Plant Virus Card Set

Each card contains information about a virus genome, shape, mode(s) of transmission, host plant(s), and disease symptom(s). Images for the vector and an infected plant are included.

Note: Reproduction of the virus cards is allowed exclusively for classroom use.

Image captions and credit lines are provided at the end of this document.

1. *Lettuce chlorosis virus* (LCV)

Genome: ssRNA+

Shape: flexible filament

Mode of transmission: whiteflies

Hosts: lettuce and sugar beet

Disease symptoms: yellowing, rolling, and brittleness of leaves

Top: Adult whitefly
Bottom: Yellowed lettuce leaves

2. *Banana streak virus* (BSV)

Genome: dsDNA

Shape: helical

Mode of transmission: mealybugs

Host: banana

Disease symptoms: necrotic streaks and flecks on leaves

Top: Mealybug
Bottom: Flecked banana leaves

3. *Beet necrotic yellow vein virus* (BNYVV)
Genome: ssRNA+
Shape: helical, rigid rods
Modes of transmission: mechanical transmission and soil microorganisms
Hosts: sugar beet, chard, and spinach
Disease symptoms: pale-green leaves, root stunting, and proliferation of lateral rootlets on the main roots in beets

Top: Mechanical transmission
Bottom: Infected sugar beet roots

4. *Carnation cryptic virus* (CCV)
Genome: dsRNA
Shape: icosahedral
Mode of transmission: seeds
Host: carnation
Disease symptoms: none

Top: Carnation seeds
Bottom: Symptomless carnation flower

5. *Radish yellow edge virus* (RYEV)
Genome: dsRNA
Shape: icosahedral
Mode of transmission: seeds
Host: radish
Disease symptom: yellowing of leaf edges

Top: Radish seeds
Bottom: Radish leaves with yellow edges

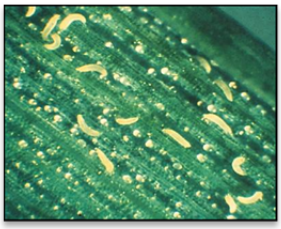
6. *Tomato yellow leaf curl virus* (TYLCV)
Genome: circular ssDNA
Shape: icosahedral
Mode of transmission: whiteflies
Hosts: tomato, potato, and pepper
Disease symptoms: twisted stems and small, yellow, curled leaves

Top: Adult whitefly
Bottom: Curled tomato leaves

7. *Cherry leaf roll virus* (CLRV)
Genome: ssRNA+
Shape: icosahedral
Modes of transmission: seeds and nematodes
Hosts: cherry, rhubarb, raspberry, and blackberry
Disease symptoms: leaf curling or rolling, ring and flame patterns on leaves, leaf death (in blackberry)

Top: Nematode
Bottom: Ring and flame patterns on cherry leaf

8. *Wheat streak mosaic virus* (WSMV)
Genome: ssRNA+
Shape: helical, flexible filament
Mode of transmission: mites
Hosts: wheat, barley, and rye
Disease symptom: yellow mottling of leaves

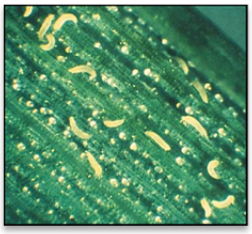


Top: Mites
Bottom: Mottling of wheat leaves

9. *Potato virus Y* (PVY)
Genome: ssRNA+
Shape: helical, flexible filament
Mode of transmission: aphids
Hosts: potato, tomato, pepper, and tobacco
Disease symptoms: mosaic of potato leaves, necrosis of potato and pepper leaves, and vein clearing of tobacco leaves

Top: Aphids
Bottom: Necrotic tomato leaf

10. *Fig mosaic virus* (FMV)
Genome: ssRNA-
Shape: icosahedral
Mode of transmission: mites
Host: fig
Disease symptoms: leaf discoloration and deformity



Top: Mites
Bottom: Infected fig leaves and fruits

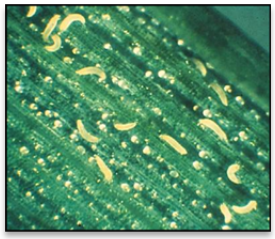
11. *Cauliflower mosaic virus* (CaMV)
Genome: dsDNA
Shape: icosahedral
Mode of transmission: aphids
Hosts: cauliflower, canola, and turnip
Disease symptoms: mottling and mosaic of leaves

