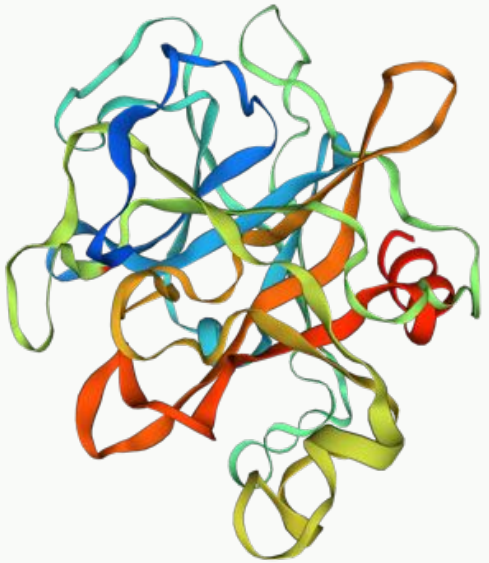
Harriet R. Benbow

Lars S. Jermiin

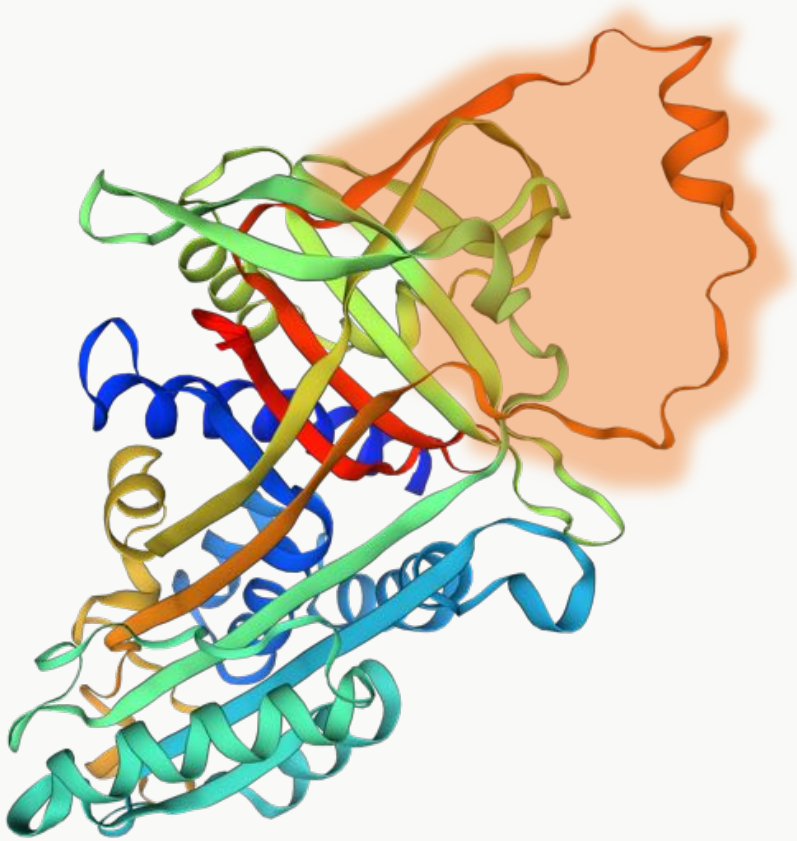
Fiona M. Doohan

The *Serpin* gene family in wheat

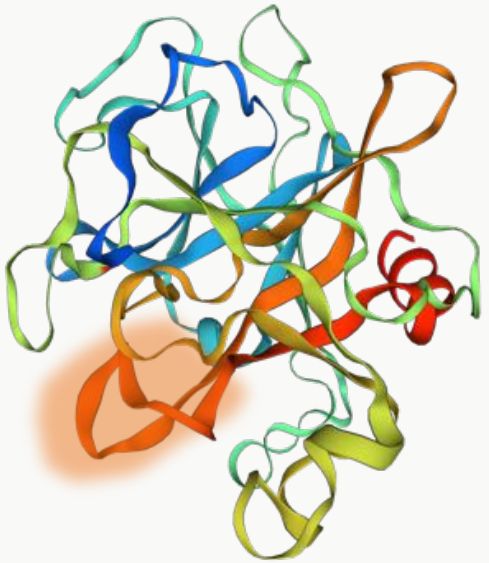
Serpins are **ser**ine **p**rotease **in**hibitors



