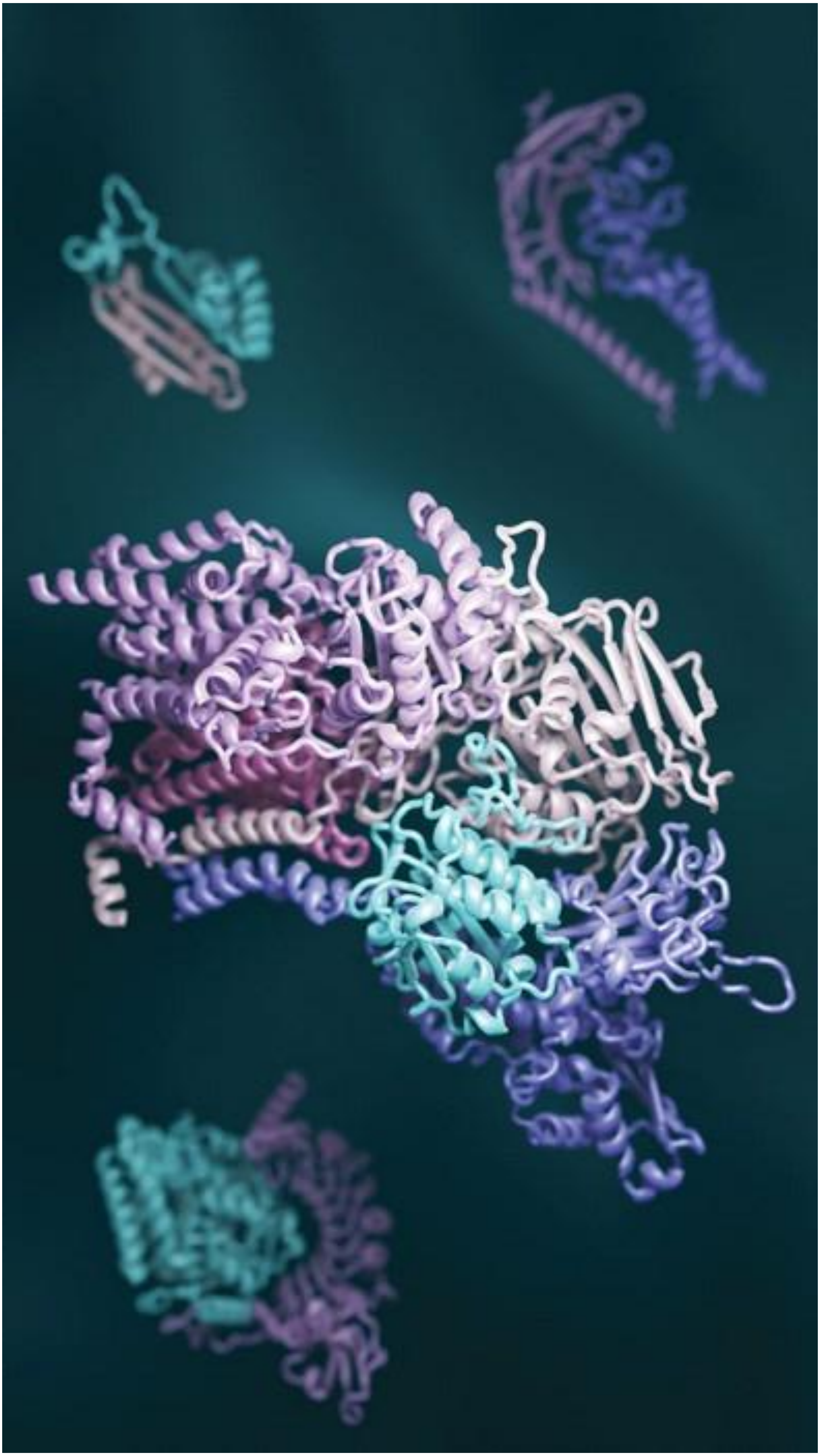
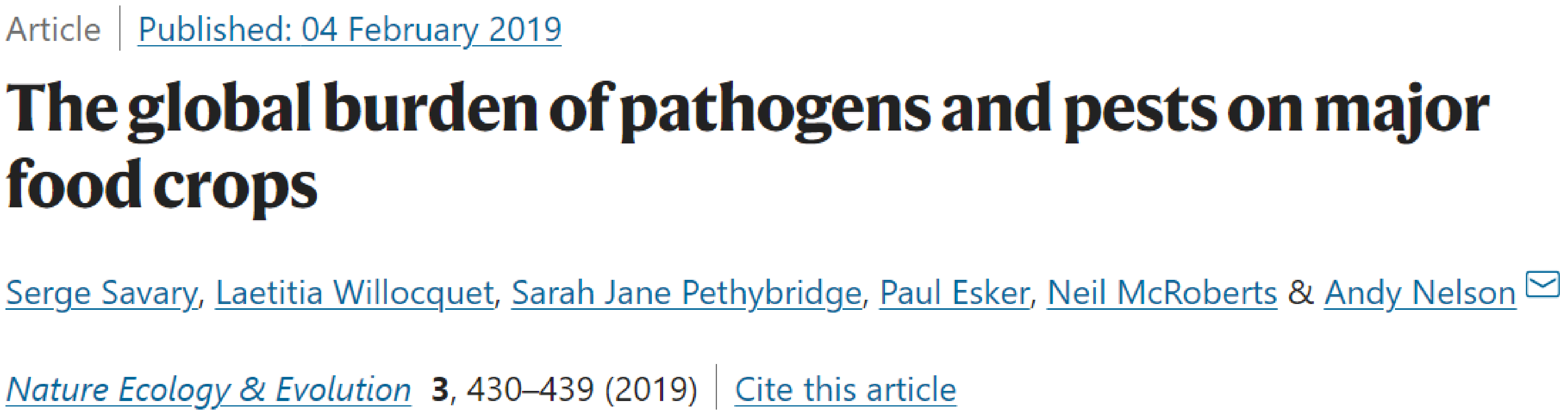