Top: Aphids
Bottom: Mosaic on cauliflower leaf

12. *Squash leaf curl virus* (SLCV)
Genome: circular ssDNA
Shape: icosahedral
Mode of transmission: whiteflies
Hosts: cucumber, legumes, and summer squash
Disease symptoms: curling, yellowing, and malformation of leaves

Top: Whitefly
Bottom: Curled squash leaves

13. *Raspberry leaf blotch virus* (RLBV)
Genome: ssRNA-
Shape: helical
Mode of transmission: mites
Host: raspberry
Disease symptom: yellow blotches on leaves

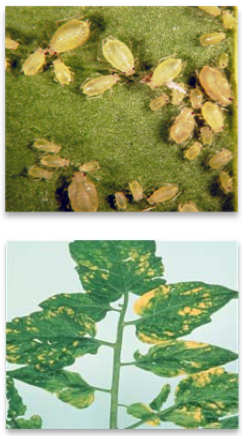


Top: Mites
Bottom: Spots on raspberry leaves

14. *Tomato bushy stunt virus* (TBSV)
Genome: ssRNA+
Shape: icosahedral
Modes of transmission: seeds, soil micro-organisms, and mechanical transmission
Hosts: tomato, pepper, potato, and eggplant
Disease symptoms: bushy growth; leaf lesions, crinkling, and deformation; small fruits with blotching

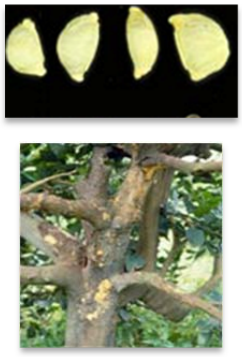
Top: Mechanical transmission
Bottom: Bushy tomato plant

15. *Alfalfa mosaic virus* (AMV)
Genome: ssRNA+
Shape: helical, rigid rod
Modes of transmission: seeds and aphids
Hosts: alfalfa, potato, and tomato
Disease symptoms: mottling of leaves and fruits, malformation and necrosis of fruits



Top: Aphids
Bottom: Mottling of tomato leaves

16. *Citrus psorosis virus* (CPsV)
Genome: ssRNA-
Shape: helical
Modes of transmission: contact and seeds
Hosts: citrus (orange and grapefruit)
Disease symptoms: tree bark scaling and wood staining



Top: Healthy orange seeds
Bottom: Scaling of citrus tree bark

Plant Virus Card Set:
Image Captions and Credits

Note: Reproduction of the virus cards is allowed exclusively for classroom use.

Card 1
Top image: An adult whitefly, *Bemisia* or *Trialeurodes* sp., on a sweetpotato petiole, *Ipomoea batatas.* Courtesy J. Davis; Reproduced, by permission, from Clark, C. A., Ferrin, D. M., Smith, T. P., and Holmes, G. J., eds. 2013. Compendium of Sweetpotato Diseases, Pests, and Disorders, 2nd ed. American Phytopathological Society, St. Paul, MN.
Bottom image: Symptoms of *Lettuce chlorosis virus* on head lettuce, *Lactuca sativa.* Courtesy Gerald Holmes, California Polytechnic State University at San Luis Obispo; Reproduced, by permission, from Bugwood.org. Used according to terms of a Creative Commons Attribution-Noncommercial 3.0 License (https://creativecommons.org/licenses/by-nc/3.0/us/legalcode).

Card 2
Top image: Obscure mealybug, *Pseudococcus viburni*, on a *Rhododendron* sp. Courtesy L. Buss; Reproduced, by permission, from Linderman, R. G., and Benson, D. M., eds. 2014. Compendium of Rhododendron and Azalea Diseases and Pests, 2nd ed. American Phytopathological Society, St. Paul, MN.
Bottom image: Valery' banana, *Musa* sp., with wilted and yellowing leaves. Courtesy I. W. Buddenhagen and M. N. Schroth; Reproduced, by permission, from Schroth, M. N., Hecht-Poinar, E. I., and Alvarez, A. M. 2010. Plant Diseases Caused by Bacteria: An Image Database and Educational Resource CD. American Phytopathological Society, St. Paul, MN.

Card 3
Top image: Mechanical transmission. Reproduced, by permission, from D'Arcy, C. J., Eastburn, D. M., and Schumann, G. L. 2001. Mechanical transmission. In: Illustrated Glossary of Plant Pathology. The Plant Health Instructor. DOI: 10.1094/PHI-I-2001-0219-01
Bottom image: Infection of sugar beet, *Beta vulgaris*, by multiple root pathogens. Courtesy C. M. Rush; Reproduced, by permission, from Harveson, R. M., Hanson, L. E., and Hein, G. L., eds. 2009. Compendium of Beet Diseases and Pests, 2nd ed. American Phytopathological Society, St. Paul, MN.

