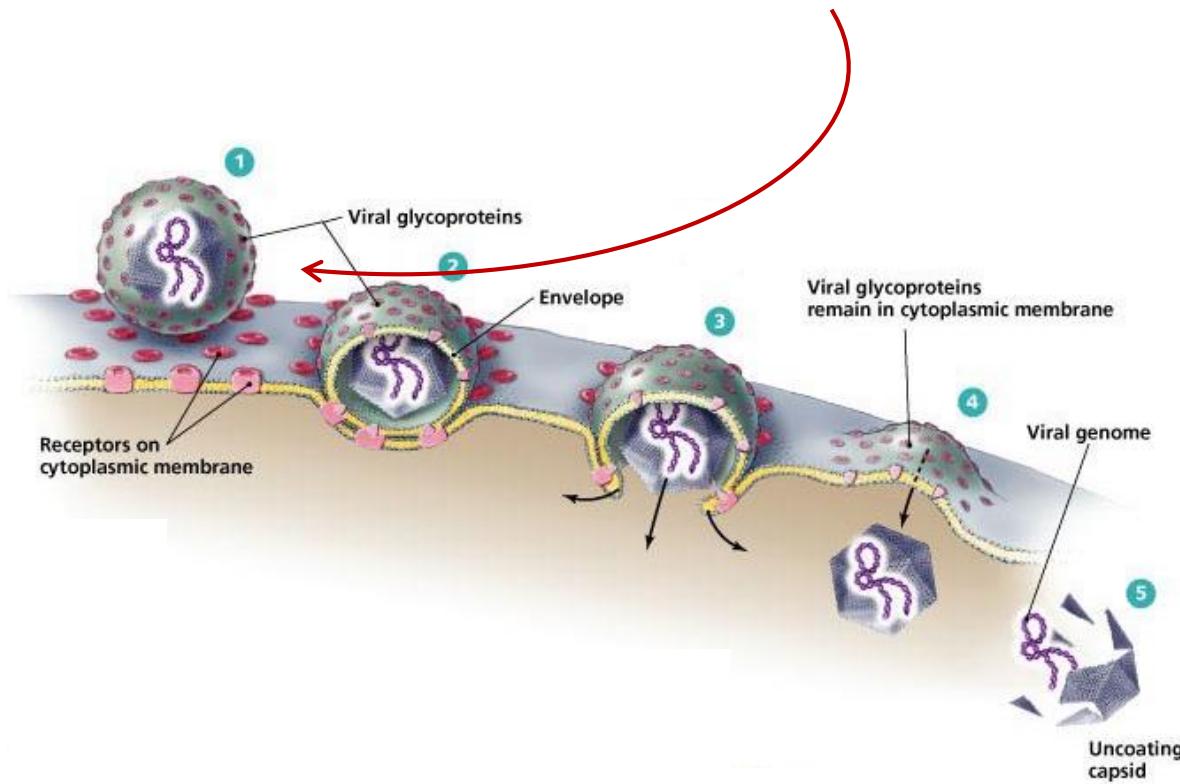
Enveloped virus – RNA genome



## Q16·COVID-19: What do we know about SARS-CoV-2? —————

### SARS-CoV-2: the virus behind the disease

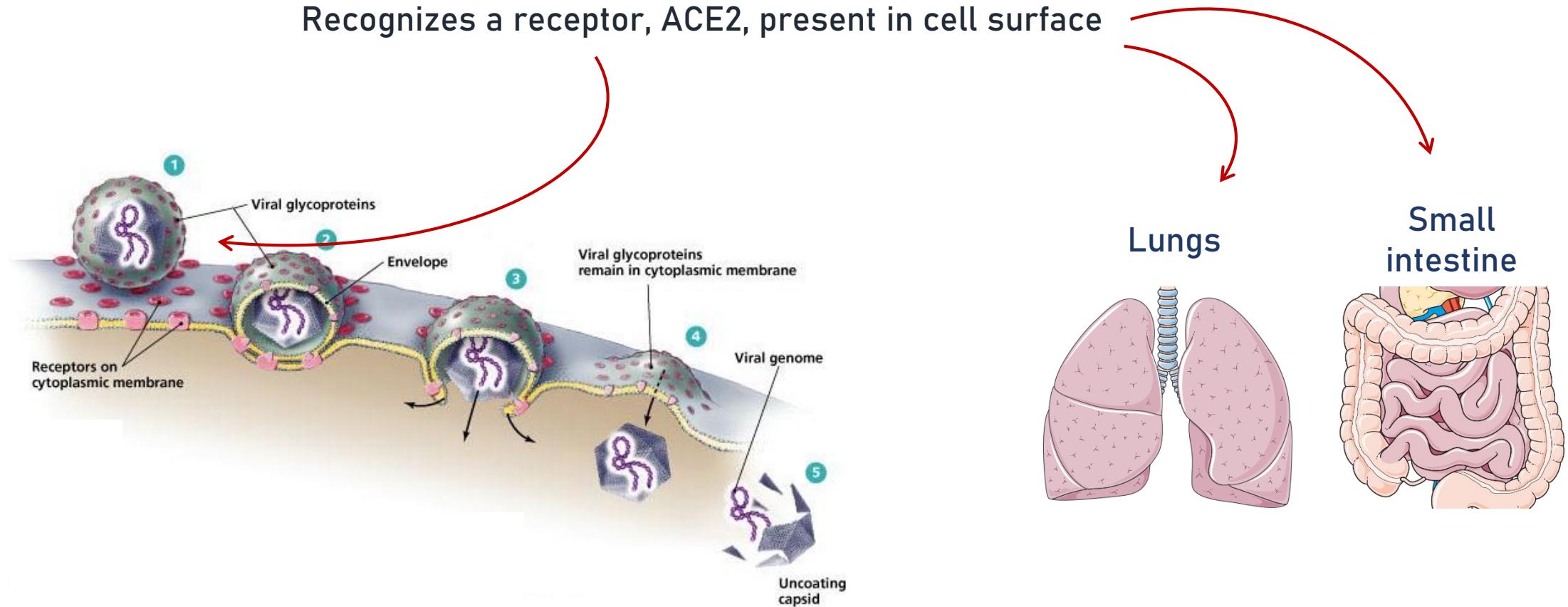
Recognizes a receptor, ACE2, present in cell surface



## Q16·COVID-19: What do we know about SARS-CoV-2? —

### SARS-CoV-2: the virus behind the disease

Recognizes a receptor, ACE2, present in cell surface



Q17·COVID-19: What is a pandemic? \_\_\_\_\_

*Q17-COVID-19: What is a pandemic? \_\_\_\_\_*

## *EPIDEMIOLOGY*

**Studies the incidence, distribution, and possible control of diseases**

Q17·COVID-19: What is a pandemic? \_\_\_\_\_

## EPIDEMIOLOGY



Not (only) a  
matter of numbers!

Studies the incidence, **distribution**, and  
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Q17·COVID-19: What is a pandemic? \_\_\_\_\_

## EPIDEMIOLOGY



Not (only) a  
matter of numbers!



Studies the incidence, distribution, and  
possible control of diseases

Some diseases are **ENDEMIC** to certain areas



Periodic, geographically contained  
outbreaks

Q17·COVID-19: What is a pandemic? \_\_\_\_\_

## EPIDEMIOLOGY



Not (only) a  
matter of numbers!



Studies the incidence, distribution, and  
possible control of diseases

When the incidence and distribution increase,  
an *EPIDEMIC* is decreed



Bigger yet somewhat geographically  
constrained outbreaks

Q17·COVID-19: What is a pandemic? \_\_\_\_\_

## EPIDEMIOLOGY

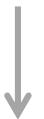


Not (only) a  
matter of numbers!



