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Study of Turnip mosaic virus transmission activation by aphids

Edwige Berthelot, Marie Ducouso, Jean Luc Macia, Florent Bogaert, Volker Baecker, Gael Thébaud, Romain Gallet, Michel Yvon, Stéphane Blanc, Mounia Khelifa, et al.

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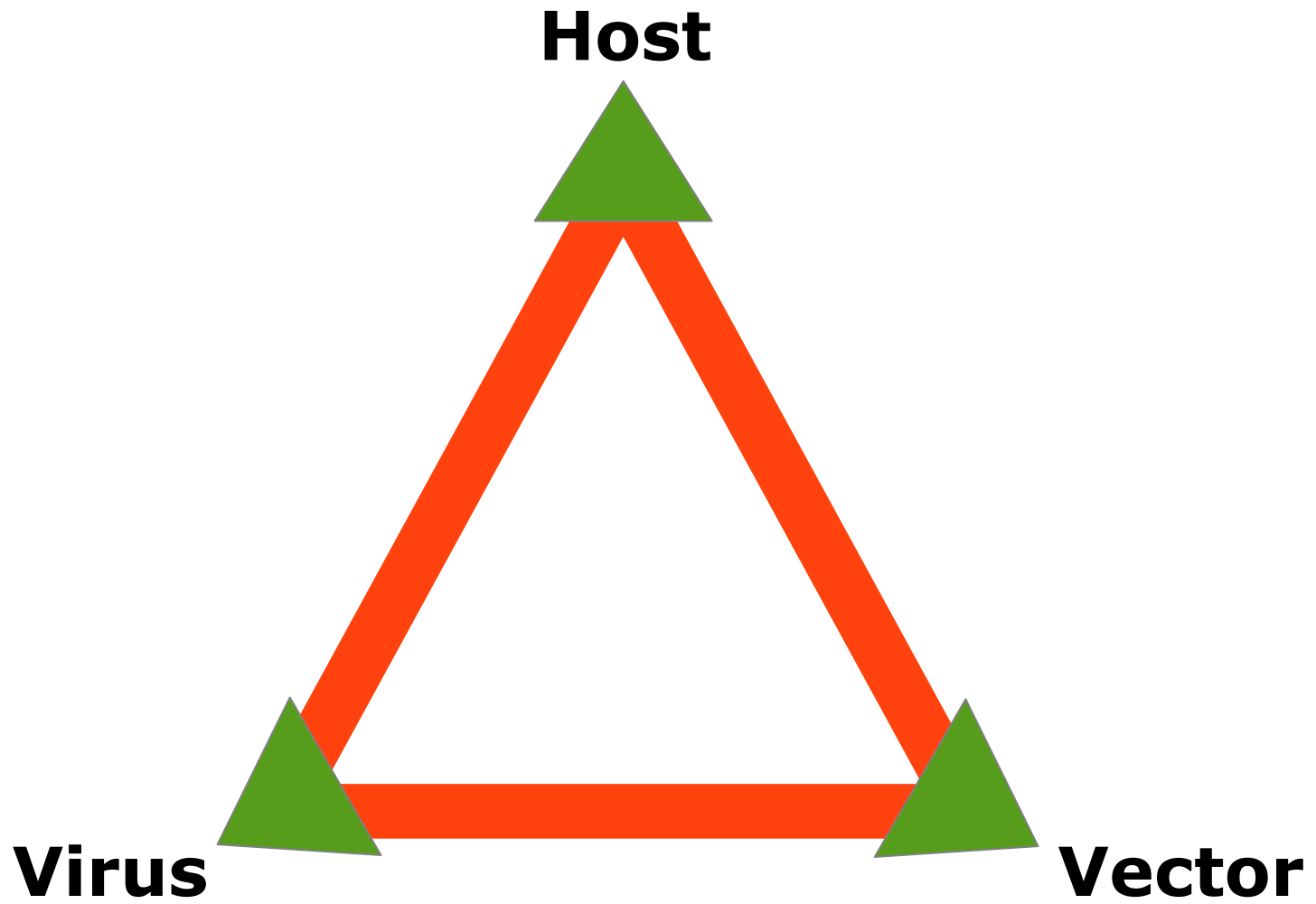
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Study of *Turnip mosaic virus* transmission activation by aphids

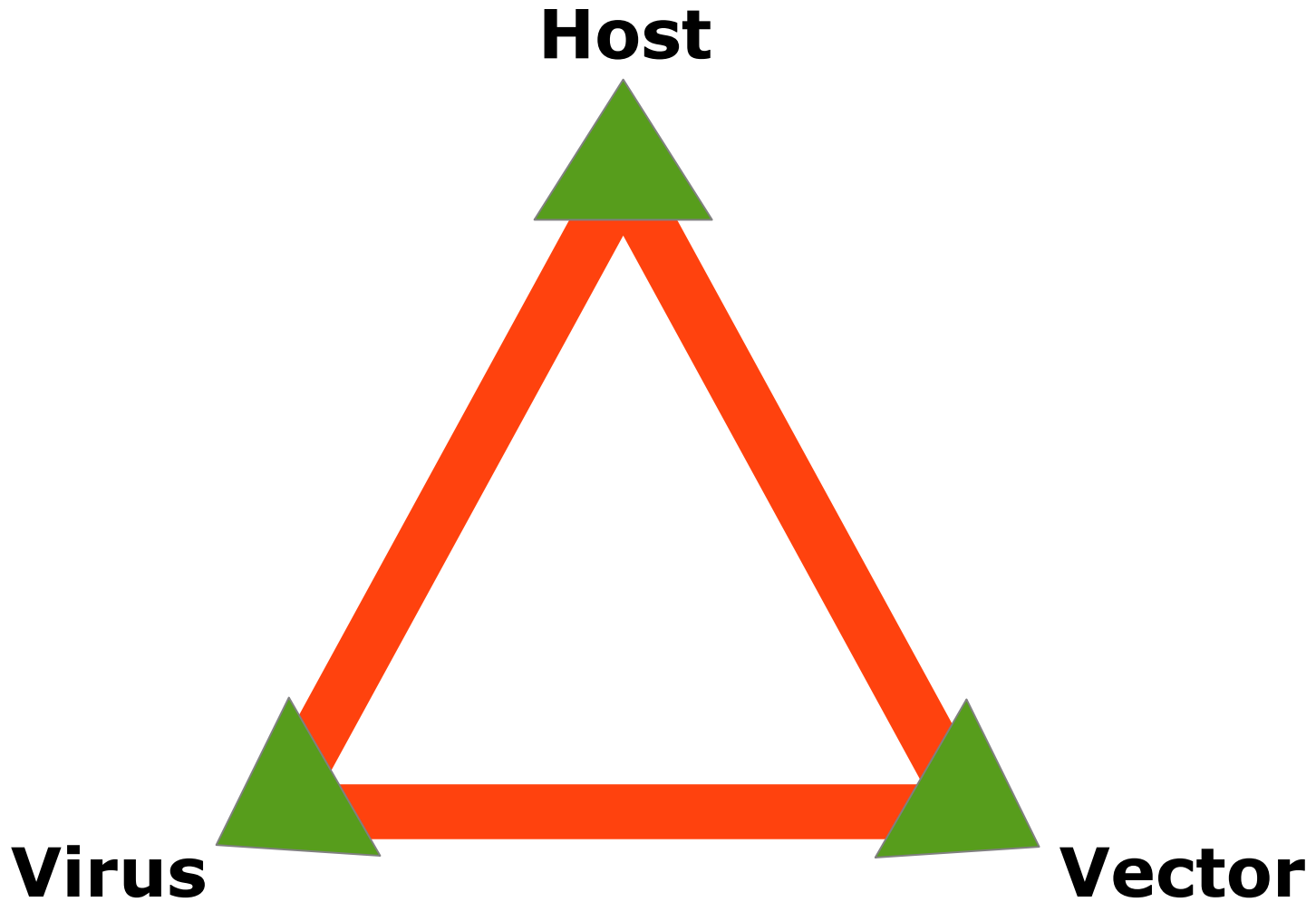
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17^{èmes} Rencontres de Virologie Végétale
27 to 31 January 2019 / Aussois - FRANCE

Transmission



**Role of virus and vector well studied
Role of host?**



Often neglected, but many pathogens manipulate their hosts to optimize transmission

Often neglected, but many pathogens manipulate their hosts to optimize transmission

Manipulation of host **independent** of presence of vector or another host

Often neglected, but many pathogens manipulate their hosts to optimize transmission

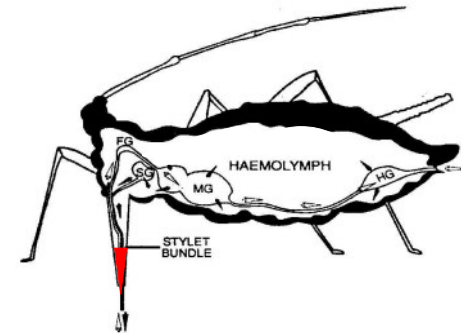
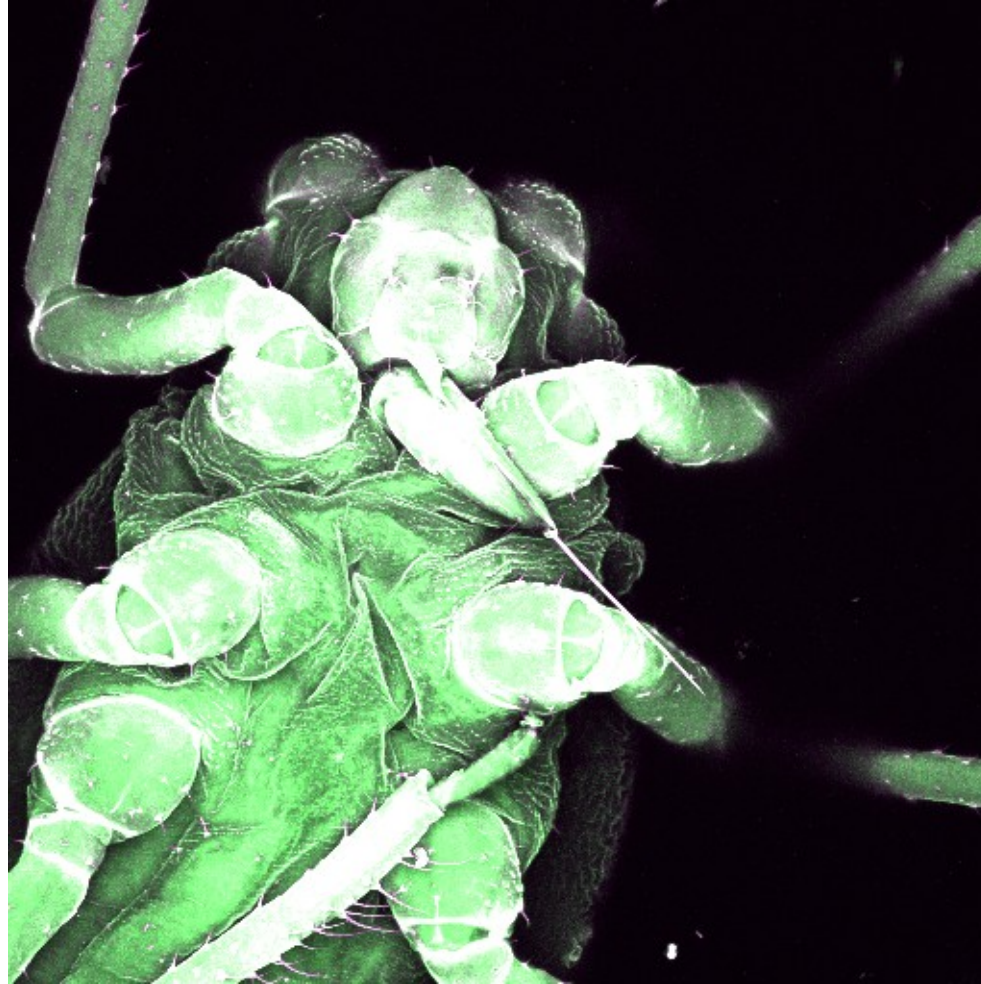
Manipulation of host **independent** of presence of vector or another host

Our results: Manipulation of host precisely when vector arrives

Example: a rhinovirus that makes you sneeze only when another person is present in the same room

Our model

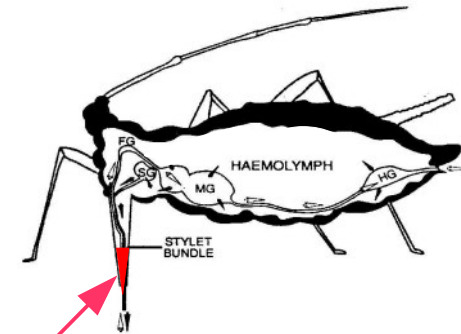
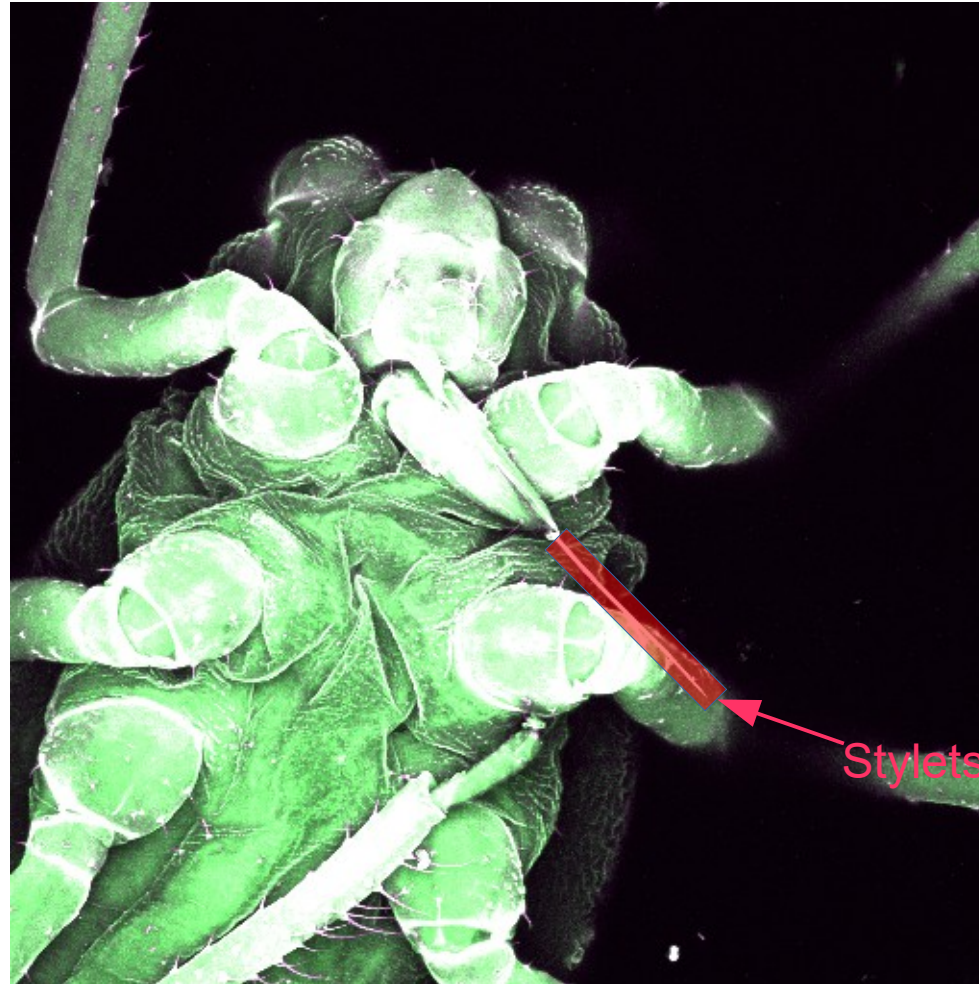
CaMV, non circulatively transmitted by aphids