source: https://cen.acs.org/physical-chemistry/protein-folding/Software-predicts-complex-protein-structures/99/web/2021/11

The importance of plant proteomics

Plants:

- make up more than 80% of the planet‘s biomass
- are foundational for global ecological and economic systems



Article | Published: 04 February 2019

The global burden of pathogens and pests on major food crops

Serge Savary, Laetitia Willocquet, Sarah Jane Pethybridge, Paul Esker, Neil McRoberts & Andy Nelson

Nature Ecology & Evolution **3**, 430–439 (2019) | Cite this article

Climate change: Key crops face major shifts as world warms

source: BBC news

By Matt McGrath
Environment correspondent

26 January

Our food system isn't ready for the climate crisis

The world's farms produce only a handful of varieties of bananas, avocados, coffee and other foods - leaving them more vulnerable to the climate breakdown

by Nina Lakhani, Alvin Chang, Rita Liu, *and* Andrew Witherspoon

source: The Guardian

A Pan-plant Protein Complex Map Reveals Deep Conservation and Novel Assemblies

Claire D. McWhite, Ophelia Papoulas, Kevin Drew, Rachael M. Cox, Viviana June, Oliver XiaoouDong, Taejoon Kwon, Cuihong Wan, Mari L. Salmi, Stanley J. Roux, Karen S. Browning, Z. Jeffrey Chen, Pamela C. Ronald, and Edward D. Marcotte

in *Cell* **181**, 460-474, April 16, 2020

presented by Annika Bamberger & Ann-Kathrin Otto

Why did so many plant proteins remain uncharacterized for such a long time?