Card 4
Top image: Seeds of Geraldton carnation weed, *Euphorbia terracina.* Courtesy Julia Scher, Federal Noxious Weeds Disseminules, USDA APHIS ITP; Reproduced, by permission, from Bugwood.org. Used according to terms of a Creative Commons Attribution-Noncommercial 3.0 License (https://creativecommons.org/licenses/by-nc/3.0/us/legalcode).
Bottom image: Carnation, *Dianthus* sp. Courtesy Howard F. Schwartz, Colorado State University; Reproduced, by permission, from Bugwood.org. Used according to terms of a Creative Commons Attribution 3.0 License (https://creativecommons.org/licenses/by/3.0/us/legalcode).

Card 5
Top image: Seeds of wild radish, *Raphanus raphanistrum.* Courtesy Bruce Ackley, The Ohio State University; Reproduced, by permission, from Bugwood.org. Used according to terms of a

Bottom image: Yellows of radish, *Raphanus sativus* var. *sativus.* Dying seedlings are brown, dry, and brittle and often remain erect while retaining their uppermost leaves. Courtesy R. H. Morrison; Reproduced, by permission, from Rimmer, S. R., Shattuck, V. I., and Buchwaldt, L., eds. 2007. Compendium of Brassica Diseases. American Phytopathological Society, St. Paul, MN.

Card 6
Top image: An adult whitefly, *Bemisia* or *Trialeurodes* sp., on a sweetpotato petiole, *Ipomoea batatas.* Courtesy J. Davis; Reproduced, by permission, from Clark, C. A., Ferrin, D. M., Smith, T. P., and Holmes, G. J., eds. 2013. Compendium of Sweetpotato Diseases, Pests, and Disorders, 2nd ed. American Phytopathological Society, St. Paul, MN.
Bottom image: Symptoms from infection with *Tomato yellow leaf curl virus* (TYLCV) on a mature tomato plant, *Solanum lycopersicum*. Courtesy D. P. Maxwell; Reproduced, by permission, from Jones, J. B., Zitter, T. A., Momol, T. M., and Miller, S. A., eds. 2014. Compendium of Tomato Diseases and Pests, 2nd ed. American Phytopathological Society, St. Paul, MN.

Card 7
Top image: Nematode. Courtesy D. Wixted; Reproduced, by permission, from Davis, E. L., and MacGuidwin, A. E. 2000. Lesion nematode disease. Portuguese translation by Rodrigo M. Saraiva, Miriam F. Fujinawa, and Hugo A. Medeiros (2014). The Plant Health Instructor (Updated 2005). DOI: 10.1094/PHI-I-2000-1030-02
Bottom image: Ring and flame patterns on a cherry leaf, *Prunus avium,* caused by *Cherry leaf roll virus* (CLRV) infection. Courtesy K. C. Eastwell, Professor Emeritus, Washington State University.

Card 8
Top image: Mites, *Aceria tosichella.* Courtesy Mary Burrows; Reproduced, by permission, from Montana State University Schutter Lab.
Bottom image: Early leaf symptoms of infection by *Wheat streak mosaic virus* (WSMV) on wheat, *Triticum aestivum.* Courtesy R. L. Bowden; Reproduced from Bockus, W. W., et al., eds. 2010. Compendium of Wheat Diseases and Pests, 3rd ed. American Phytopathological Society, St. Paul, MN.

Card 9
Top image: Green peach aphids, *Myzus persicae.* Courtesy G. L. Hein; Reproduced, by permission, from Harveson, R. M., Hanson, L. E., and Hein, G. L., eds. 2009. Compendium of Beet Diseases and Pests, 2nd ed. American Phytopathological Society, St. Paul, MN.
Bottom image: Necrosis of leaflets on a tomato plant, *Solanum lycopersicum,* infected by *Potato virus Y* (PVY). Courtesy H. Laterrot; Reproduced, by permission, from Jones, J. B., Zitter, T. A., Momol, T. M., and Miller, S. A., eds. 2014. Compendium of Tomato Diseases and Pests, 2nd ed. American Phytopathological Society, St. Paul, MN.

Card 10
Top image: Mites, *Aceria tosichella.* Courtesy Mary Burrows; Reproduced, by permission, from Montana State University Schutter Lab.