Bak et al. 2013 J Virol 87(22), Cover

Our model

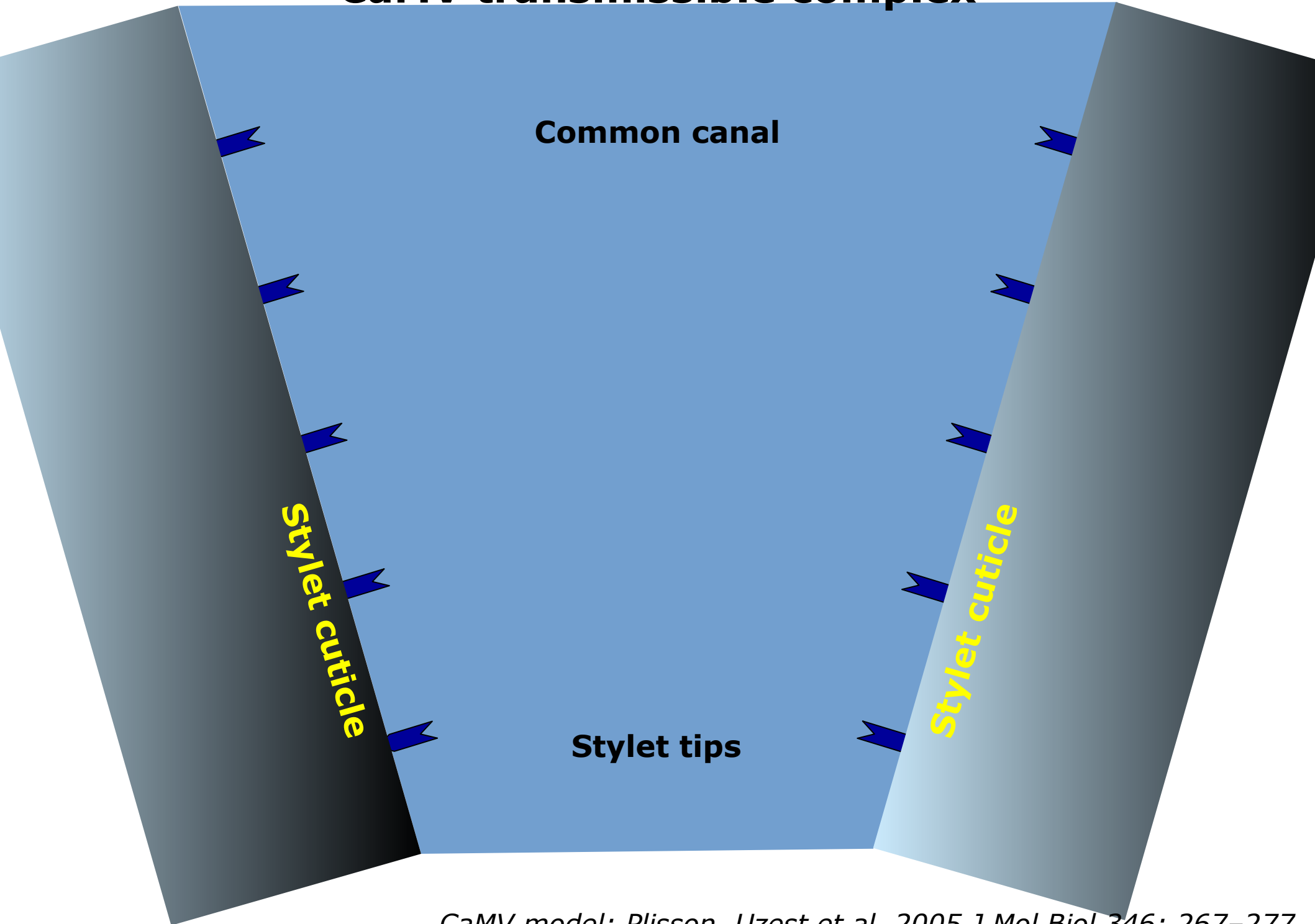
CaMV, non circulatively transmitted by aphids



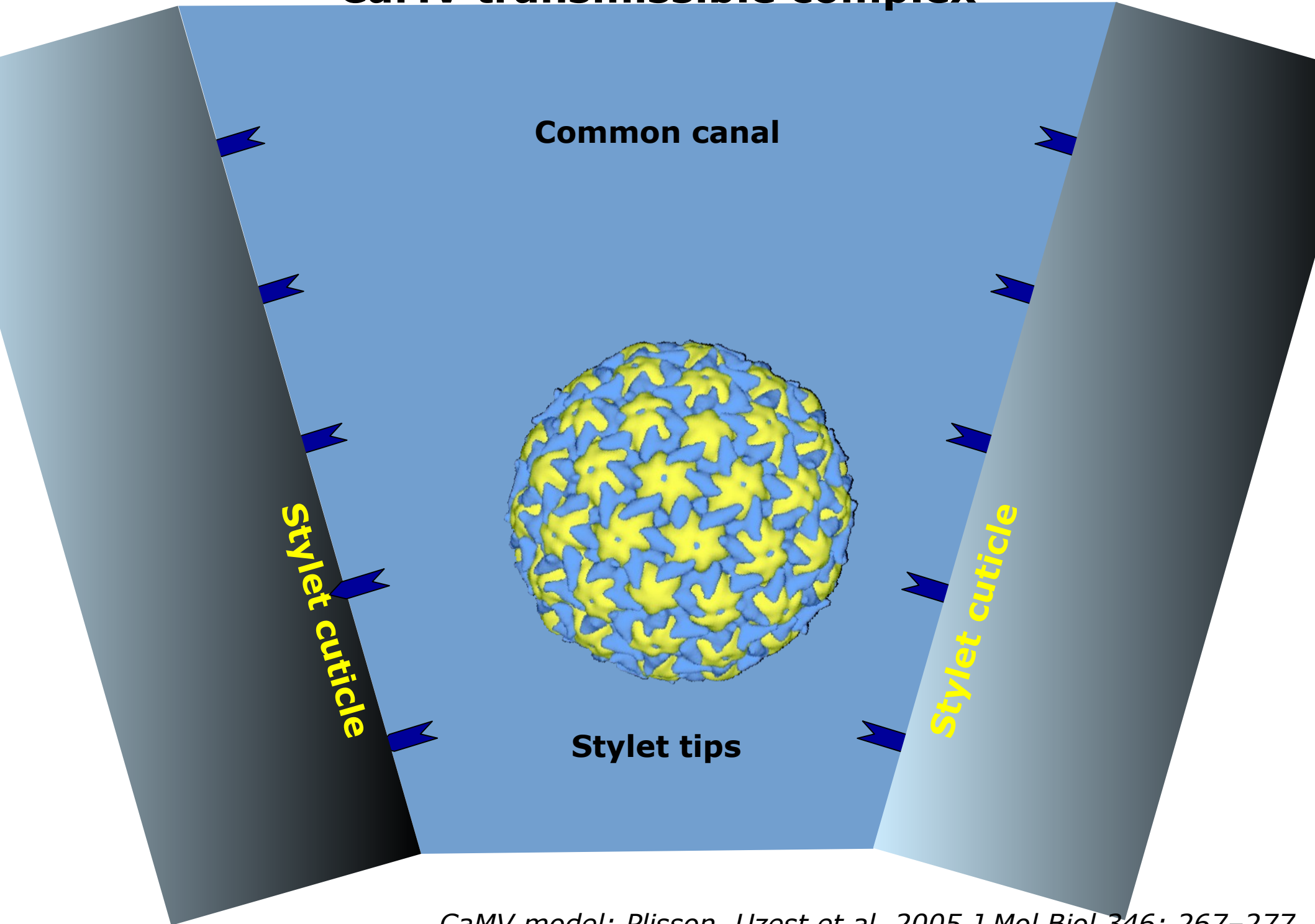
Stylets

Bak et al. 2013 J Virol 87(22), Cover

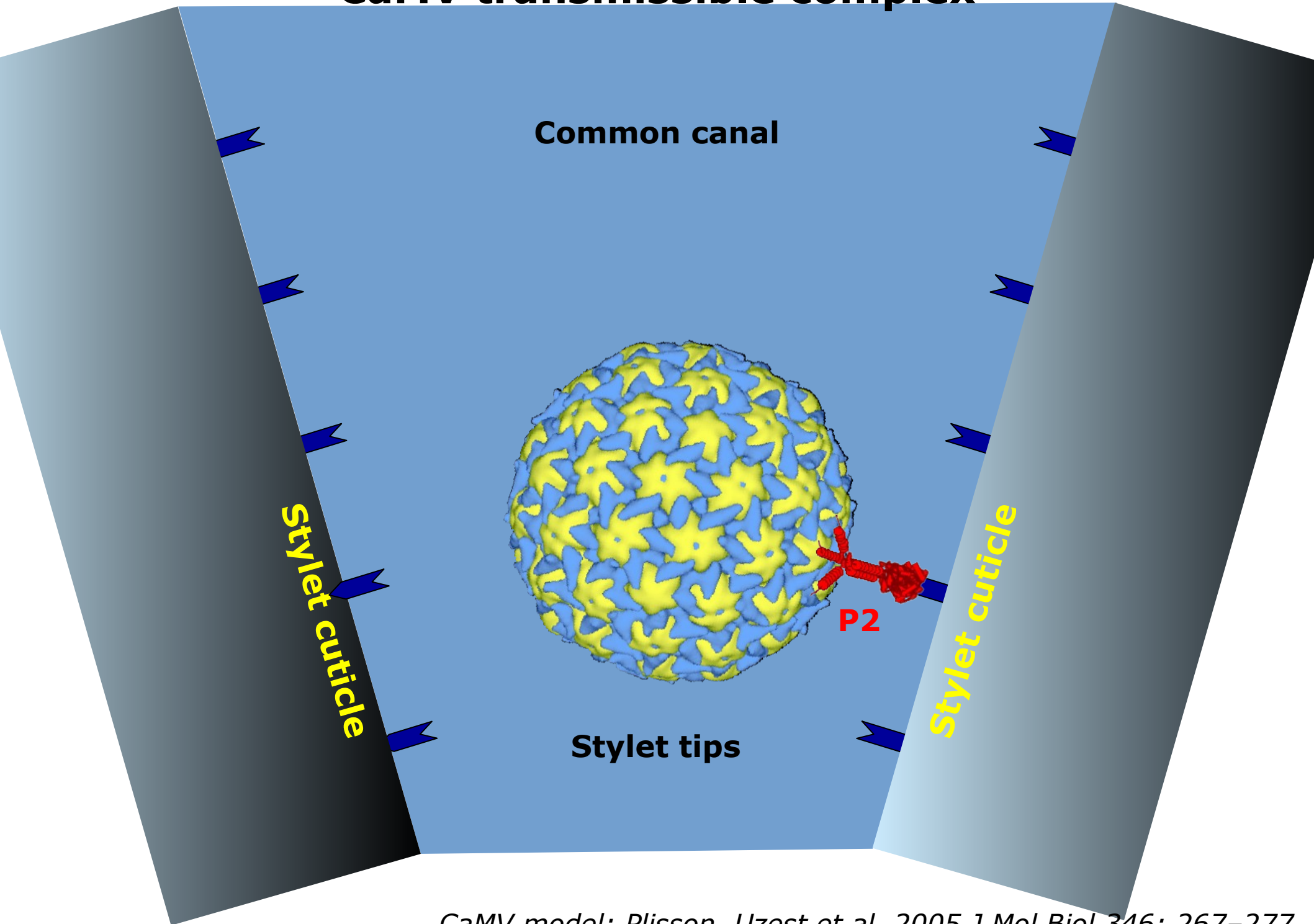
CaMV transmissible complex



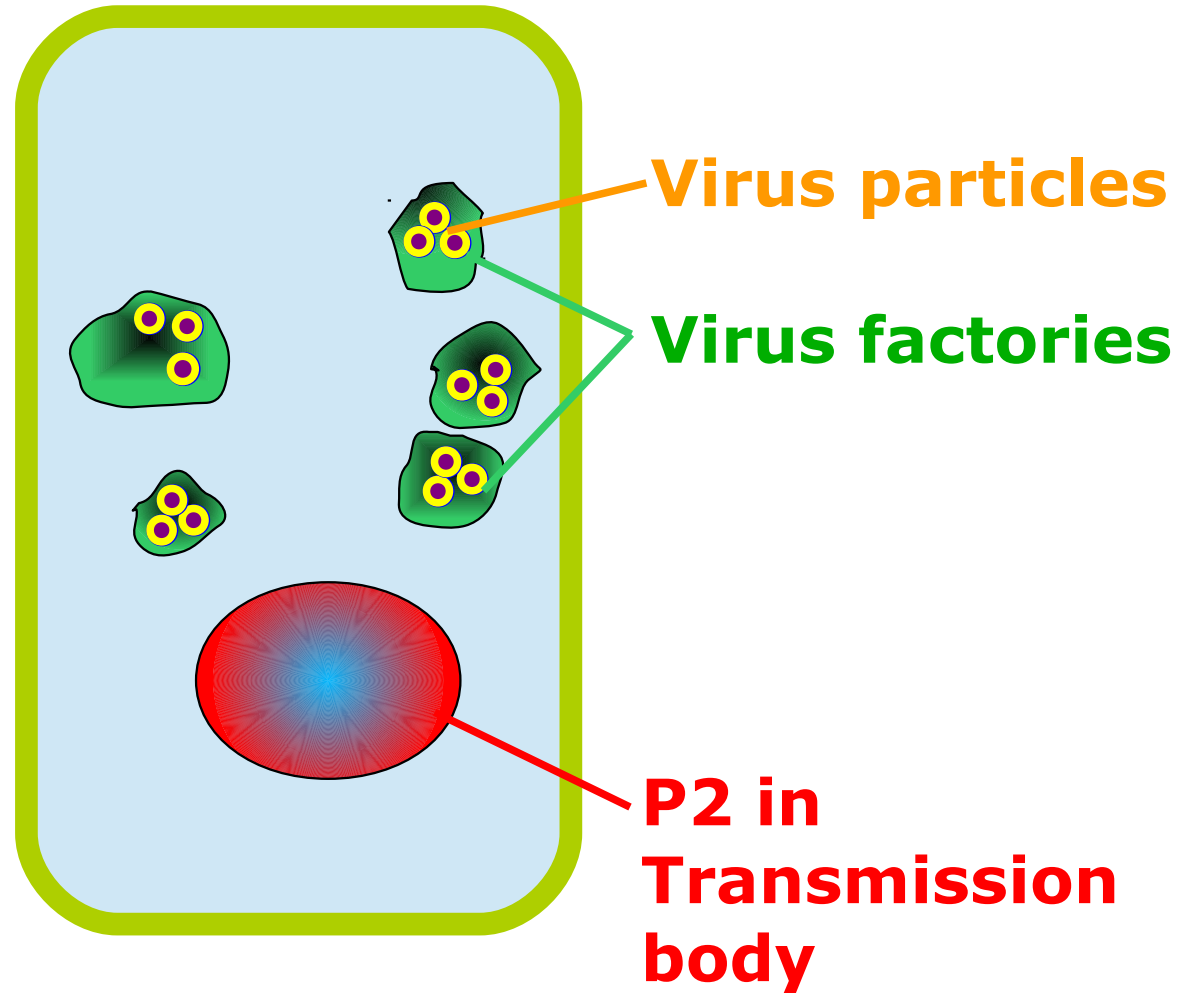
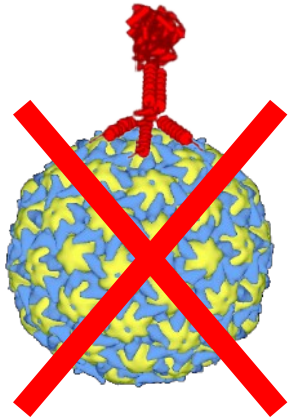
CaMV transmissible complex