- plant genomes are complex:
  - polyploidity
  - whole-genome duplications

source: https://agricsite.com/wheat-farming/

source: https://www.innerbody.com/image/musfov.html

- hexaploid
- > 100,000 genes
- 42 chromosomes

- diploid
- ca. 30,000 genes
- 46 chromosomes

→ Plants have mulitple near-identical proteins

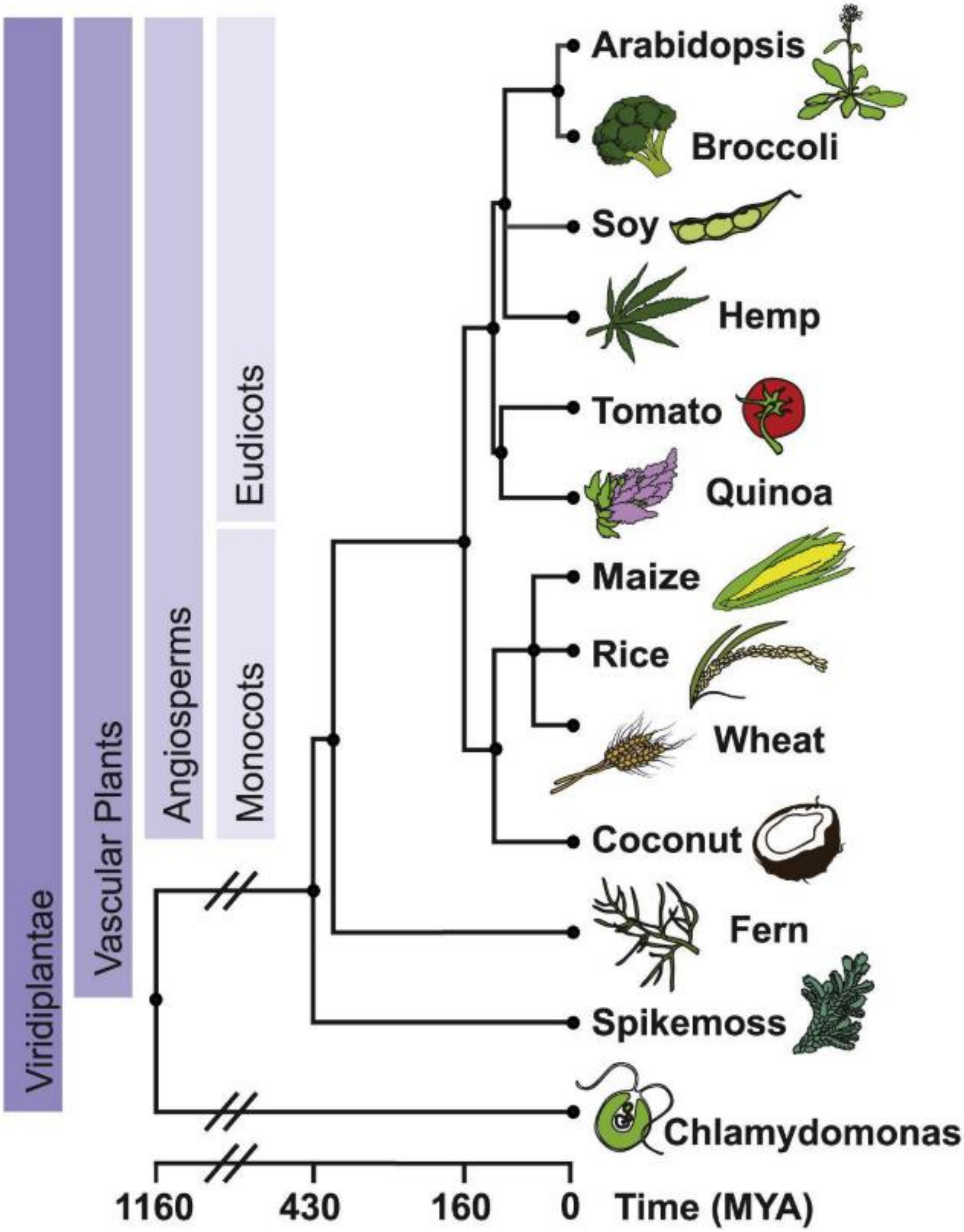
An evolution-informed protein grouping approach

Orthogroups (OGs): “Sets of genes in modern organisms that derive from the same original gene in those organisms‘ last common ancestor.“ (McWhite et al., 2020)