Serpins are **ser**ine **p**rotease **in**hibitors



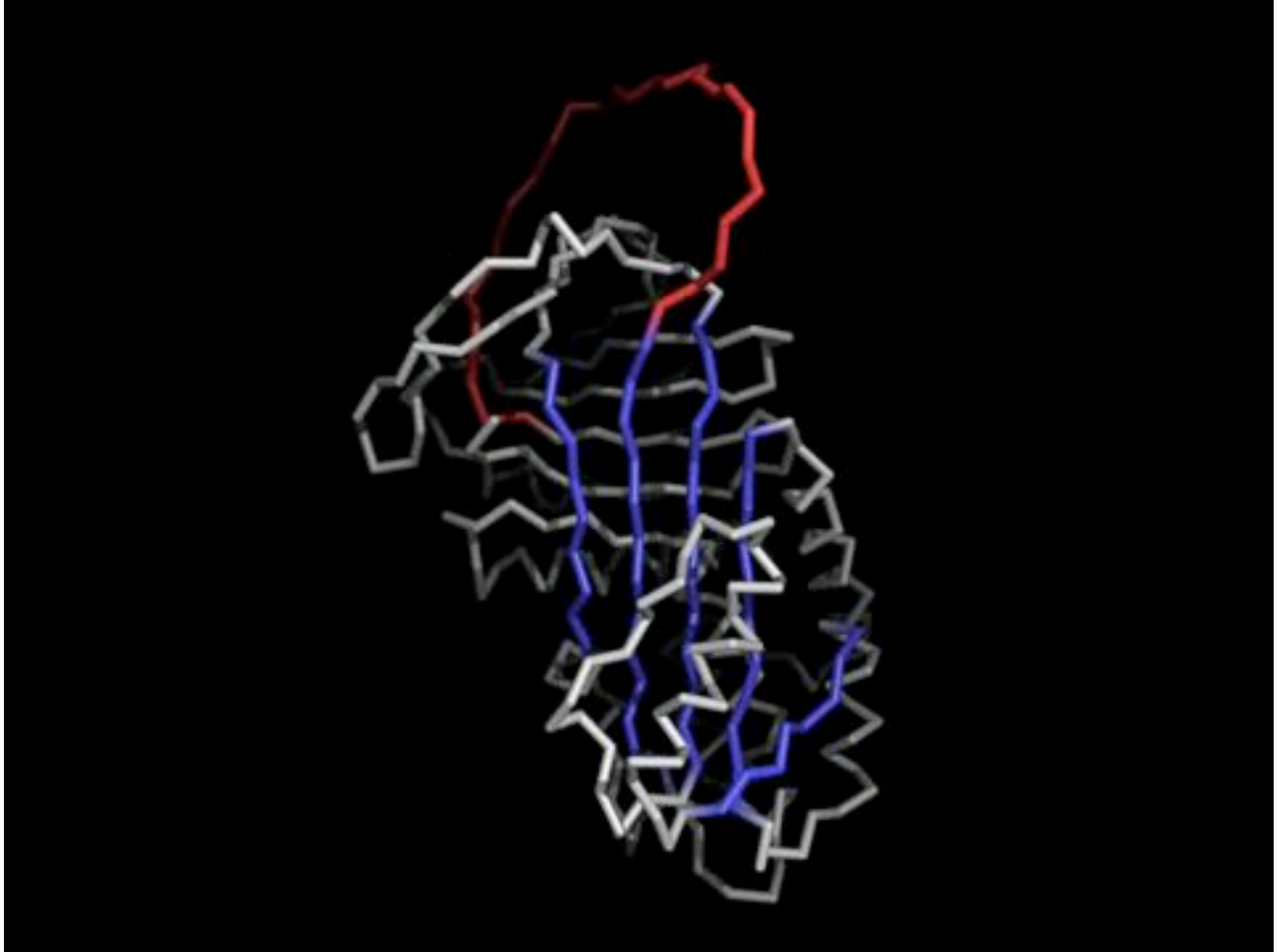
Reactive Central Loop



Catalytic triad

The Michealis Complex

The Michealis Complex



Why are wheat serpins interesting?