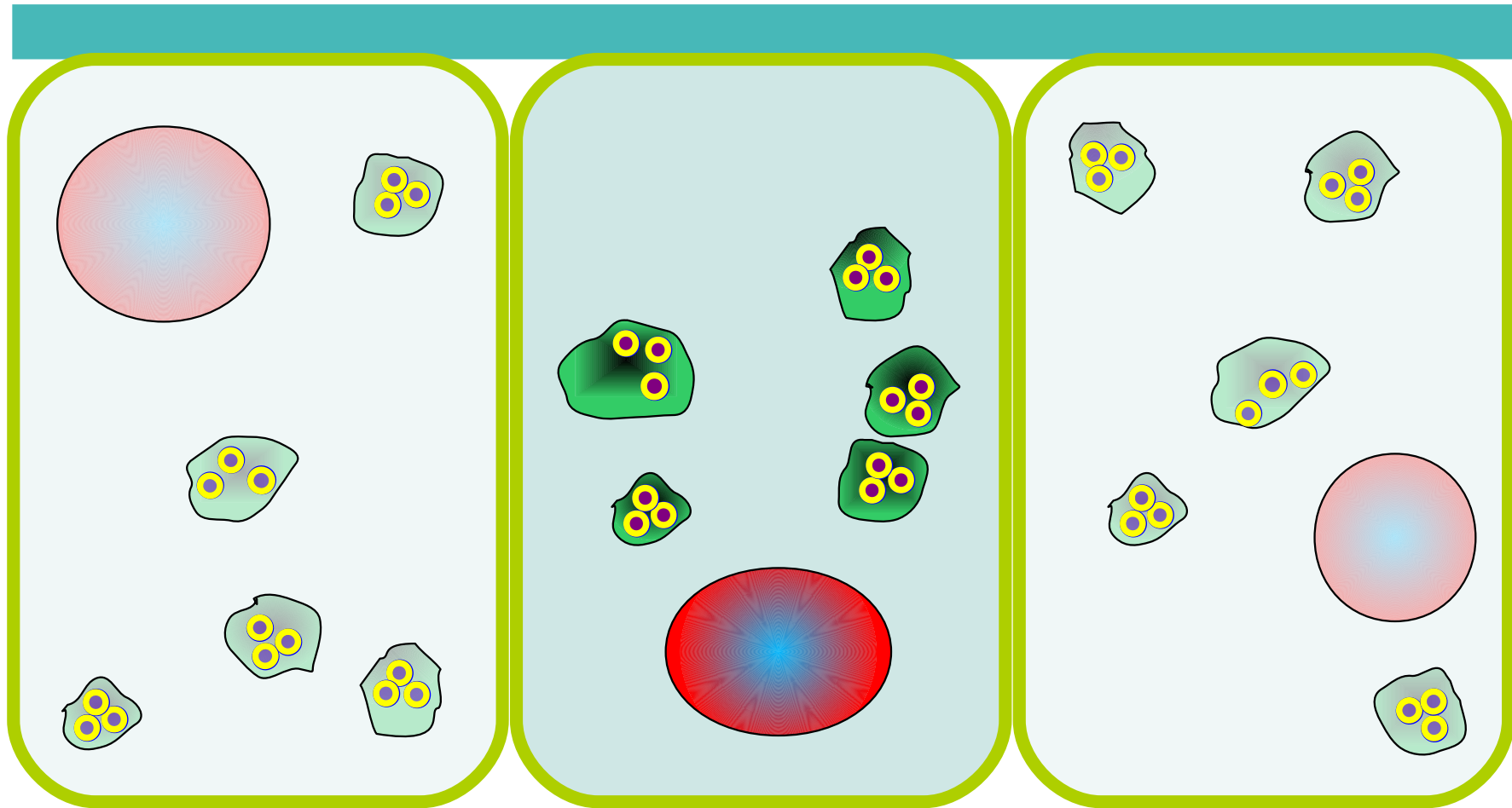
CaMV transmissible complex



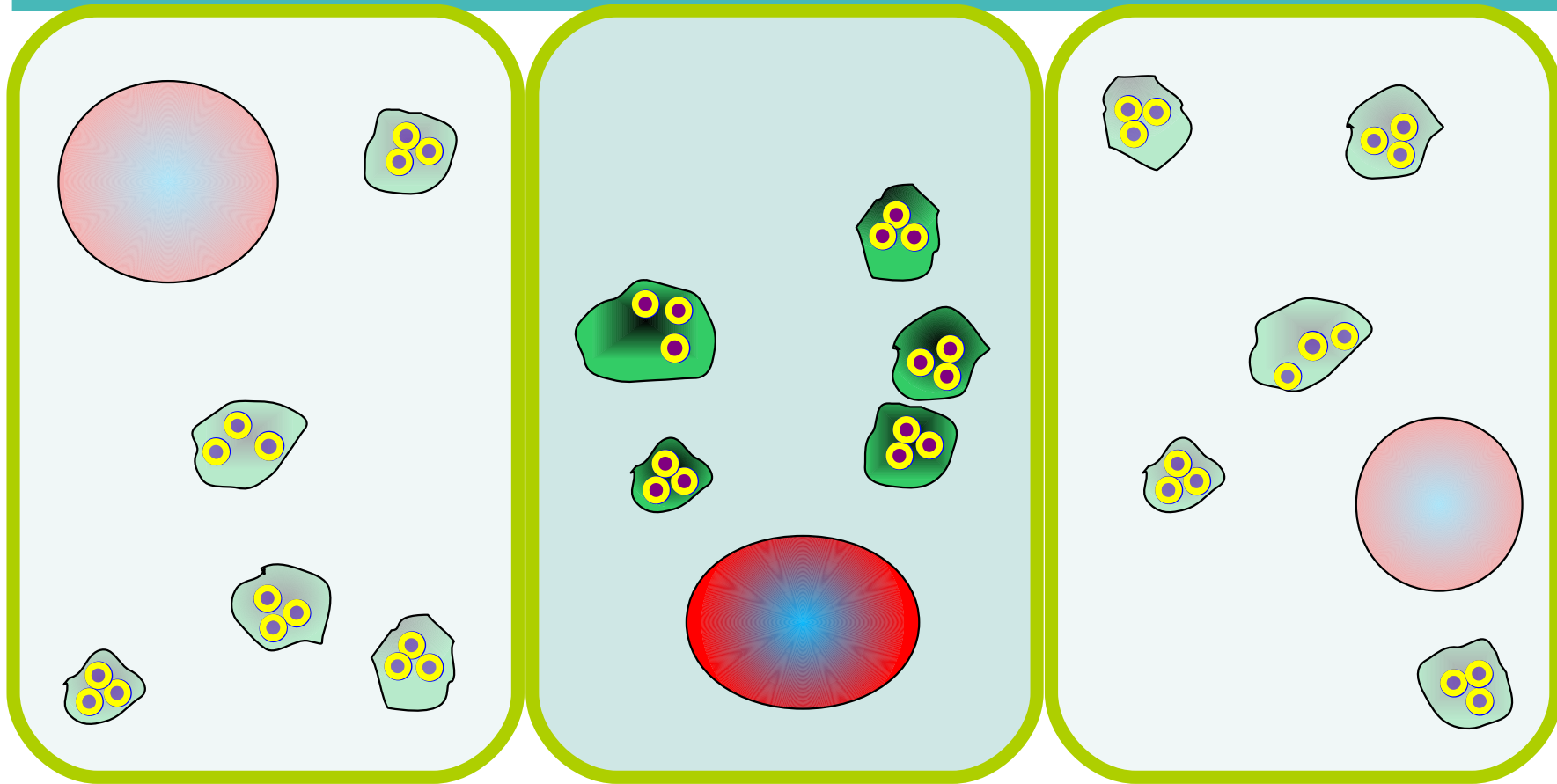
Spatial separation of P2 and virus controls CaMV transmission



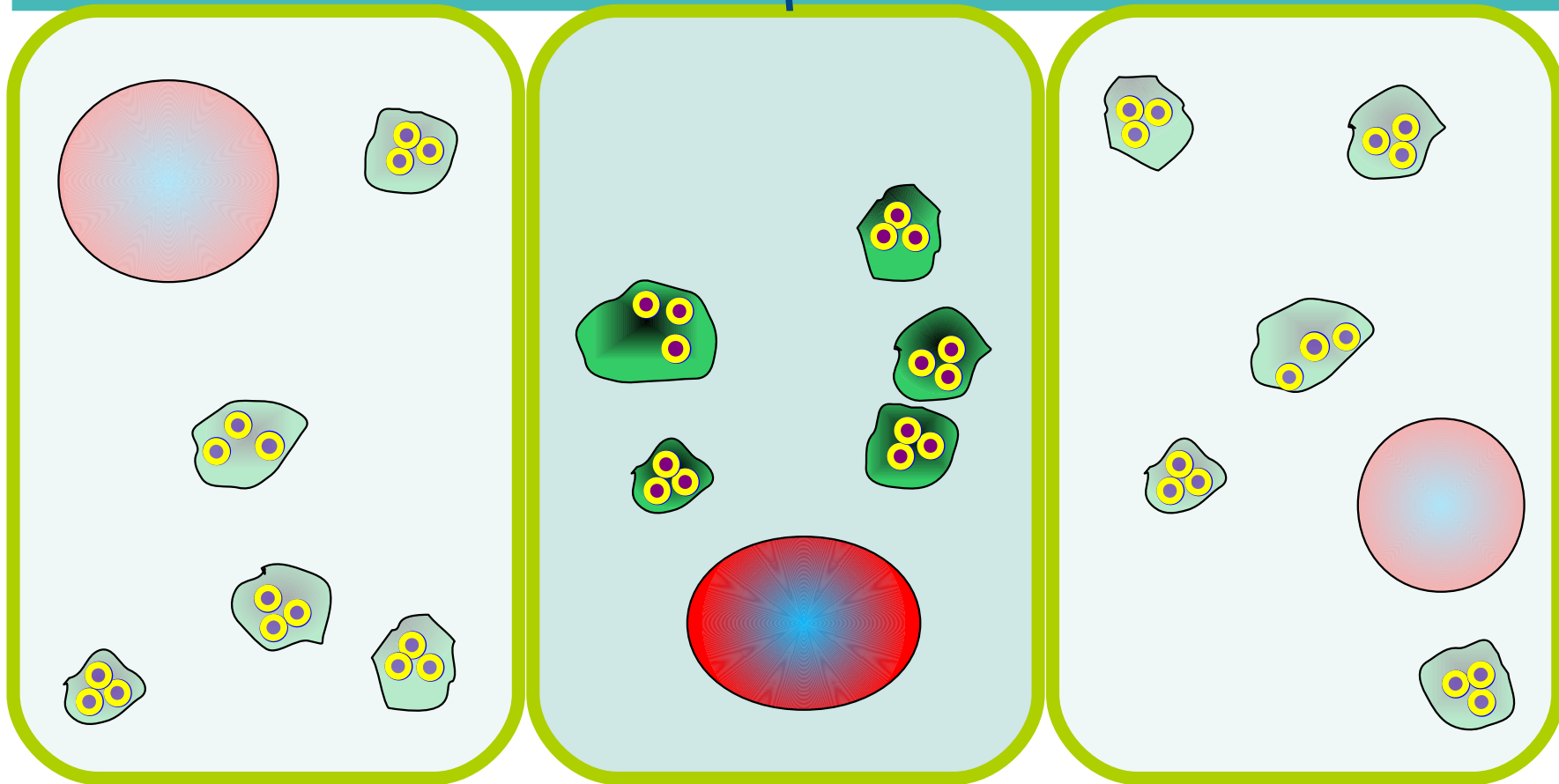
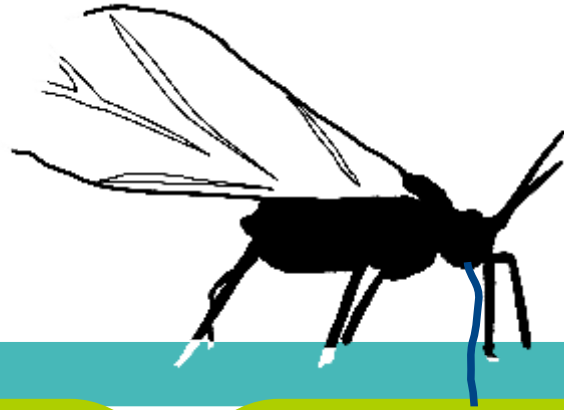
Aphid activity induces CaMV transmission



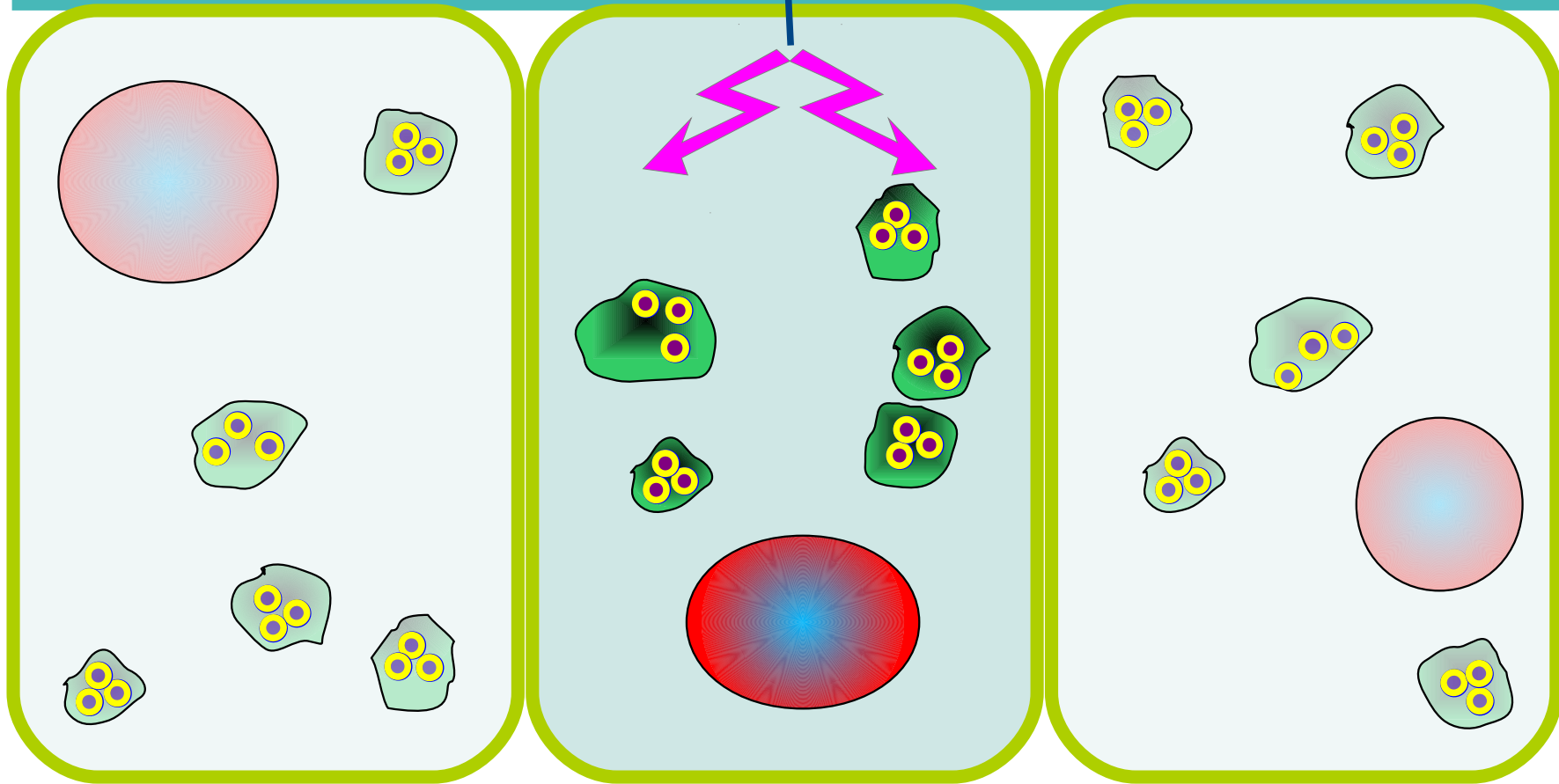
Aphid activity induces CaMV transmission



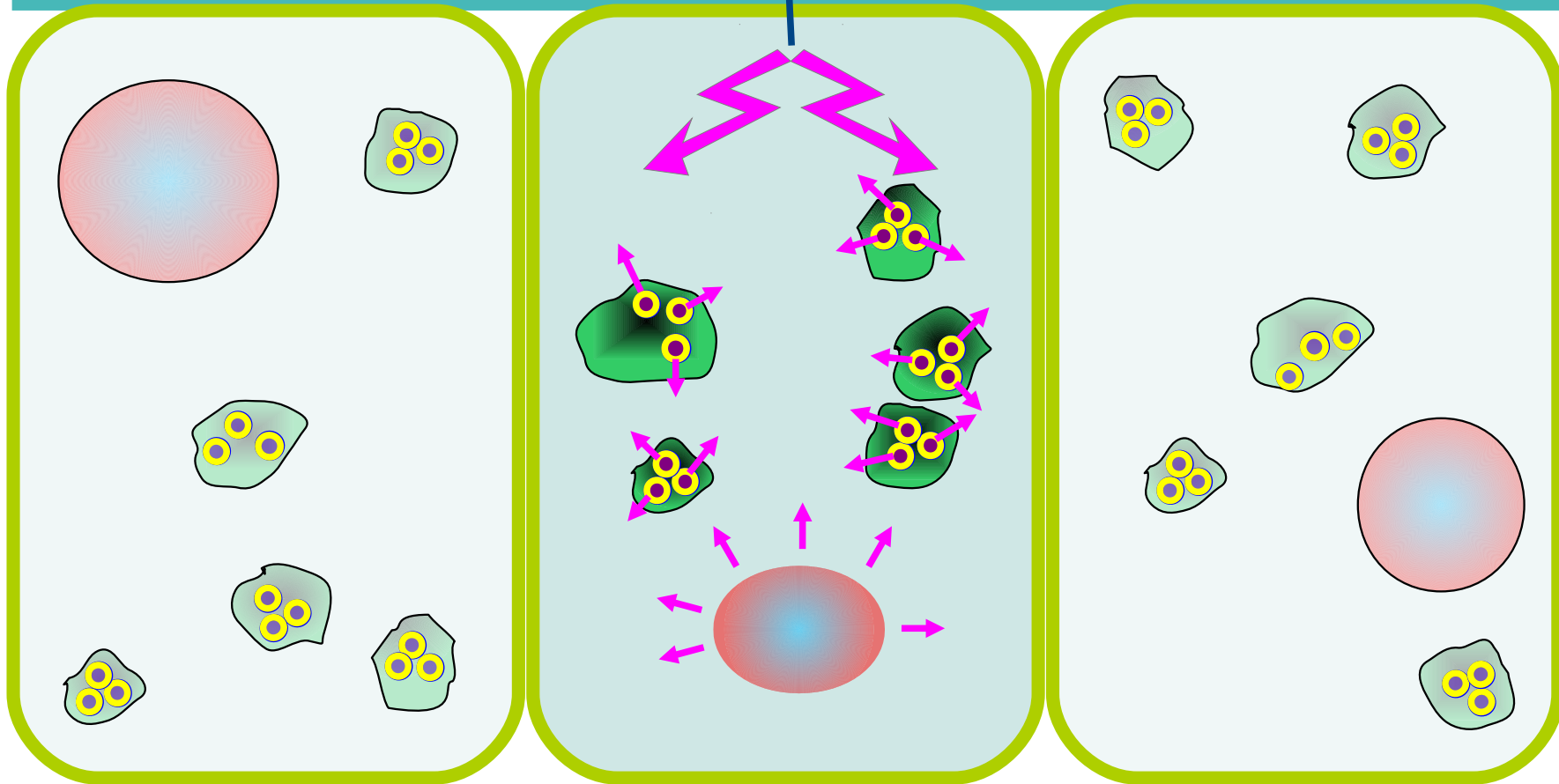
Aphid activity induces CaMV transmission