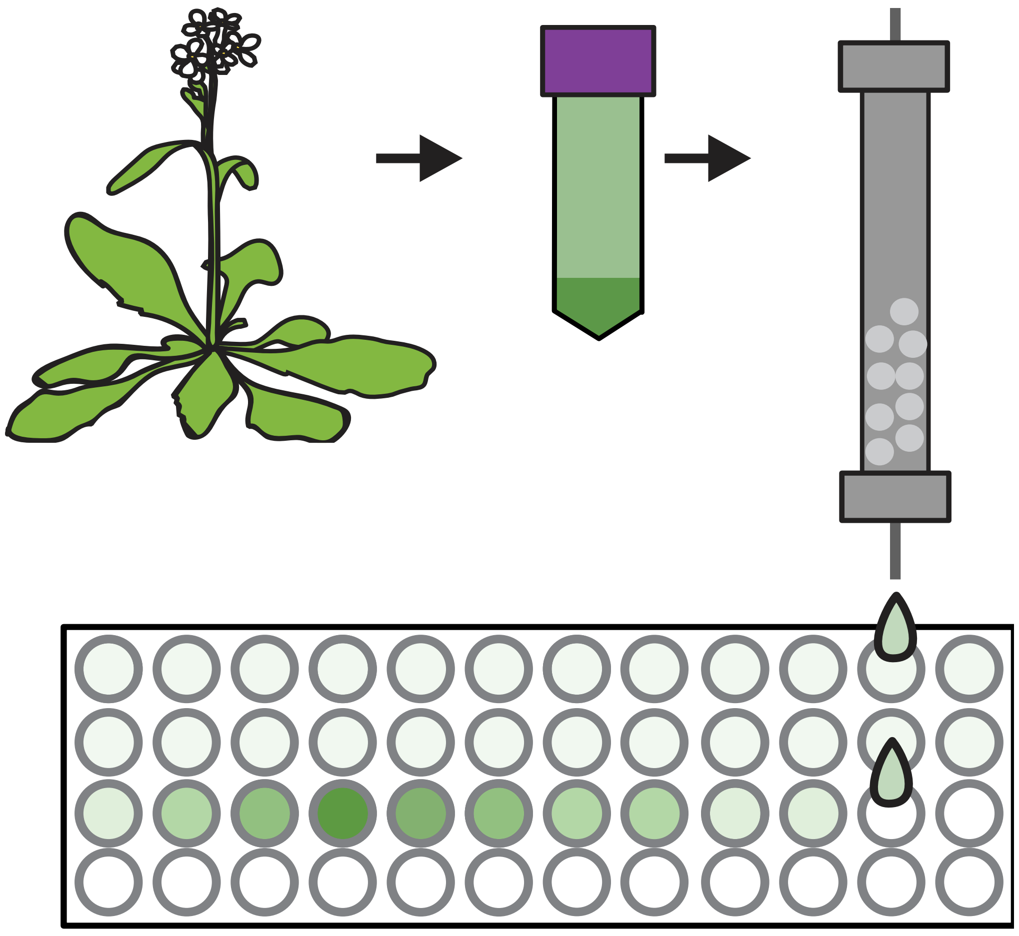
- eggNOG-mapper
- eggNOG database

- highly related proteins clustered into same OG
- overcome problem of polyploidity and redundant proteins

The dataset

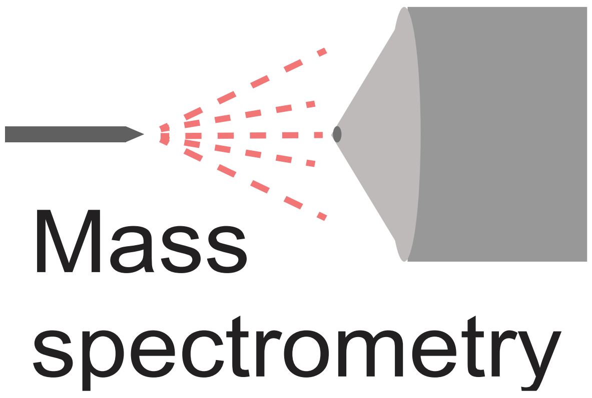

Viridiplantae
Vascular Plants
Angiosperms
Eudicots
Monocots
Arabidopsis
Broccoli
Soy
Hemp
Tomato
Quinoa
Maize
Rice
Wheat
Coconut
Fern
Spikemoss
Chlamydomonas
1160
430
160
0
Time (MYA)