Studies the incidence, distribution, and  
possible control of diseases

When the disease expands to a global  
distribution, it's the start of a **PANDEMIC**



Global (not geographically constrained)  
outbreak

*Q18·COVID-19: Is there any treatment? \_\_\_\_\_*

## *Q18·COVID-19: Is there any treatment?*

---

For now, all treatments are aimed at reducing symptoms and stimulating immune response



A lot of effort is made towards finding a way to **cure** and **prevent** COVID-19

*Q19·COVID-19: Shall we expect a vaccine soon? \_\_\_\_\_*

## *Q19·COVID-19: Shall we expect a vaccine soon?*

---

Remember all these steps?

1. Characterize the clothes and how the virus wear them
2. Identify the clothes that the immune system detects better
3. Create “fake clothes” to trick the immune system
4. Try if they work in the lab, then in animals, then in humans
5. Evaluate **SAFETY** and **EFFICACY**
6. Produce in large quantities and make available

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GOOD NEWS!

We had never done this faster  
than with SARS-CoV-2 and  
we're starting this step



## *Q19·COVID-19: Shall we expect a vaccine soon?*

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**BAD(ish) NEWS!**

*These steps take at least 1.5 years and cannot be rushed*

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You cannot commercialize a vaccine before you're sure it works well enough and doesn't have heavy side effects!!

**BAD(ish) NEWS!**

*These steps take at least 1.5 years and cannot be rushed*



**Serious ethical implications**



*Q20·COVID-19: What can we do in the meantime? \_\_\_\_\_*

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**Help prevent spread of the virus**

*Q20·COVID-19: What can we do in the meantime? \_\_\_\_\_*

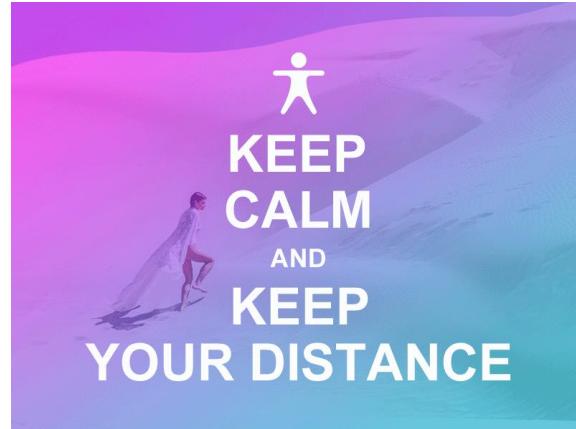
**Help prevent spread of the virus**



*Don't panic*

*Q20·COVID-19: What can we do in the meantime? \_\_\_\_\_*

## Help prevent spread of the virus



*Don't panic  
Keep physical distance*

*Q20·COVID-19: What can we do in the meantime? \_\_\_\_\_*

## **Help prevent spread of the virus**



*Don't panic*

*Keep physical distance*

*Wash your hands*

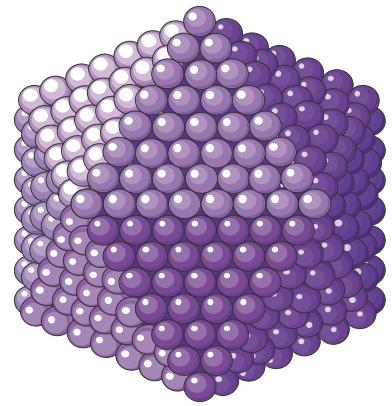
*Q20·COVID-19: What can we do in the meantime? \_\_\_\_\_*

## **Help prevent spread of the virus**



*Don't panic  
Keep physical distance  
Wash your hands  
Cover your mouth and nose*



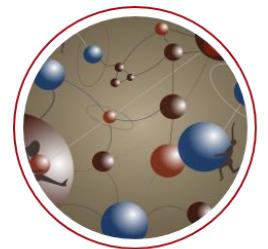


*Hope you learned something today!*

*Any questions?*



**Just One Giant Lab**  
learning & solving together



Lecturers Without  
Borders