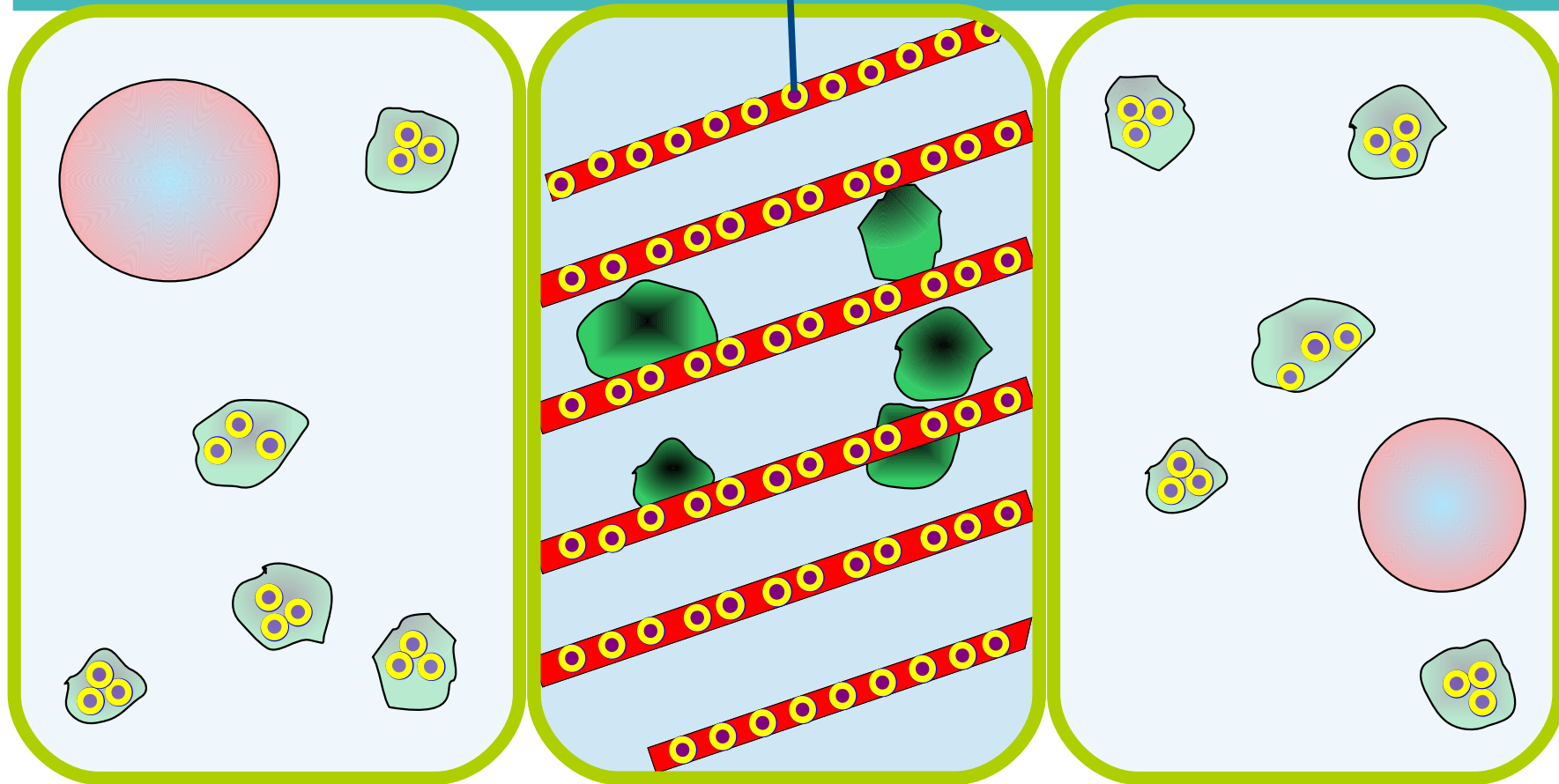
Aphid activity induces CaMV transmission



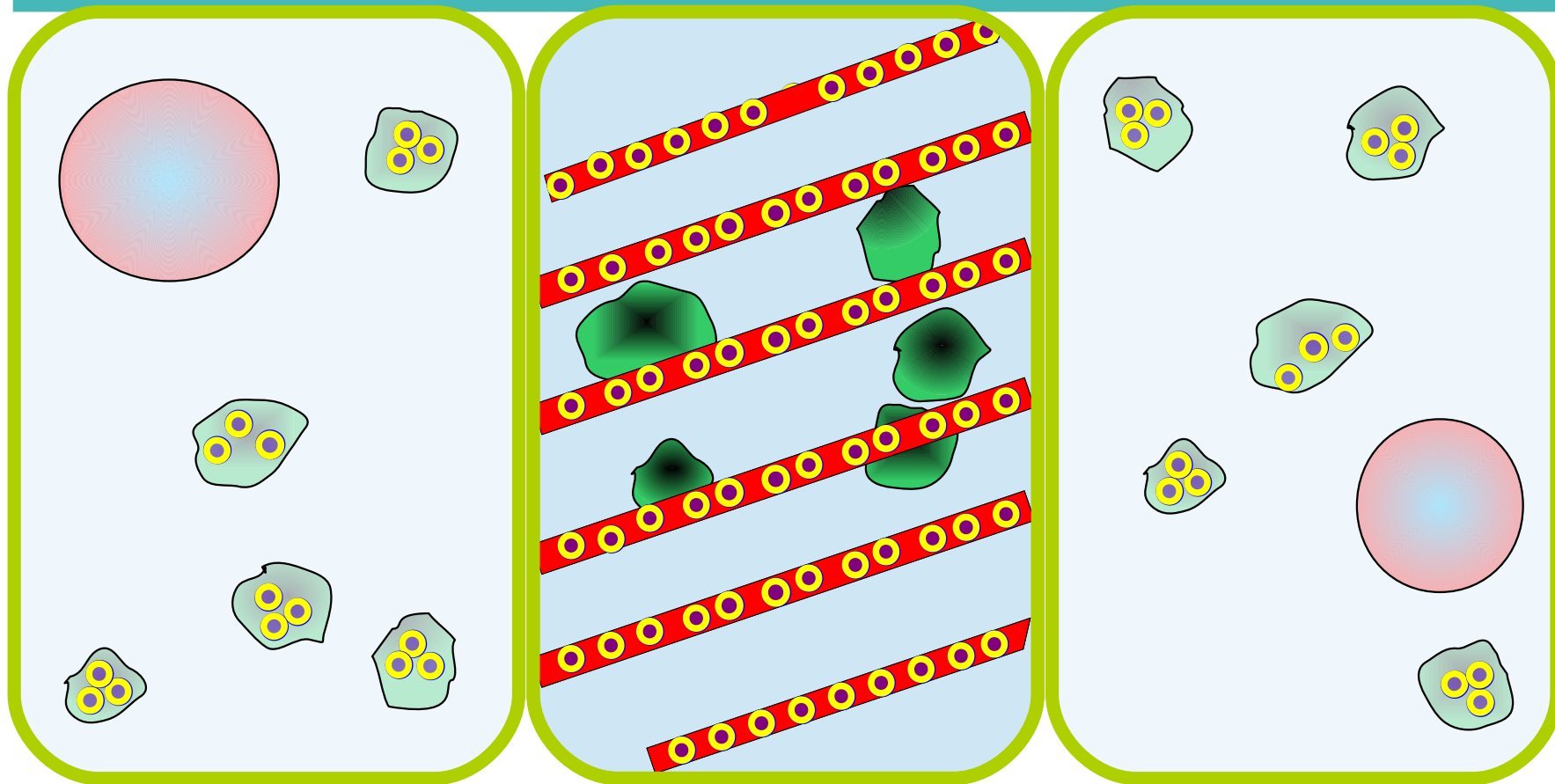
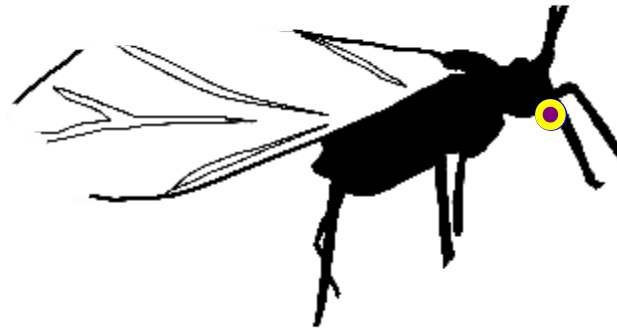
Aphid activity induces CaMV transmission



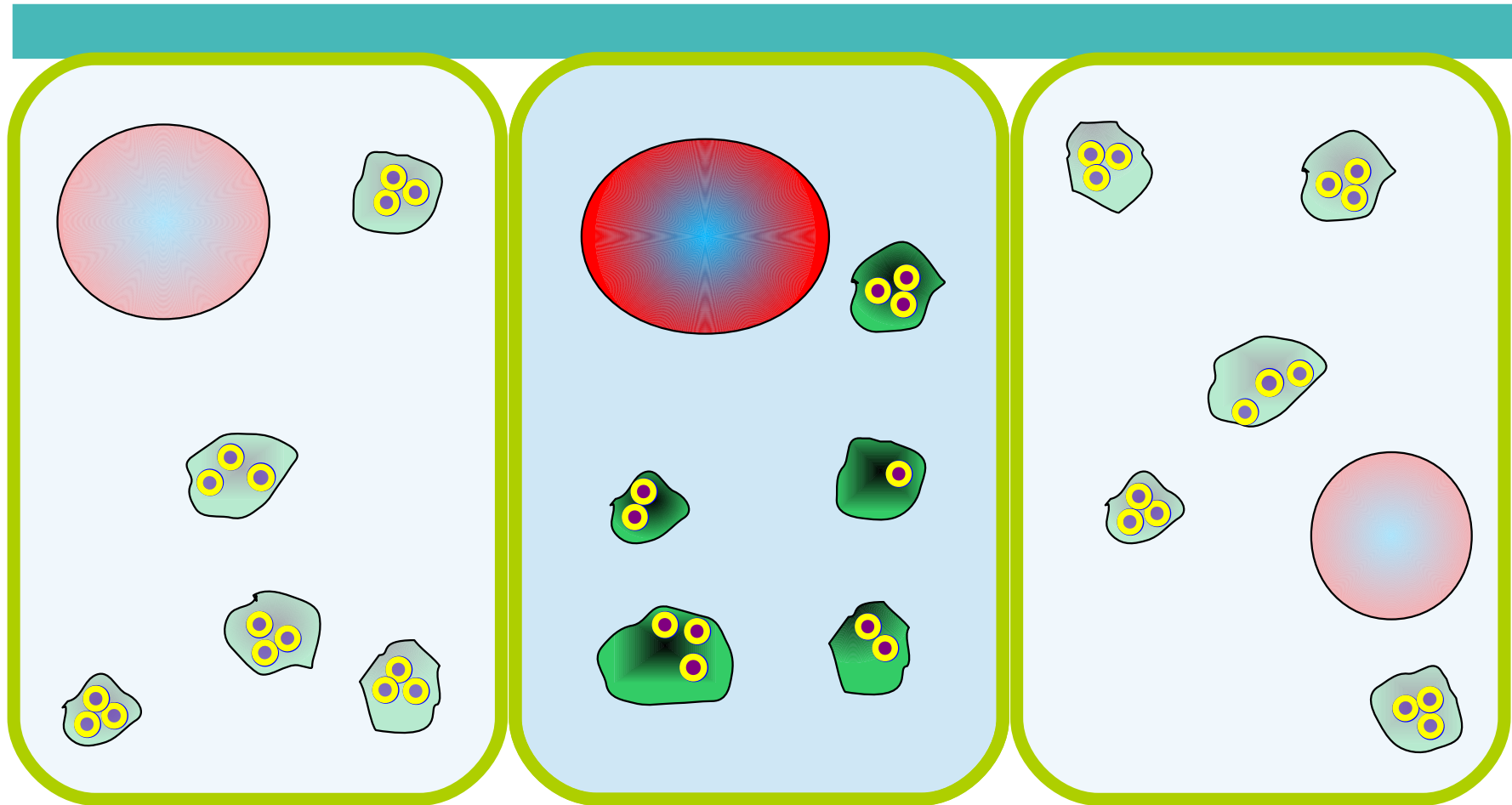
Aphid activity induces CaMV transmission



Aphid activity induces CaMV transmission



Aphid activity induces CaMV transmission



CaMV responds to vector activity on plants
and prepares for transmission

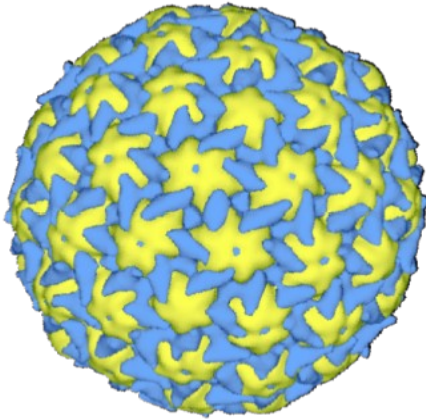
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Transmission activation

What about other viruses?

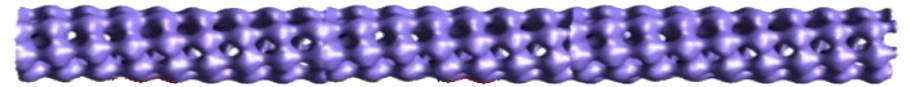
First candidate: TuMV

CaMV



Icosahedral
DNA

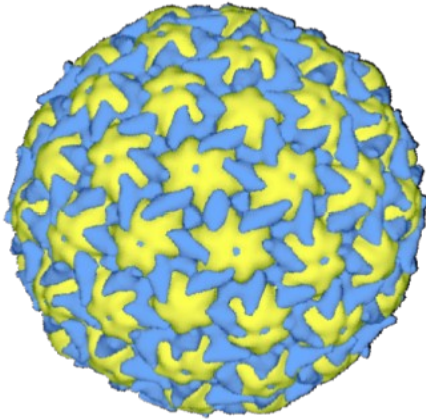
TuMV



Filamentous
RNA

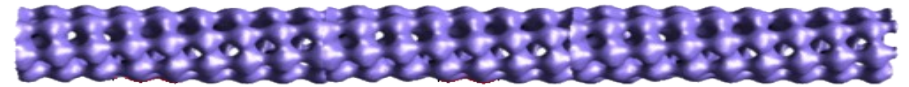
First candidate: TuMV

CaMV



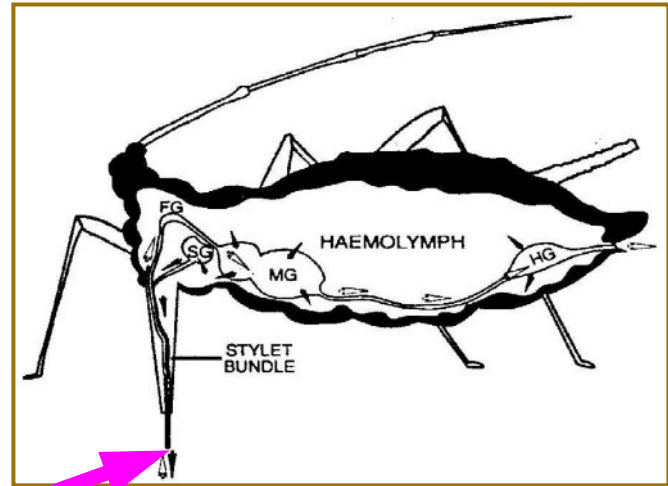
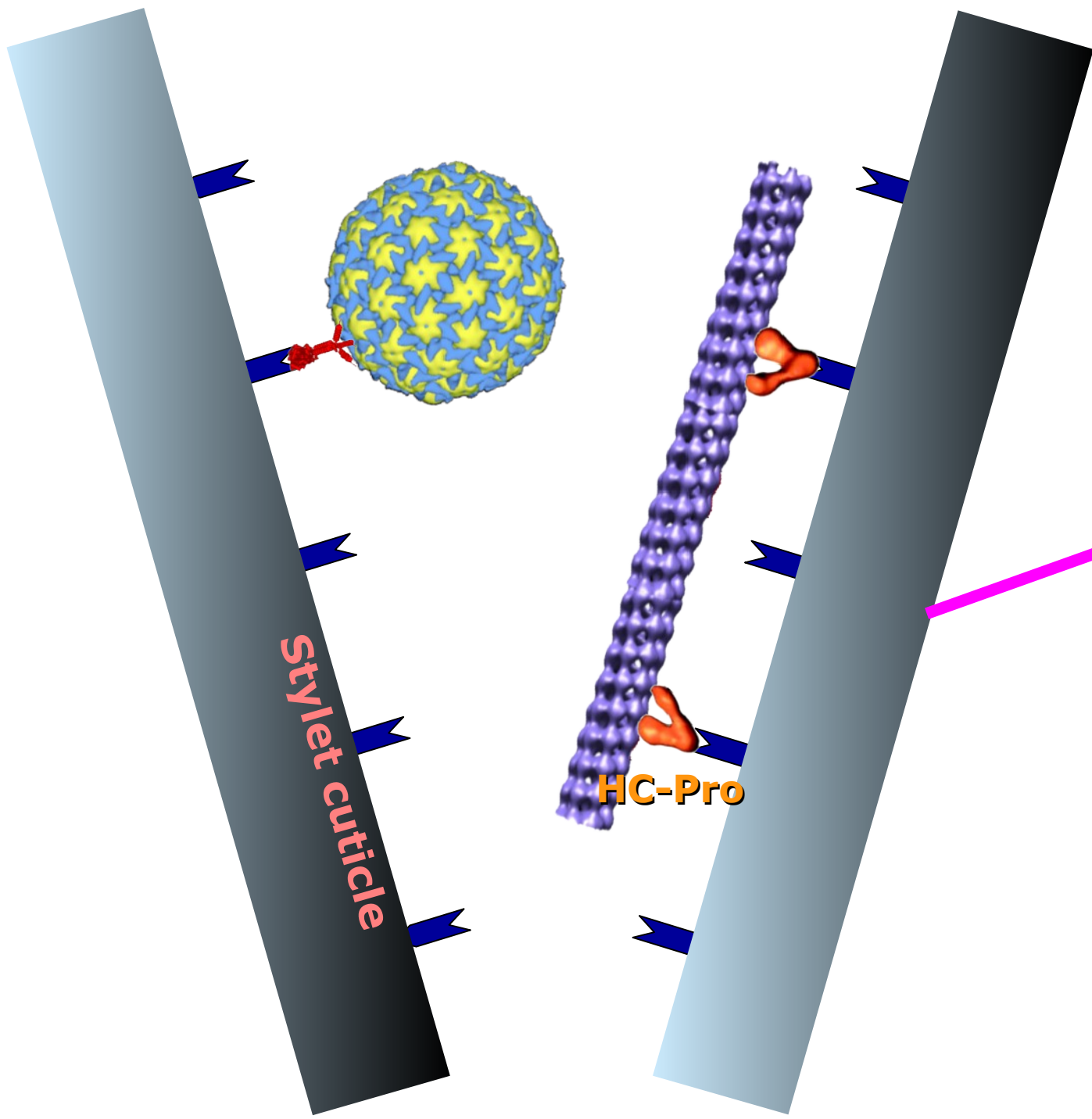
Icosahedral
DNA