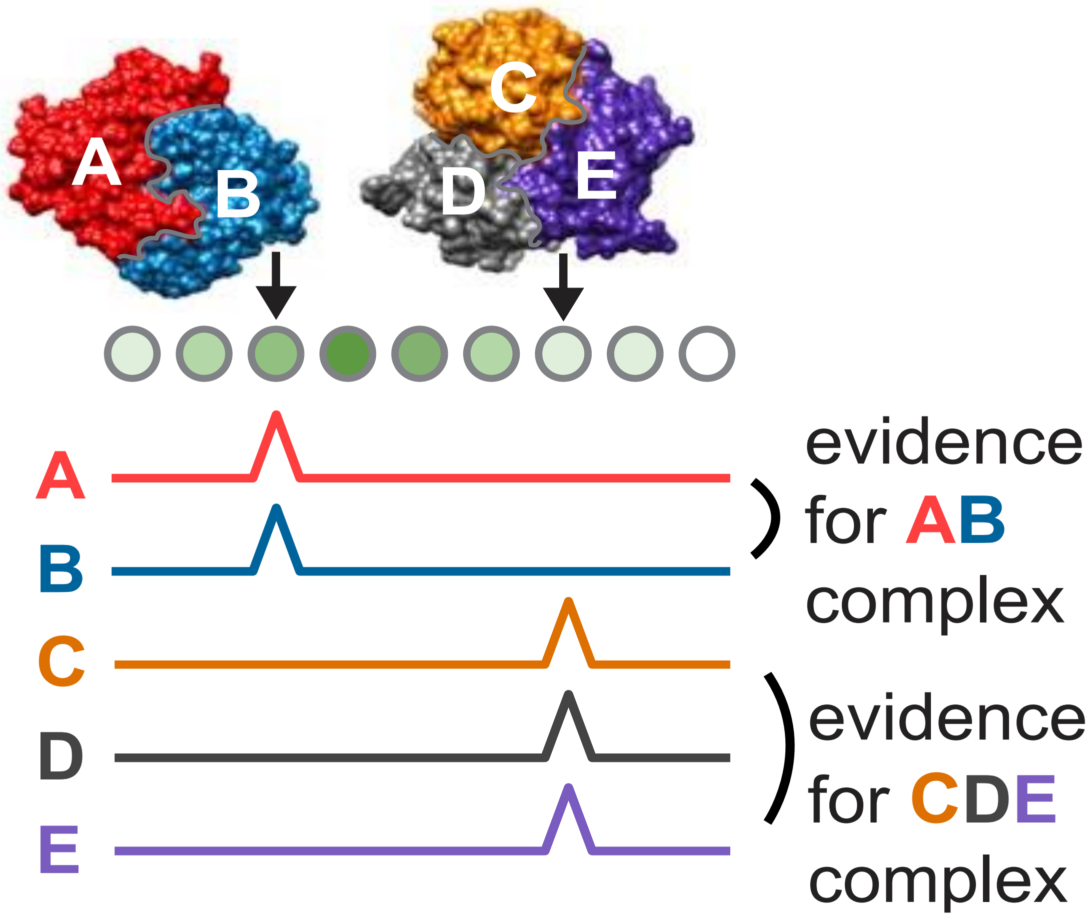
Co-fractionation mass spectrometry (CF-MS)