Bottom image: Mosaic pattern, deformation of leaves, and yellow spots on fruits of edible fig, *Ficus carica*, caused by *Fig mosaic virus* (FMV) infection. Photo by Bryce Falk, © The Regents of the University of California, Davis campus. Reproduced according to terms of Creative Commons License (CC) BY-NC-ND 4.0; this Public License and a disclaimer of warranties are available at https://creativecommons.org/licenses/by-nc-nd/4.0/legalcode.

Card 11
Top image: Green peach aphids, *Myzus persicae.* Courtesy G. L. Hein; Reproduced, by permission, from Harveson, R. M., Hanson, L. E., and Hein, G. L., eds. 2009. Compendium of Beet Diseases and Pests, 2nd ed. American Phytopathological Society, St. Paul, MN.
Bottom image: General vein clearing on a cauliflower leaf, *Brassica oleracea* var. *botrytis*, caused by *Cauliflower mosaic virus*. Courtesy R. H. Morrison; Reproduced, by permission, from Rimmer, S. R., Shattuck, V. I., and Buchwaldt, L., eds. 2007. Compendium of Brassica Diseases. American Phytopathological Society, St. Paul, MN.

Card 12
Top image: Adult whitefly, *Bemisia* or *Trialeurodes* sp., on a sweetpotato petiole, *Ipomoea batatas.* Courtesy J. Davis; Reproduced, by permission, from Clark, C. A., Ferrin, D. M., Smith, T. P., and Holmes, G. J., eds. 2013. Compendium of Sweetpotato Diseases, Pests, and Disorders, 2nd ed. American Phytopathological Society, St. Paul, MN.
Bottom image: Squash plant, *Cucurbita pepo*, severely infected with *Squash leaf curl virus* (SLCV). Courtesy Peter Abrahamian; Reproduced, by permission, from Image Resources, American Phytopathological Society.
www.apsnet.org/publications/imageresources/Pages/fi00195.aspx

Card 13
Top image: Mites, *Aceria tosichella.* Courtesy Mary Burrows; Reproduced, by permission, from Montana State University Schutter Lab.
Bottom image: Leaf spots on raspberry, *Rubus* sp., caused by infection by *Raspberry leaf blotch virus* (RLBV). Courtesy D. Jevremović; Reproduced, by permission, from EPPO data base (EPPO code: RLBV00).

Card 14
Top image: Mechanical transmission. Reproduced, by permission, from D'Arcy, C. J., Eastburn, D. M., and Schumann, G. L. 2001. Mechanical transmission. In: Illustrated Glossary of Plant Pathology. The Plant Health Instructor. DOI: 10.1094/PHI-I-2001-0219-01
Bottom image: Characteristic bushy foliage of a tomato plant, *Solanum lycopersicum*, produced by *Tomato bushy stunt virus* (TBSV). Courtesy C. E. Fribourg; Reproduced, by permission, from Jones, J. B., Zitter, T. A., Momol, T. M., and Miller, S. A., eds. 2014. Compendium of Tomato Diseases and Pests, 2nd ed. American Phytopathological Society, St. Paul, MN.

Card 15
Top image: Green peach aphids, *Myzus persicae.* Courtesy G. L. Hein; Reproduced, by permission, from Harveson, R. M., Hanson, L. E., and Hein, G. L., eds. 2009. Compendium of Beet Diseases and Pests, 2nd ed. American Phytopathological Society, St. Paul, MN.
Bottom image: Symptoms of alfalfa mosaic on tomato leaves, *Solanum lycopersicum.* Courtesy J. E. Thomas; Reproduced, by permission, from Jones, J. B., Zitter, T. A., Momol, T. M., and Miller, S. A., eds. 2014. Compendium of Tomato Diseases and Pests, 2nd ed. American

Phytopathological Society, St. Paul, MN.

Card 16

Top image: Healthy orange seeds, *Citrus* × *sinensis.* Courtesy J. M. Bové, INRA Centre de Recherches de Bordeaux; Reproduced, by permission, from Bugwood.org. Used according to terms of a Creative Commons Attribution-Noncommercial 3.0 License (https://creativecommons.org/licenses/by-nc/3.0/us/legalcode).

Bottom image: Bark scaling of an orange tree, *Citrus* × *sinensis,* associated with citrus ringspot and some forms of psorosis. Courtesy Stephen M. Garnsey, USDA-ARS, South Atlantic Area; Reproduced, by permission, from Bugwood.org. Used according to terms of a Creative Commons Attribution-Noncommercial 3.0 License (https://creativecommons.org/licenses/by-nc/3.0/us/legalcode).