TuMV



Filamentous
RNA

Both are transmitted by aphids using the non-circulative/non-persistent mode

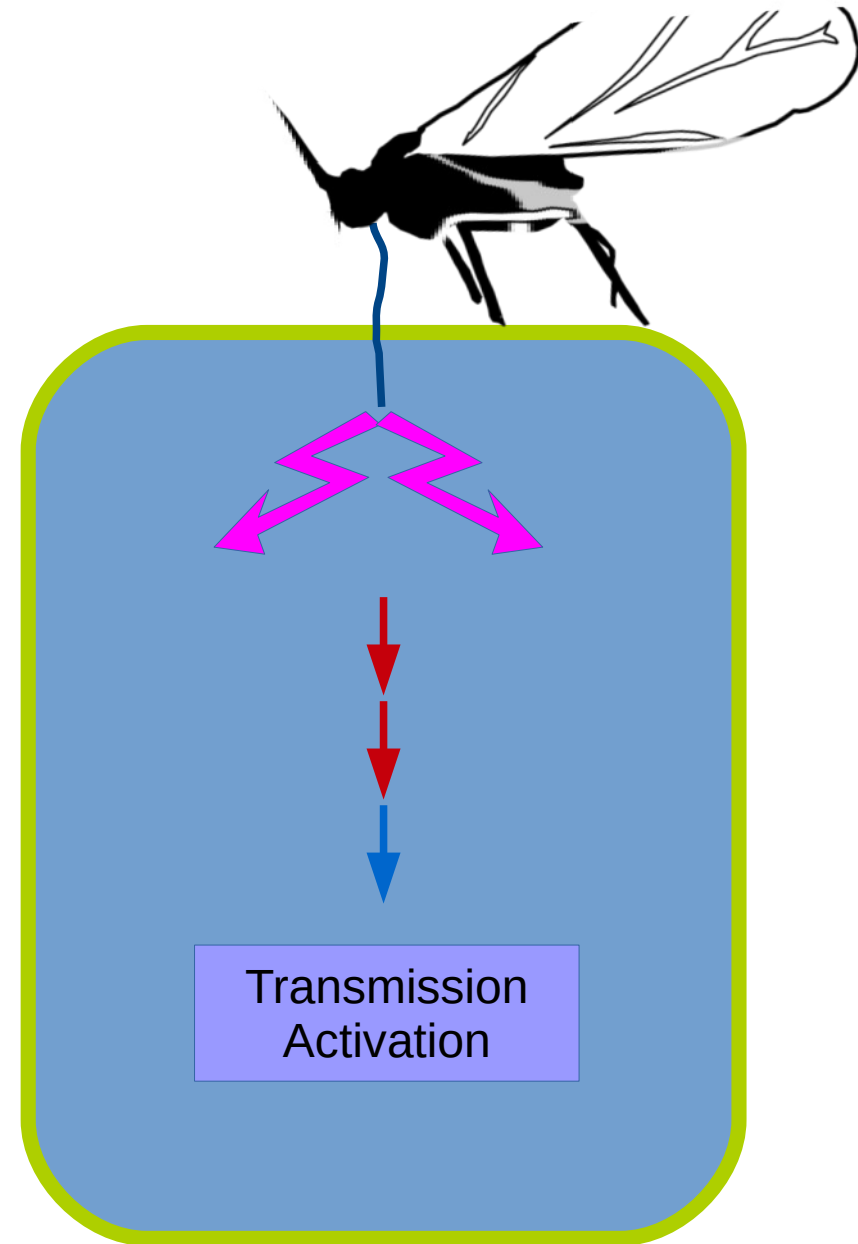


How to test transmission activation?

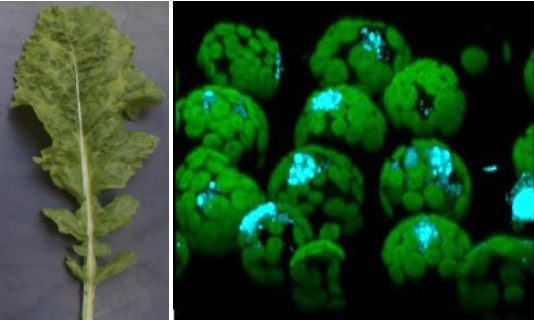
Hypothesis:
Transmission activation requires

Signaling

→ Test effect of signaling molecules on transmission

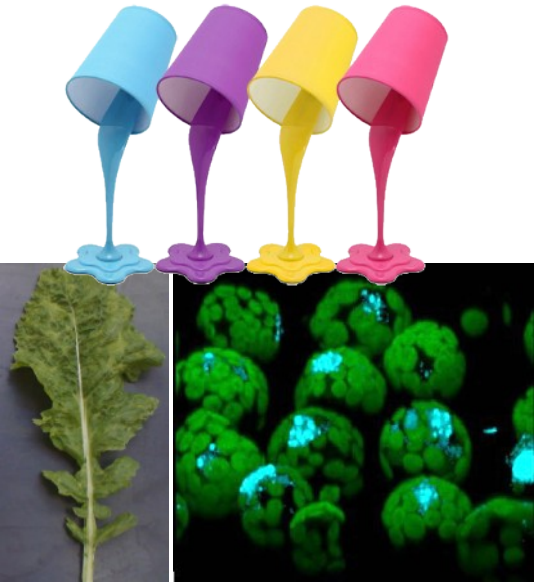


Transmission test system



Protoplasts/
infected leaves

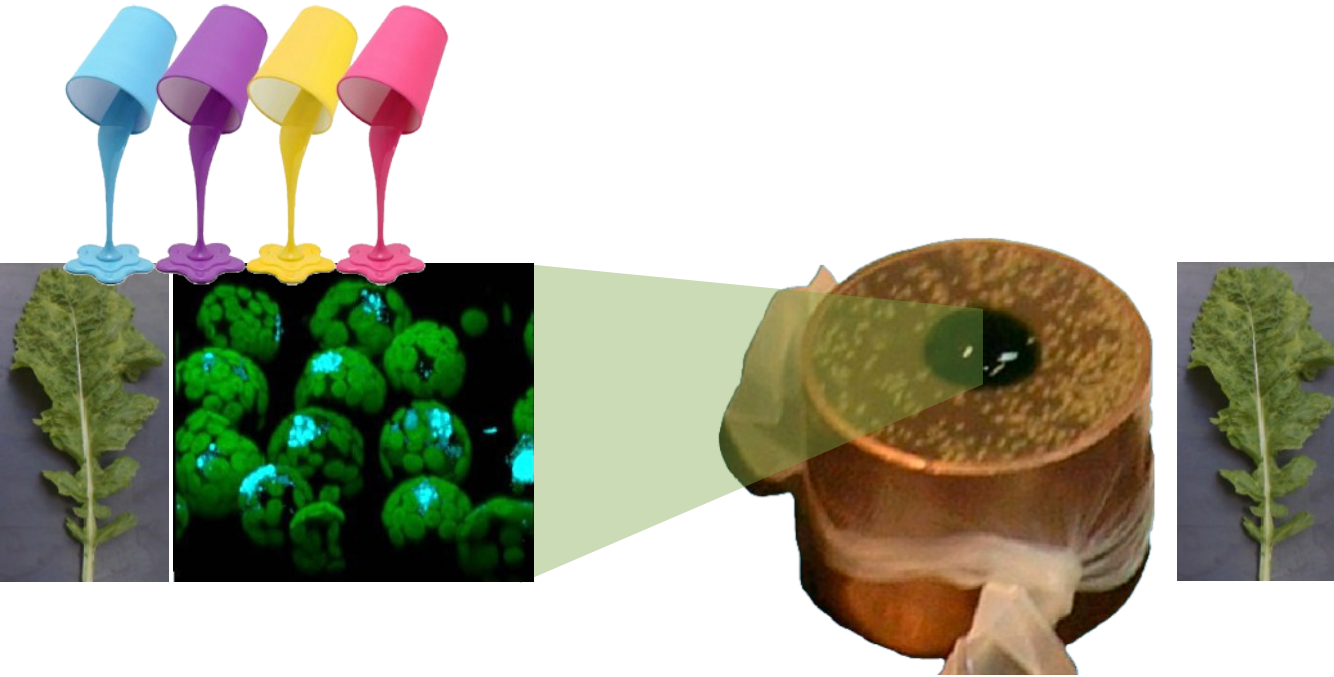
Transmission test system



Protoplasts/
infected leaves

Incubate with
signaling
molecules

Transmission test system

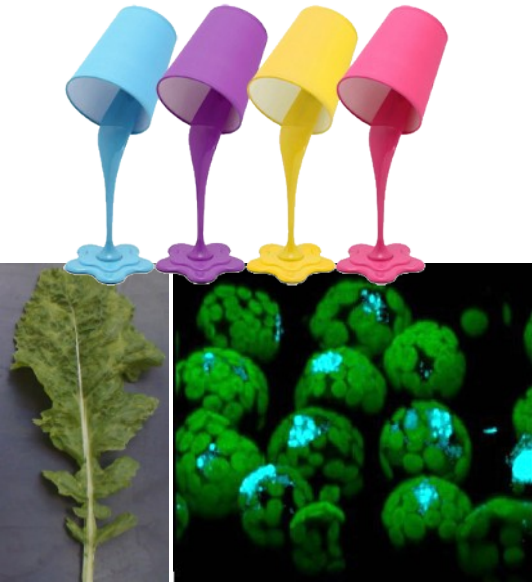


Protoplasts/
infected leaves

Incubate with
signaling
molecules

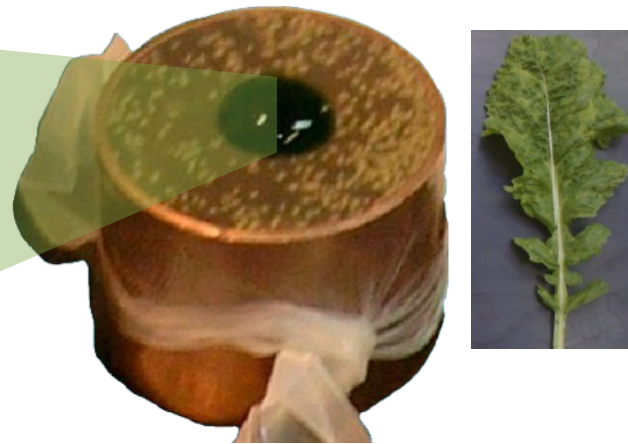
Acquisition
by aphids

Transmission test system



Protoplasts/
infected leaves

Incubate with
signaling
molecules



Acquisition
by aphids



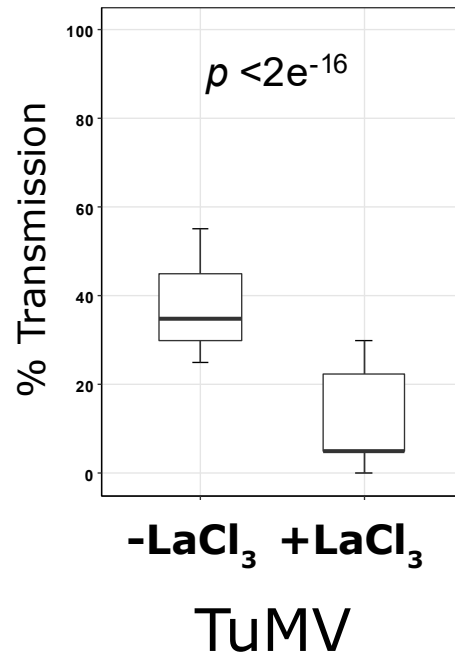
Transmission
tests



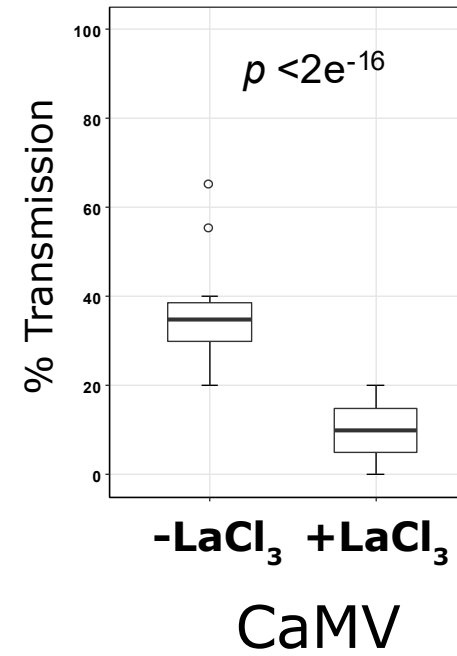
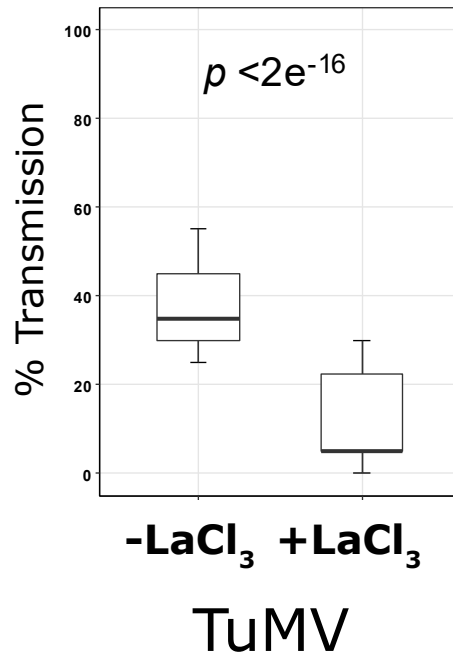
Analysis