1. Chromatography/Fractionation

- separate protein complexes into fractions

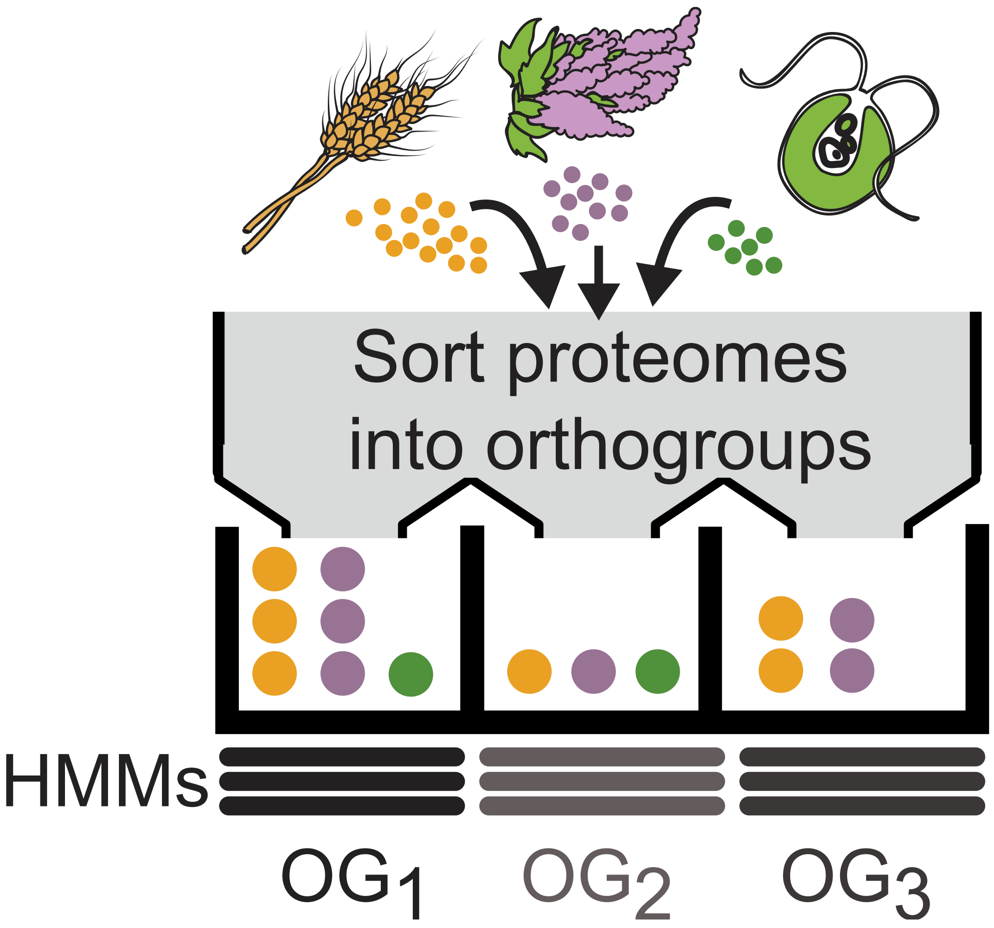




2. Mass Spectrometry (MS)

- identify proteins within fractions
- elution-profile
- co-elution

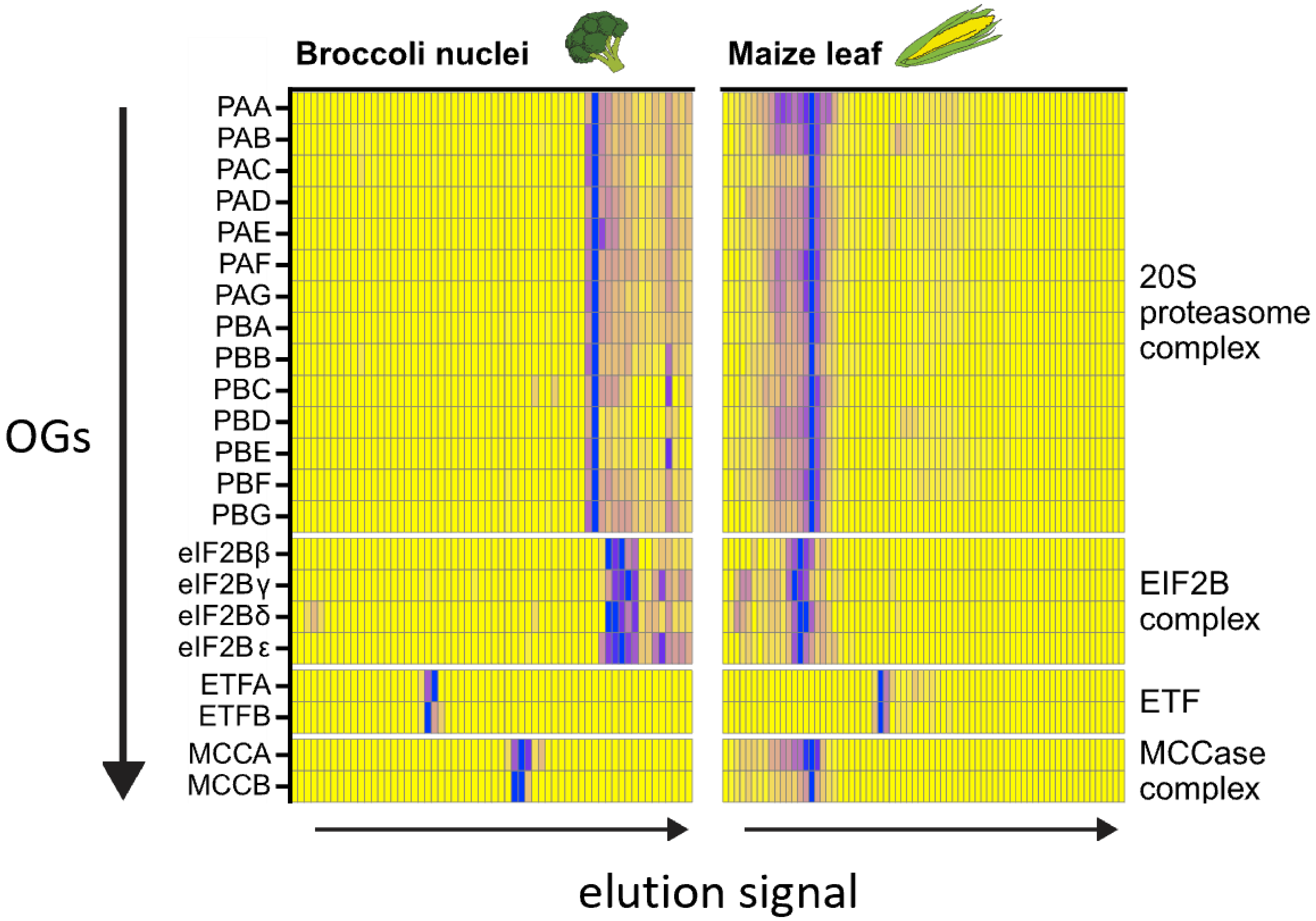
A cross-species OG detection profile



Sort proteomes into orthogroups

HMMs

OG_1 OG_2 OG_3



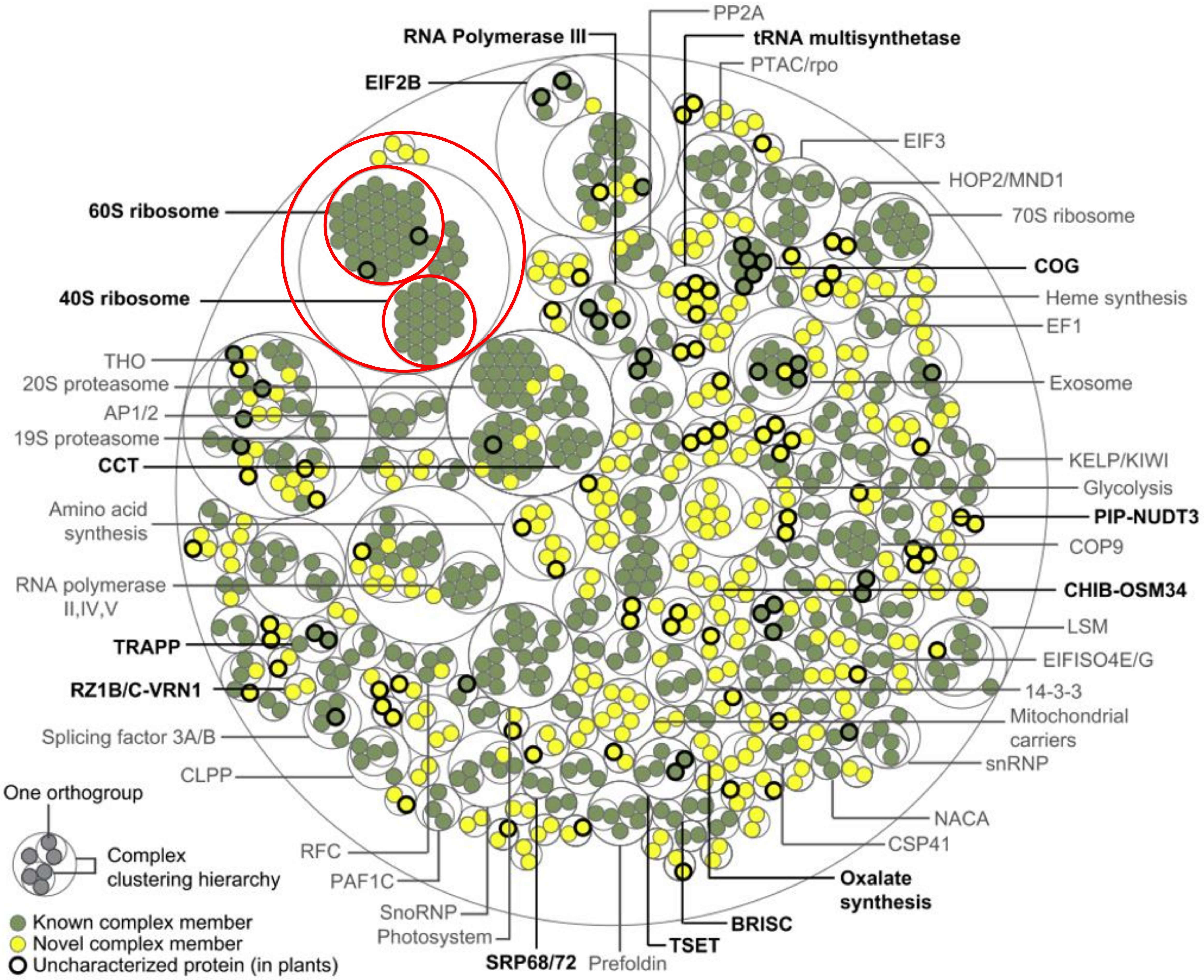
Computational framework

- for the identification of co-eluting proteins
- supervised Machine Learning approach

→ **probabilistic CF-MS score**: likelihood of a physical association

Identification of many new complex members

- unsupervised hierarchical clustering



Differences in protein interactions in plants and humans

- arrangements of interacting proteins → species-specific subunits

- analog assemblies