- Serpins are responsive to fungal pathogens in:
  - Soybean
  - Maize
  - *Arabidopsis*
  - Tomato
  - Barley
  - Wheat

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  - *Arabidopsis*
  - Tomato
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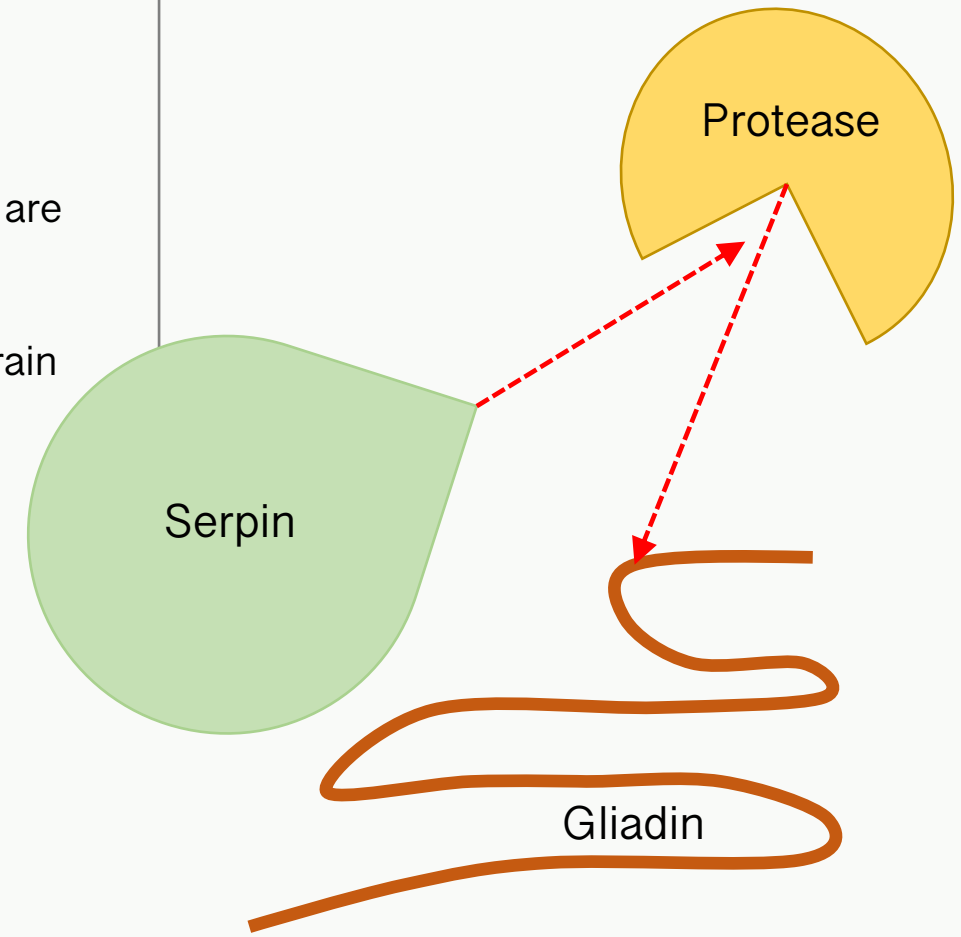
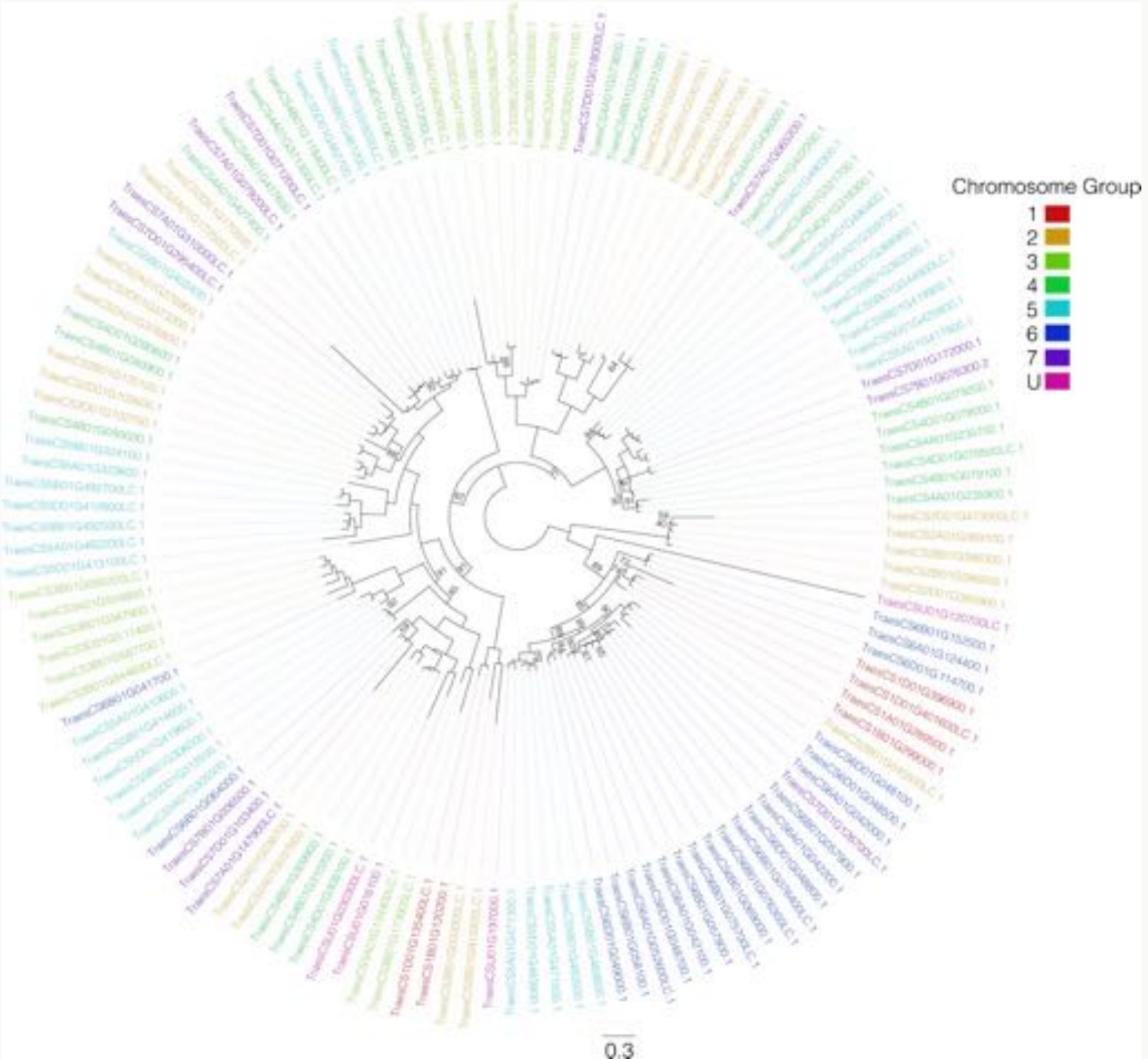
- Serpins can inhibit proteases from:
  - *Zymoseptoria tritici*
  - *Fusarium culmorum*
  - *Puccinia striiformis*

Why are wheat serpins interesting?