Lanthanum inhibits transmission

Lanthanum inhibits transmission



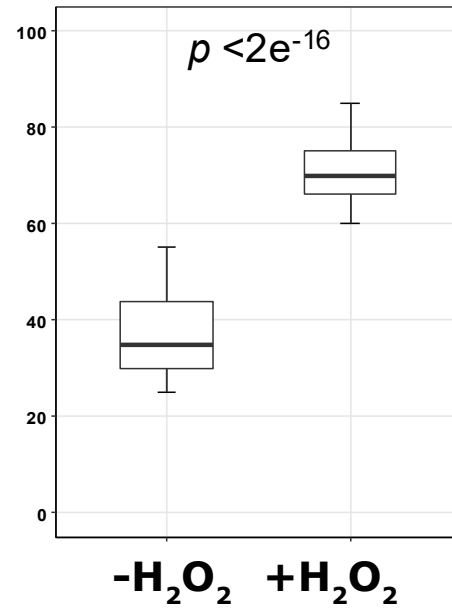
Lanthanum inhibits transmission



➔ Calcium signaling is involved TuMV and CaMV transmission

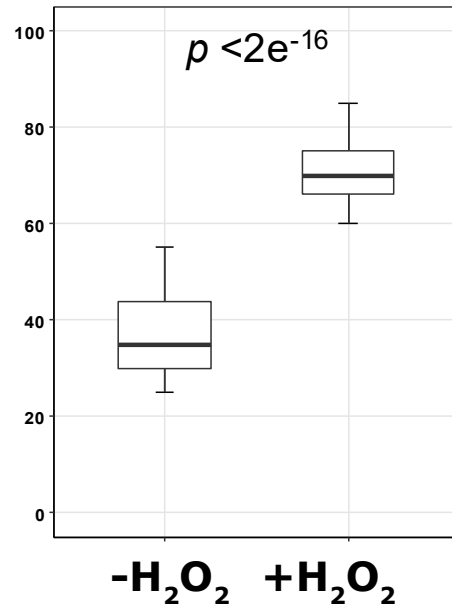
H₂O₂ increases transmission

H₂O₂ increases transmission

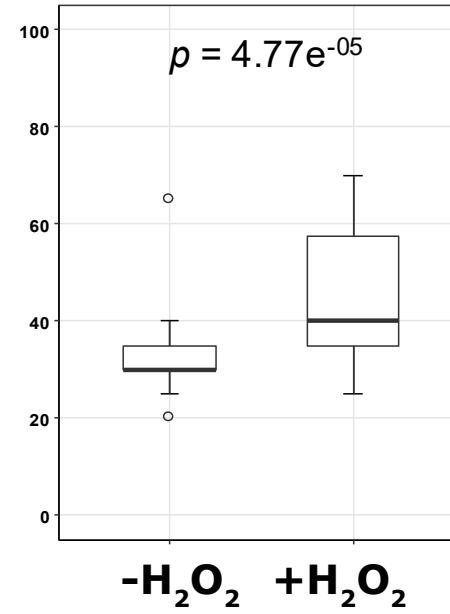


TuMV

H₂O₂ increases transmission

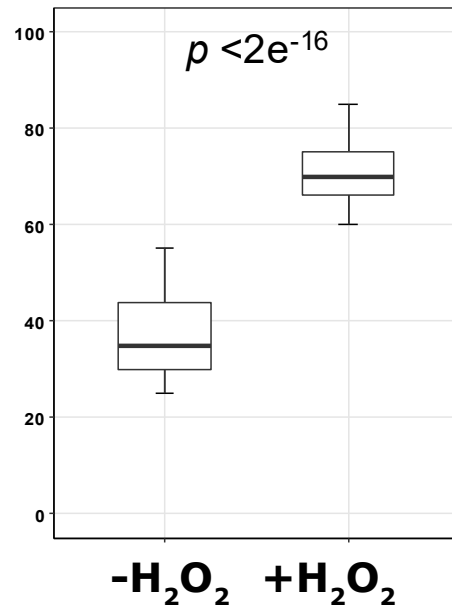


TuMV

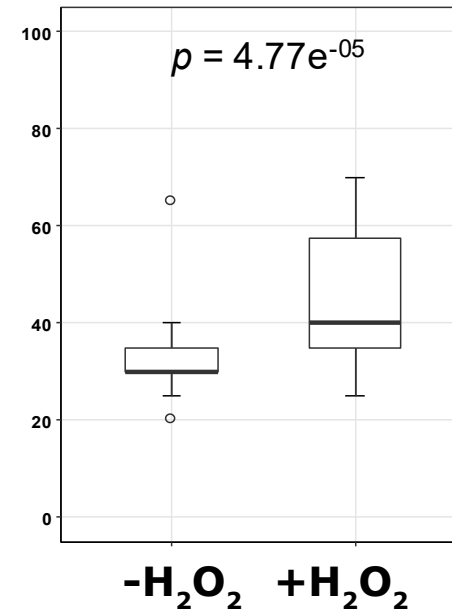


CaMV

H₂O₂ increases transmission



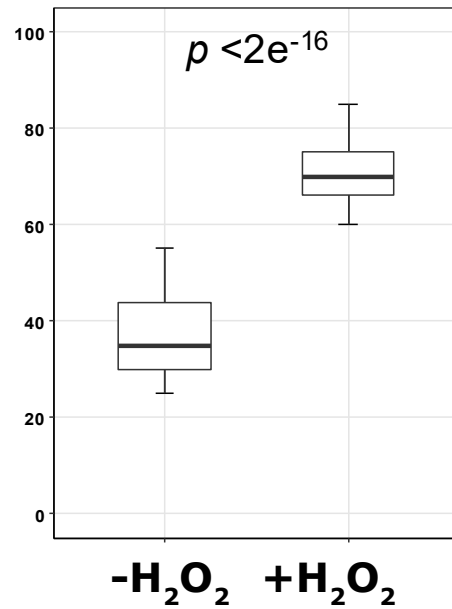
TuMV



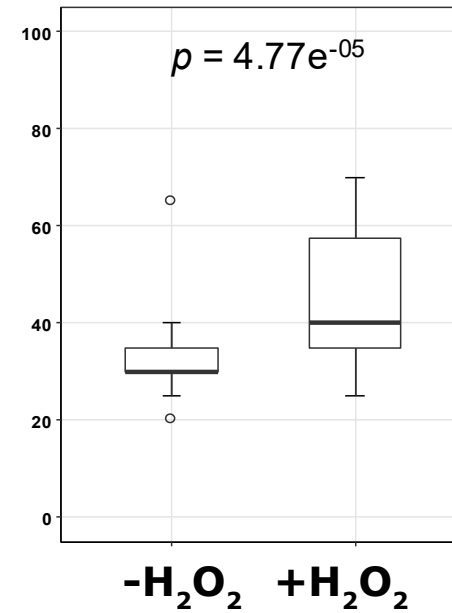
CaMV

➔ ROS is involved in TuMV and CaMV transmission

H₂O₂ increases transmission



TuMV



CaMV

- ROS is involved in TuMV and CaMV transmission
- TuMV transmission can be activated

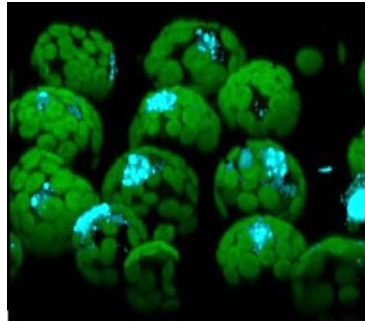
Mechanism of TuMV transmission activation

Mechanism of TuMV transmission activation

Duolink *in situ* protein-protein interaction assay to detect HC-Pro/CP interactions

Mechanism of TuMV transmission activation

Duolink *in situ* protein-protein interaction assay to detect HC-Pro/CP interactions



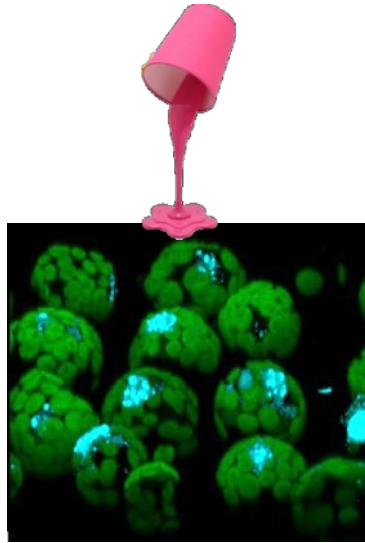
Mechanism of TuMV transmission activation

Duolink *in situ* protein-protein interaction assay to detect HC-Pro/CP interactions



Mechanism of TuMV transmission activation

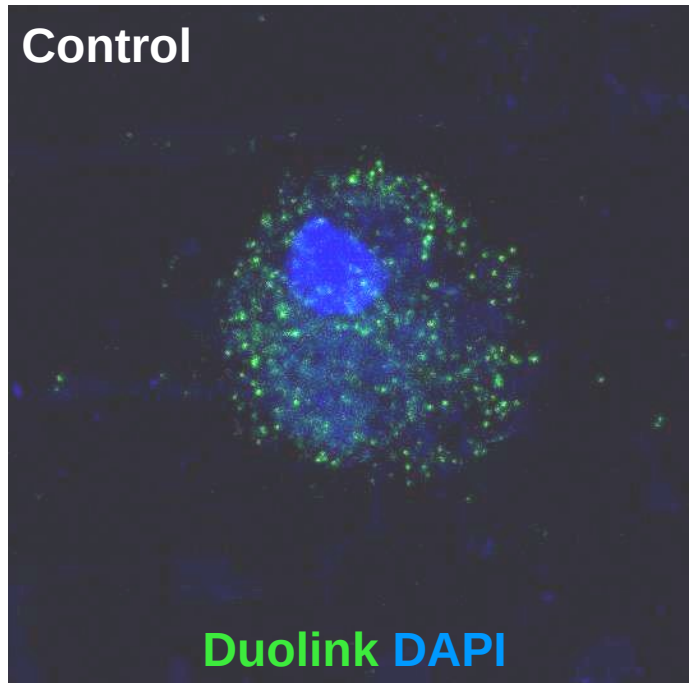
Duolink *in situ* protein-protein interaction assay to detect HC-Pro/CP interactions



→ Duolink

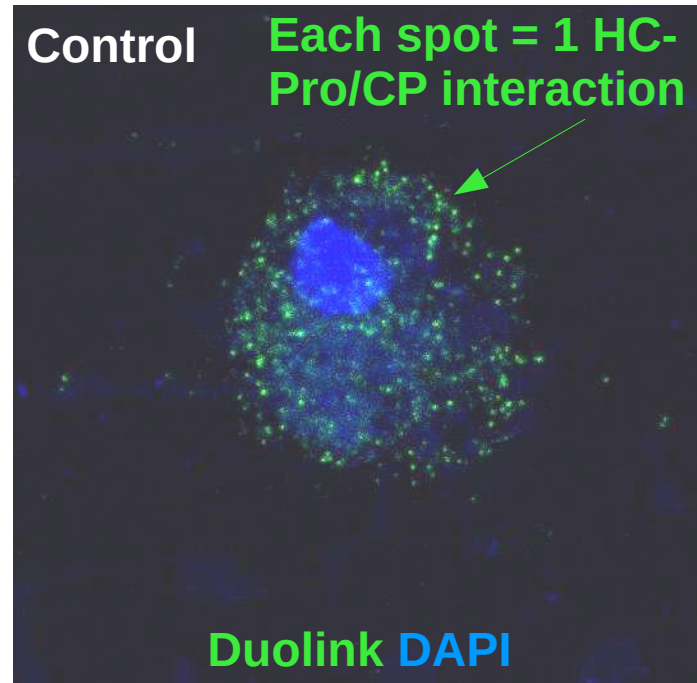
Mechanism of TuMV transmission activation

Duolink *in situ* protein-protein interaction assay to detect HC-Pro/CP interactions



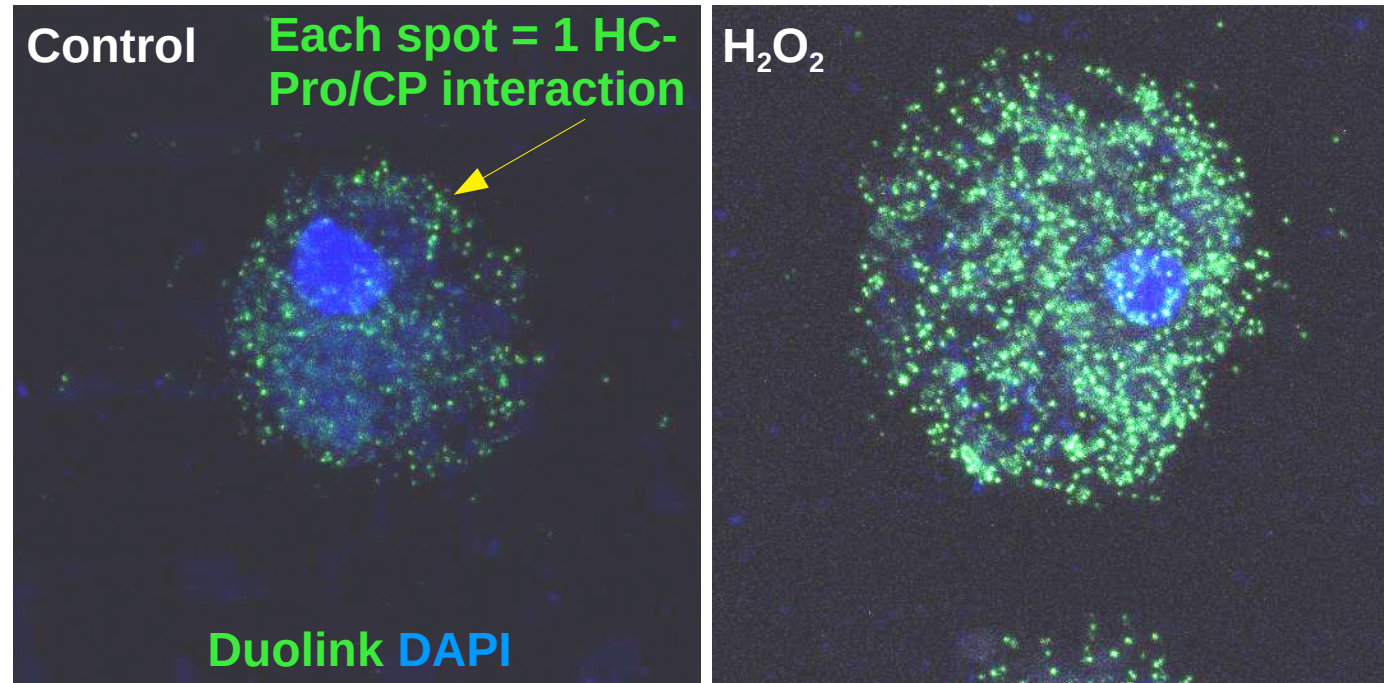
Mechanism of TuMV transmission activation

Duolink *in situ* protein-protein interaction assay to detect HC-Pro/CP interactions



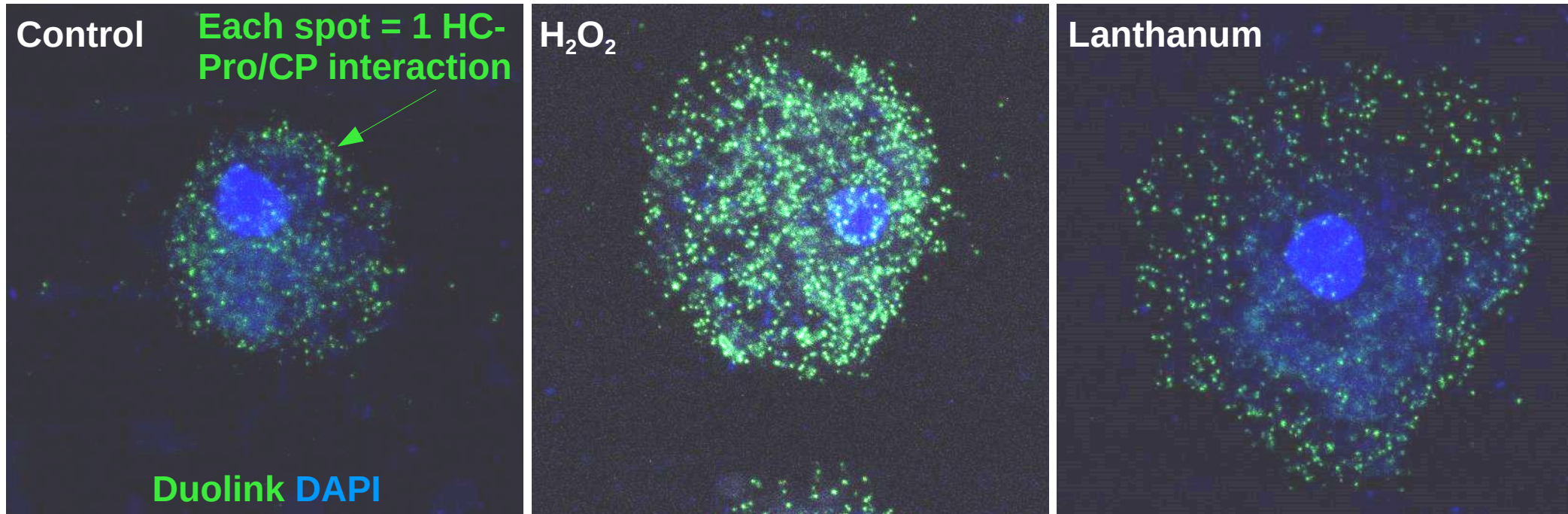
Mechanism of TuMV transmission activation

Duolink *in situ* protein-protein interaction assay to detect HC-Pro/CP interactions