  - similar functions
  - different molecular interactions

→ Sequence analysis not always suffices to predict the function and structure of a protein complex.

Findings that could help solve food crop problems

- linking protein interactions to phenotypes
  - identification of complexes involved in pathogen defense
    - example: CHIB-OSM34, involved in combatting gray mold infections

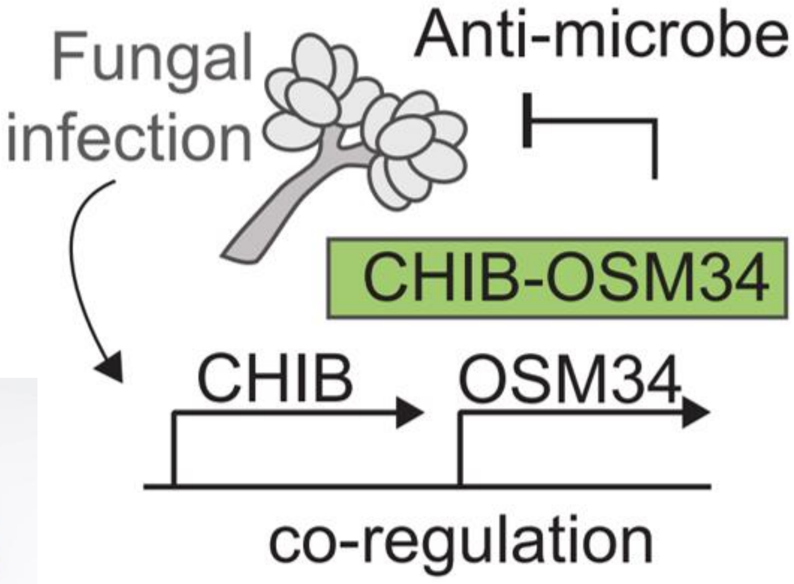


image sources:
Lafayette Online, (no date). *Gray and pink molds turning uup in Indiana cornfields*. [online] http://www.lafayette-online.com/business/agriculture/2009/10/gray-pink-molds-indiana-cornfields
April Lee, (2021). Ways to Tell if Broccoli Is Bad. *Farmhouse Guide*. [online] https://farmhouseguide.com/ways-to-tell-if-broccoli-is-bad/
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Amy Grant, (2021). Gray Mold Of Tomatoes: How To Treat Gray Mold In Tomato Plants. *Gardening know how*. [online] https://www.gardeningknowhow.com/edible/vegetables/tomato/gray-mold-in-tomato-plants.htm

Thank you for your attention.

List of additional literature:

Martinez-Perez et al. (2003). Chromosomes form into seven groups in hexaploid and tetraploid wheat as a prelude to meiosis. *The Plant Journal* **36**, Issue 1, pp. 21-29.

National Human Genome Research Institute, (2020). Human Genome Project FAQ. [online] https://www.genome.gov/human-genome-project/Completion-FAQ

World Economic Forum, (2021). *Visualizing the total biomass of every animal on earth*. [online] What is the total weight of all the animals on Earth? | World Economic Forum (weforum.org)

Link to the quiz: https://forms.gle/g6ygUuGeyK4icJBL6