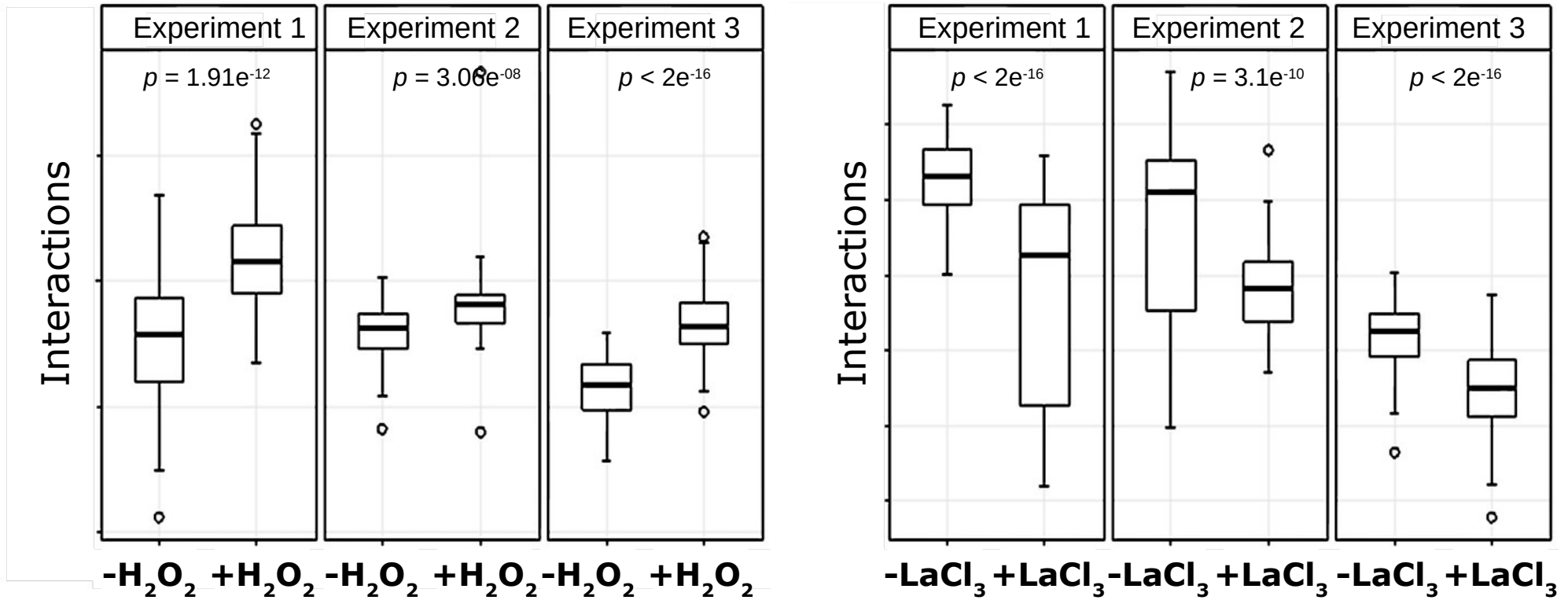
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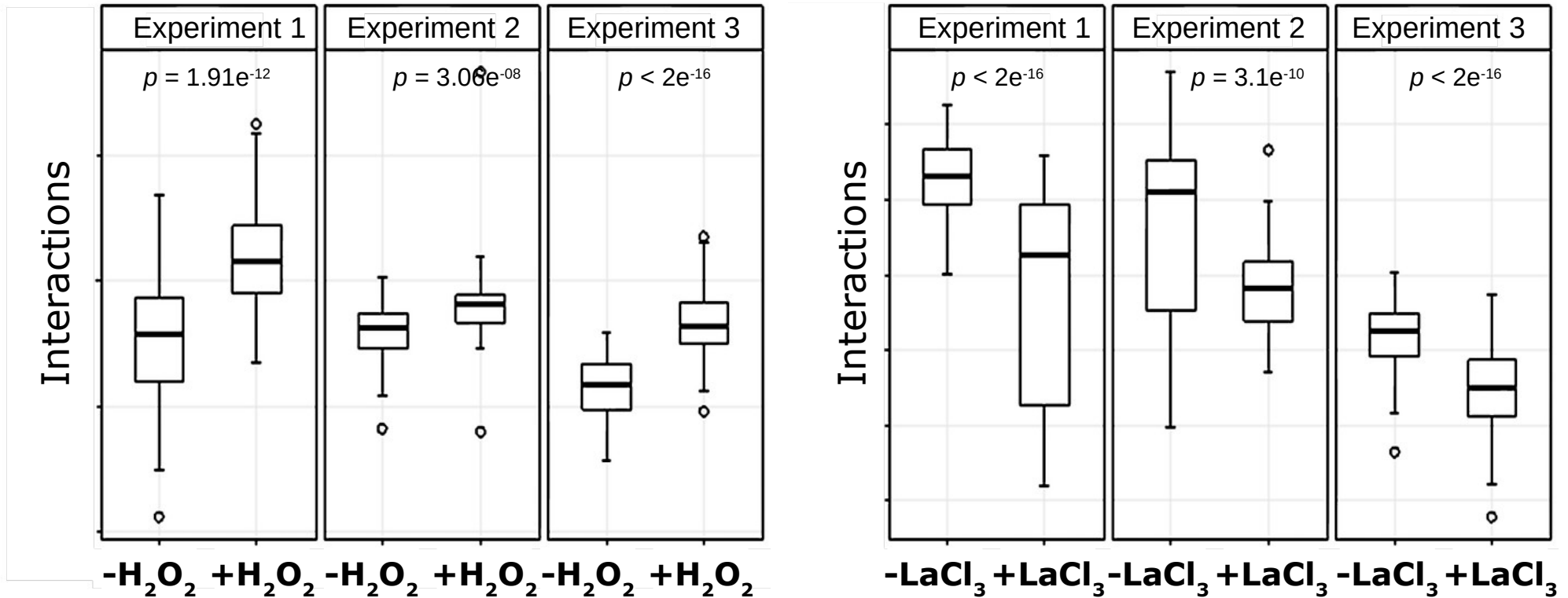
Mechanism of TuMV transmission activation

Duolink *in situ* protein-protein interaction assay to detect HC-Pro/CP interactions

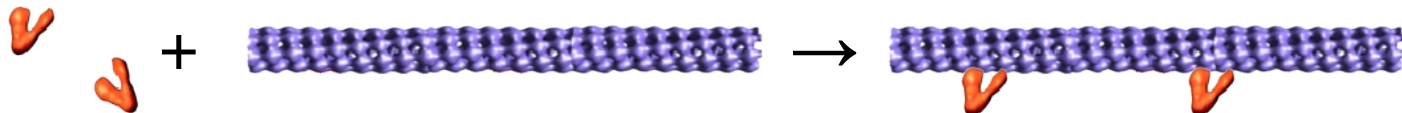


Mechanism of TuMV transmission activation

Duolink *in situ* protein-protein interaction assay to detect HC-Pro/CP interactions



→ H₂O₂ induces TuMV transmissible complexes



Mechanism of TuMV transmission activation

Mechanism of TuMV transmission activation

Non-reducing Western blot to detect posttranslational protein modifications

Mechanism of TuMV transmission activation

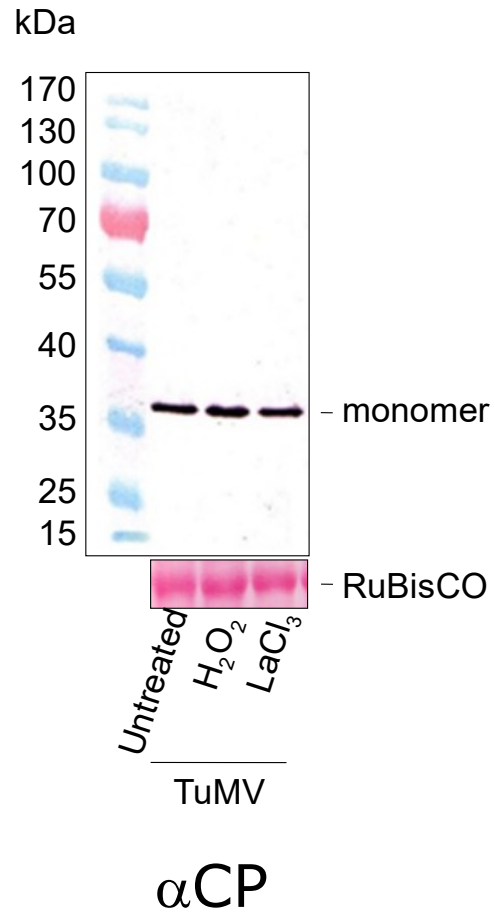
Non-reducing Western blot to detect posttranslational protein modifications



→ Western blot

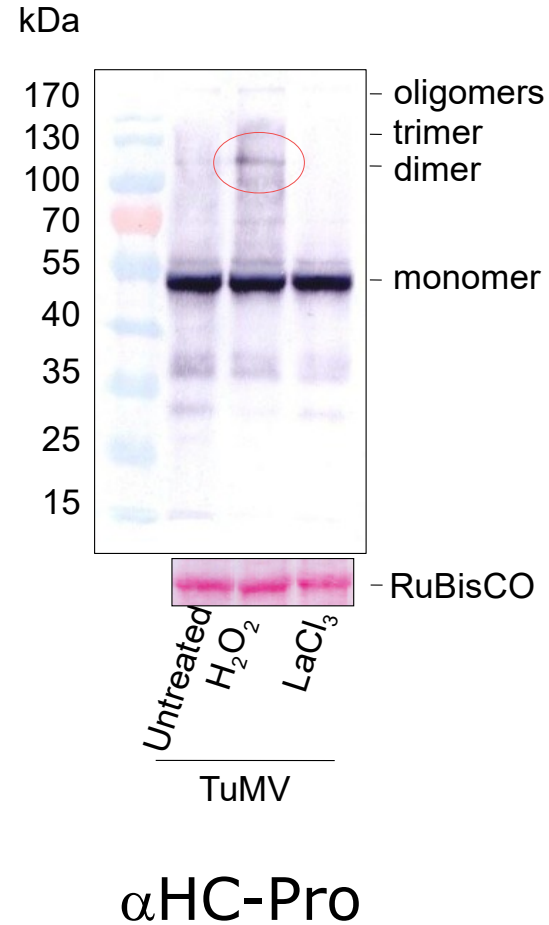
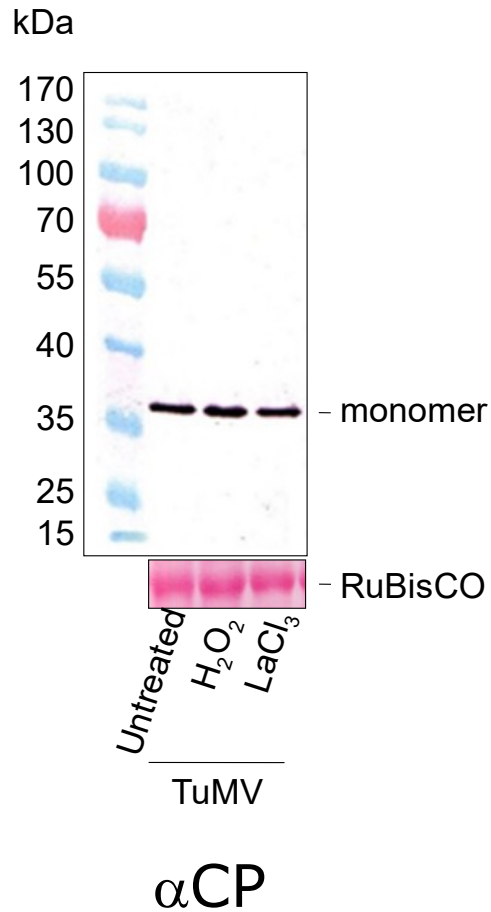
Mechanism of TuMV transmission activation

Non-reducing Western blot to detect posttranslational protein modifications



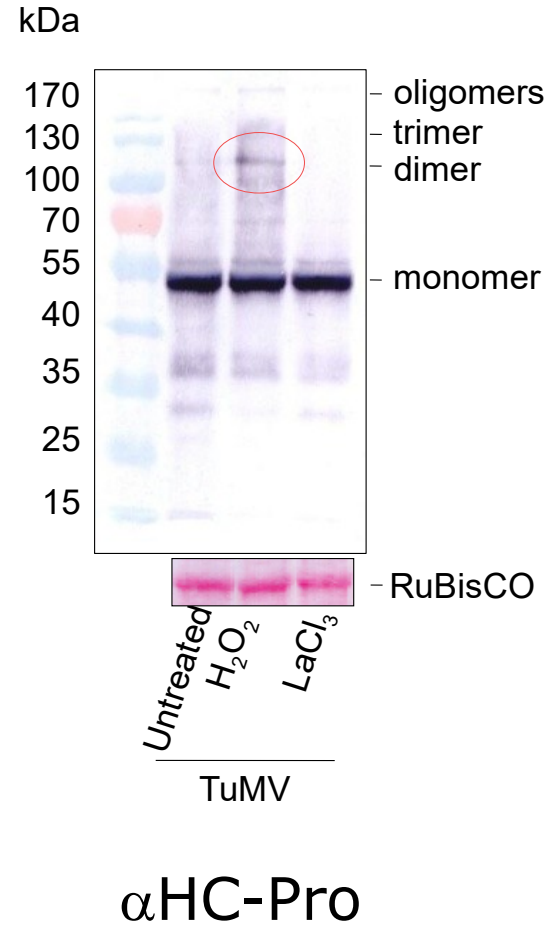
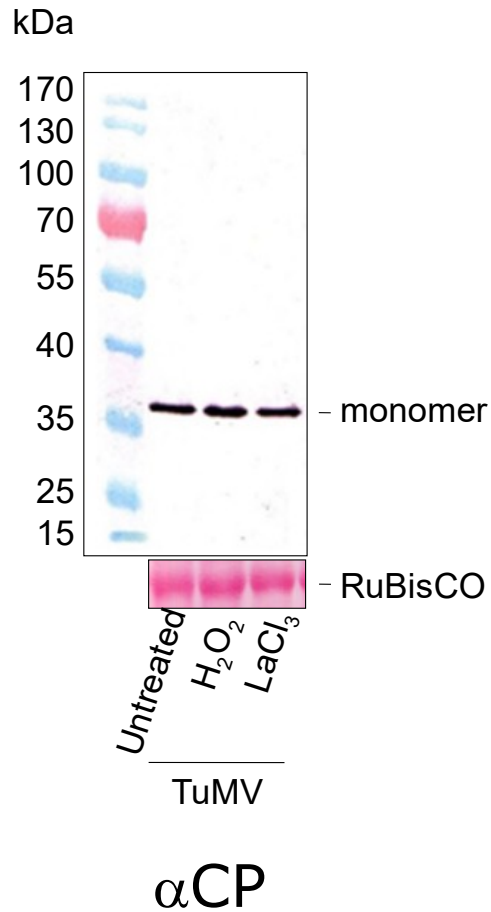
Mechanism of TuMV transmission activation

Non-reducing Western blot to detect posttranslational protein modifications



Mechanism of TuMV transmission activation

Non-reducing Western blot to detect posttranslational protein modifications



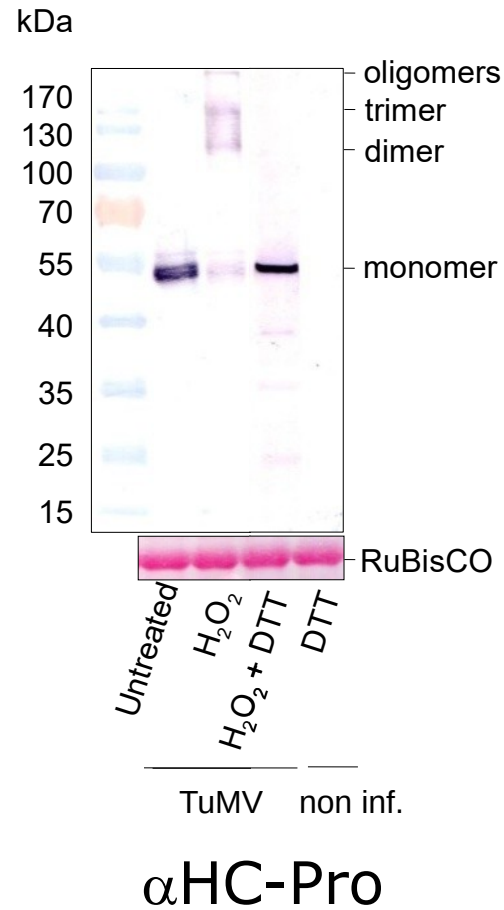
➔ H₂O₂ induces HC-Pro dimers

Mechanism of TuMV transmission activation

Non-reducing Western blot to detect posttranslational protein modifications

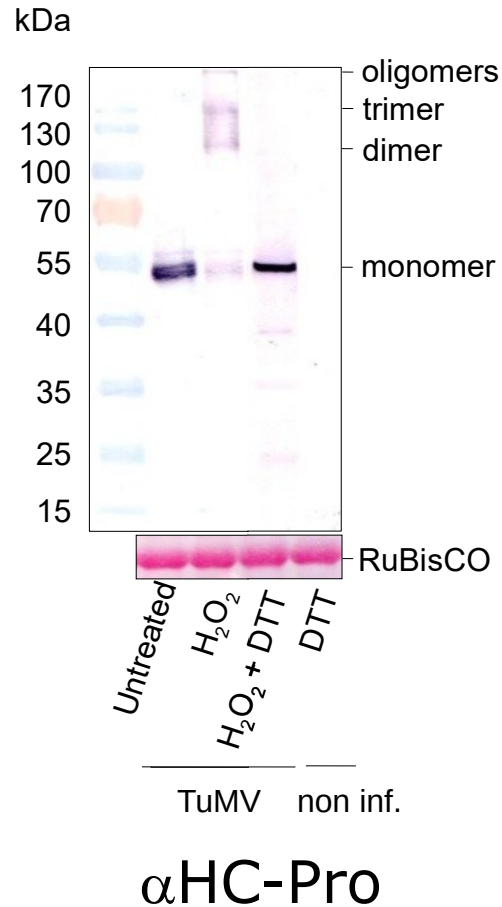
Mechanism of TuMV transmission activation

Non-reducing Western blot to detect posttranslational protein modifications



Mechanism of TuMV transmission activation

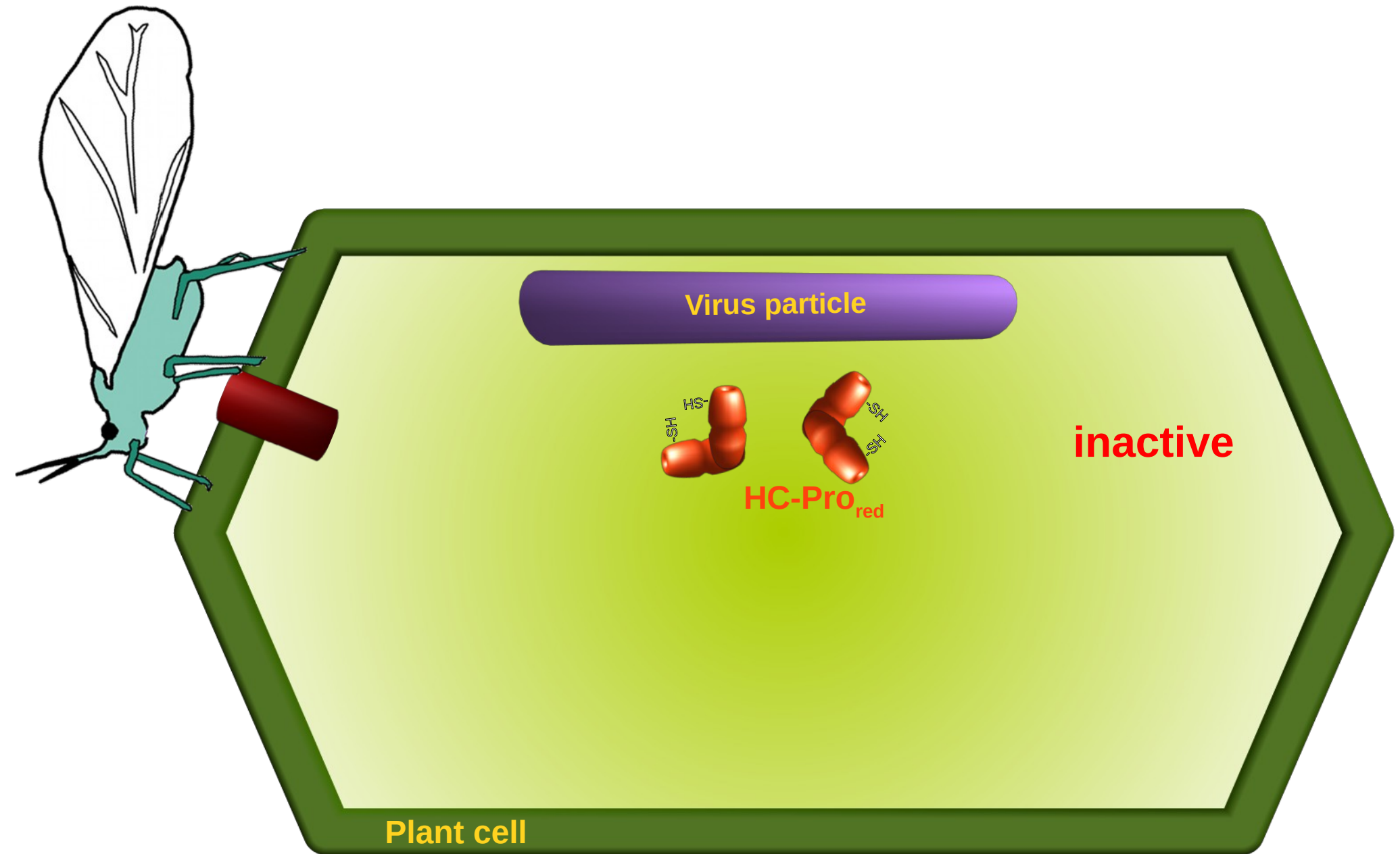
Non-reducing Western blot to detect posttranslational protein modifications



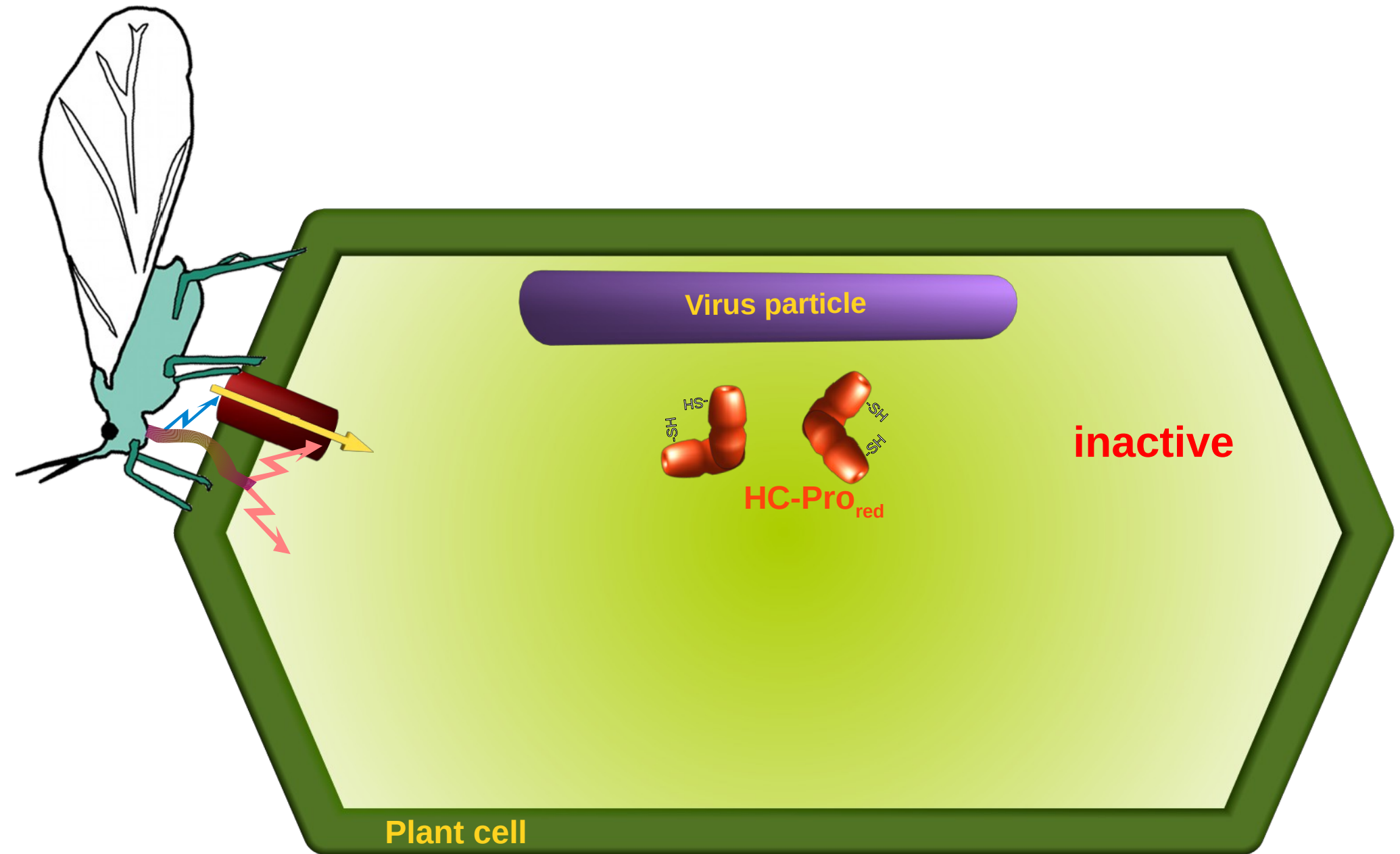
→ HC-Pro dimers are formed by intermolecular cysteine bridges

Model of TuMV transmission activation

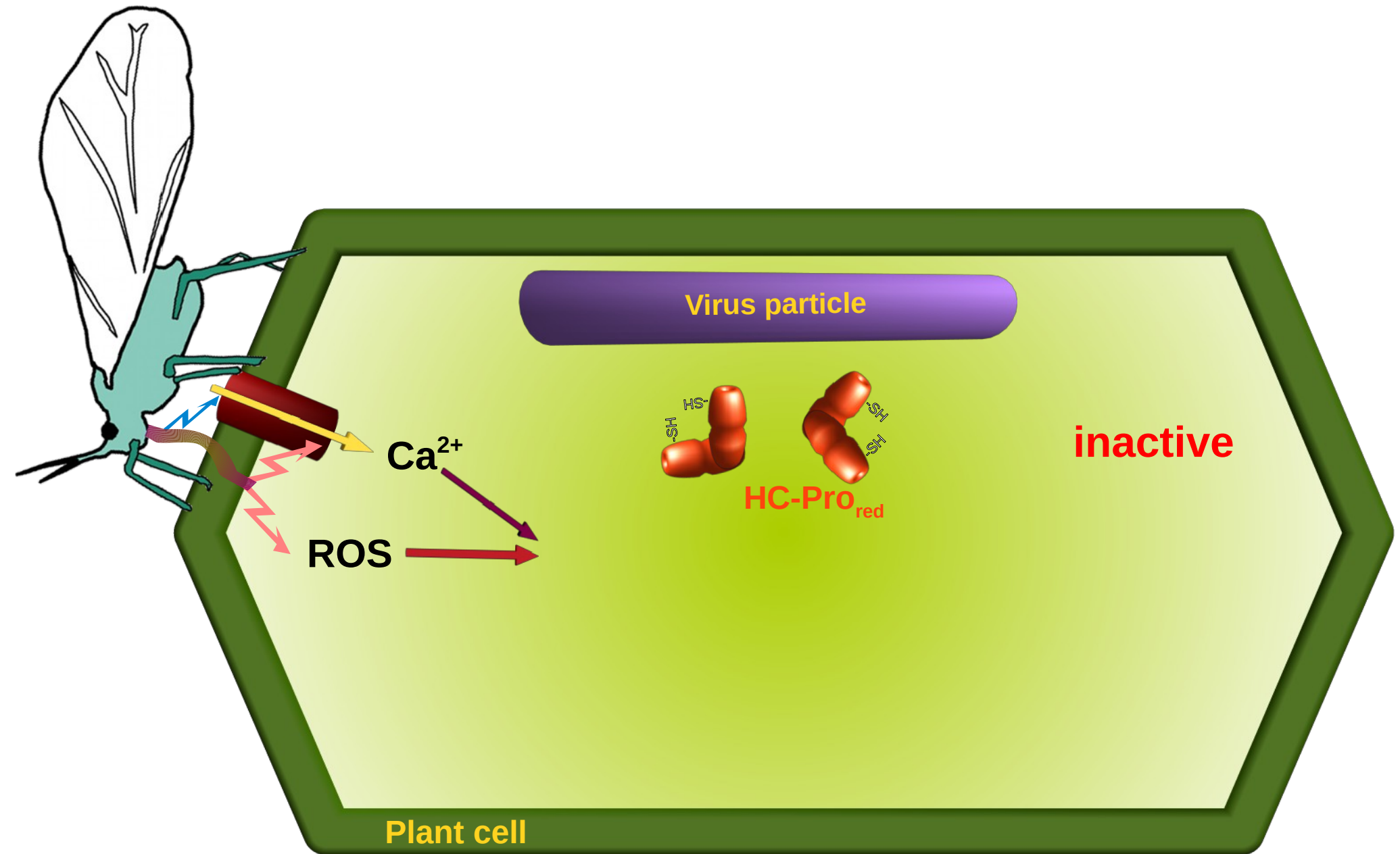
Model of TuMV transmission activation



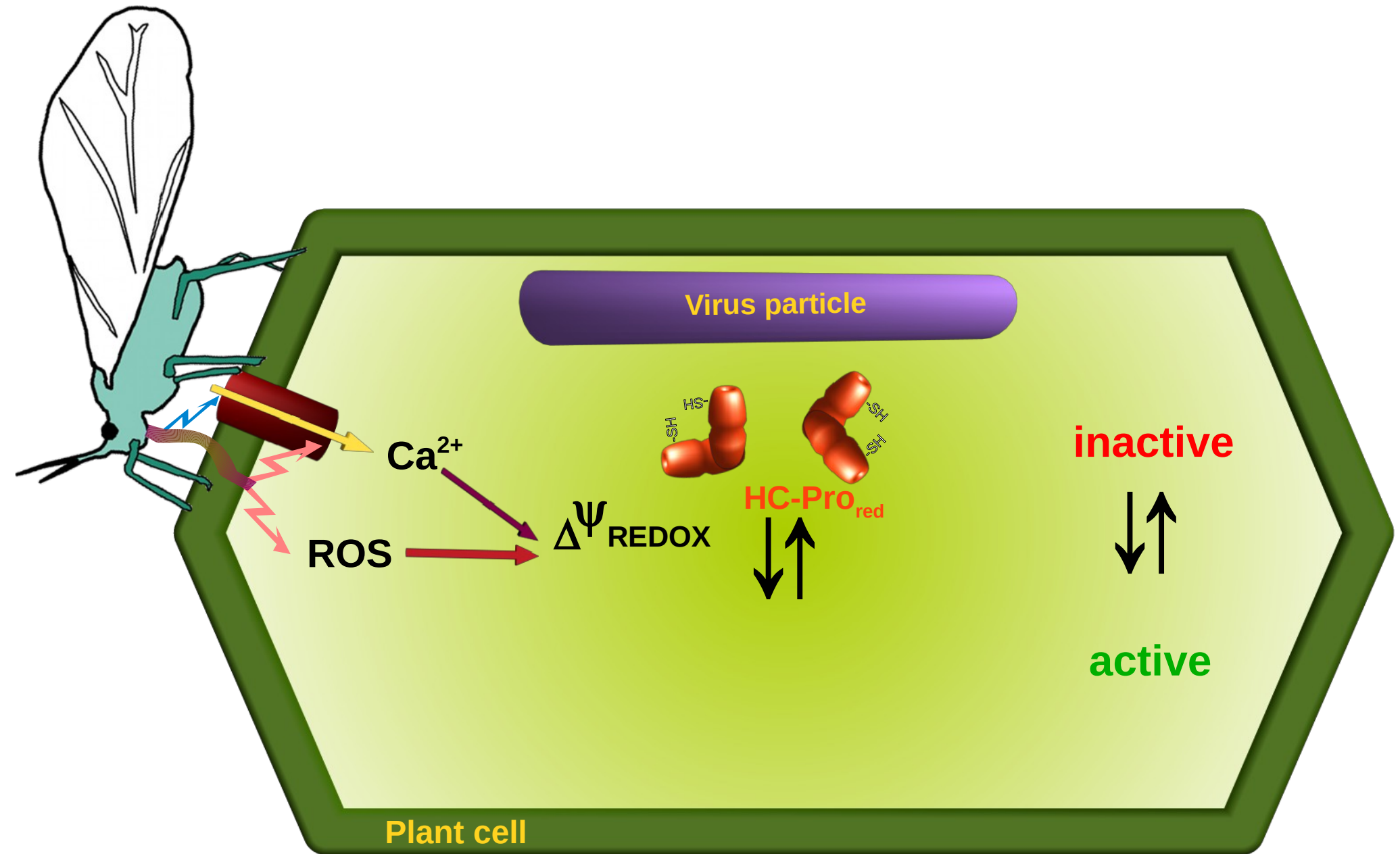
Model of TuMV transmission activation



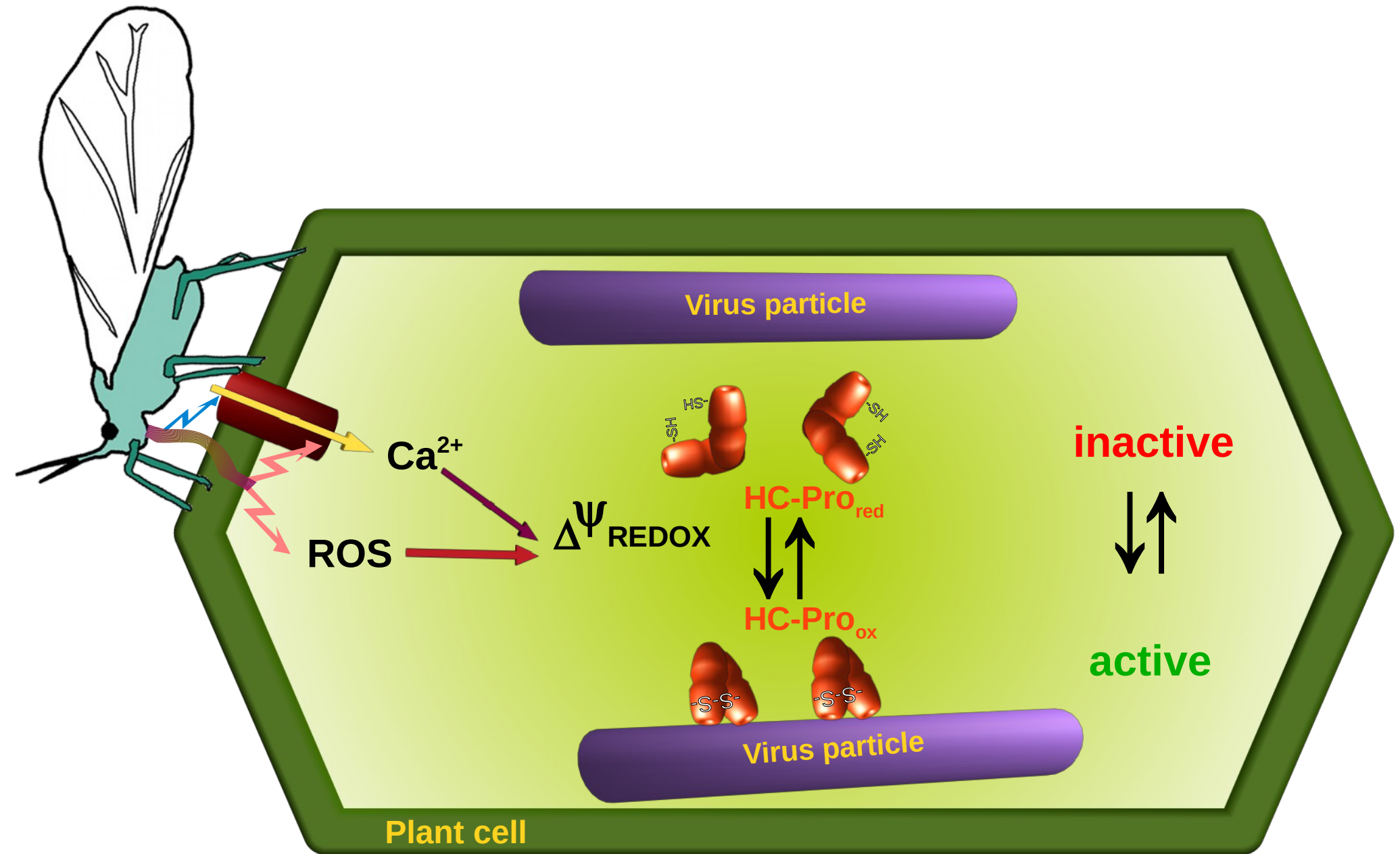
Model of TuMV transmission activation



Model of TuMV transmission activation



Model of TuMV transmission activation



People and money



Marie
Ducouso



Jean-Luc
Macia



Edwige
Berthelot



Mounia
Khelifa



Stéphane
Blanc

Finances