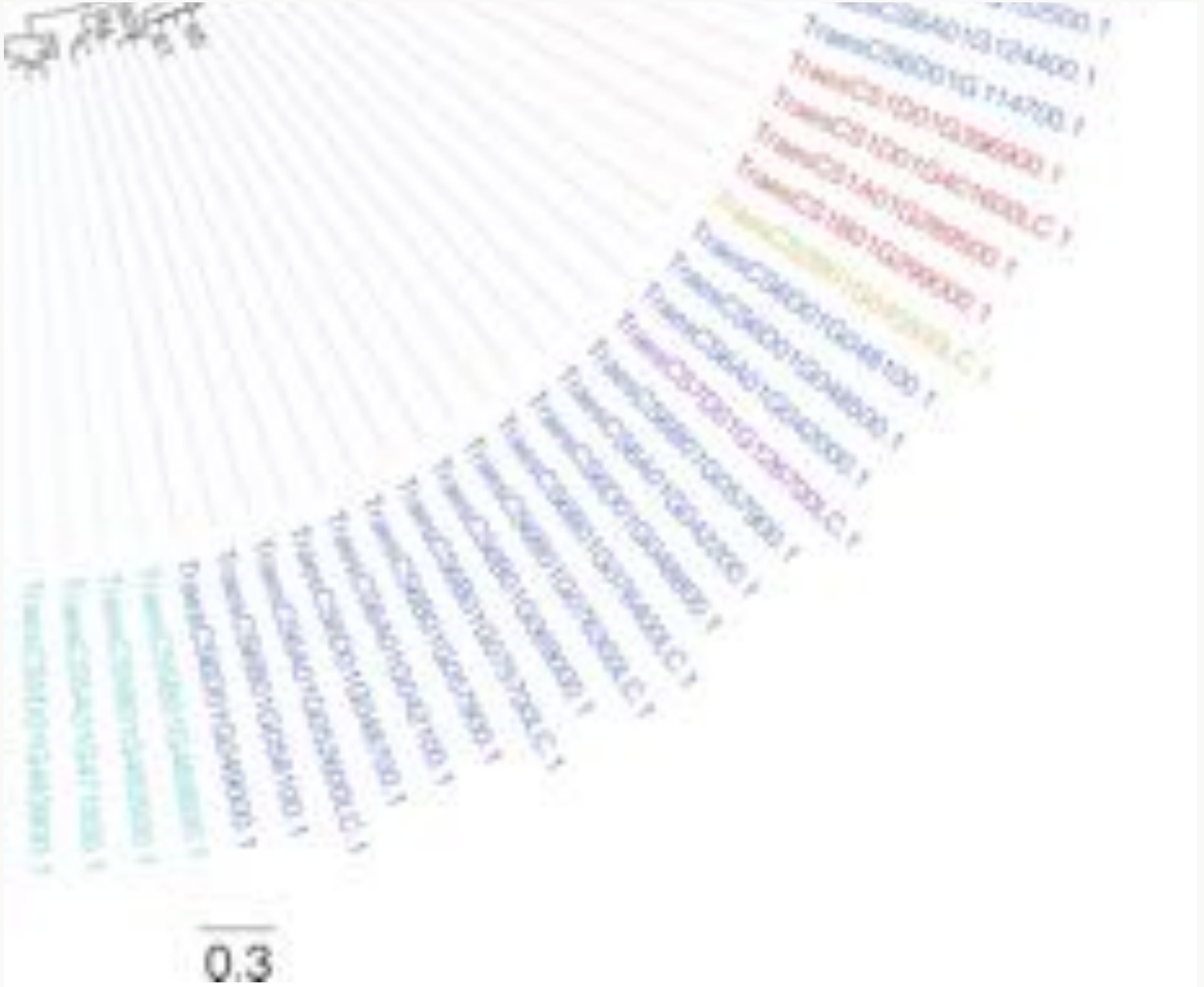
- Protect the developing grain from protein degradation
- Inhibit proteases with an affinity for prolamins
  - Prolamin storage proteins are rich in lysine, proline and glutamine
  - Contribute ~50% of the grain protein



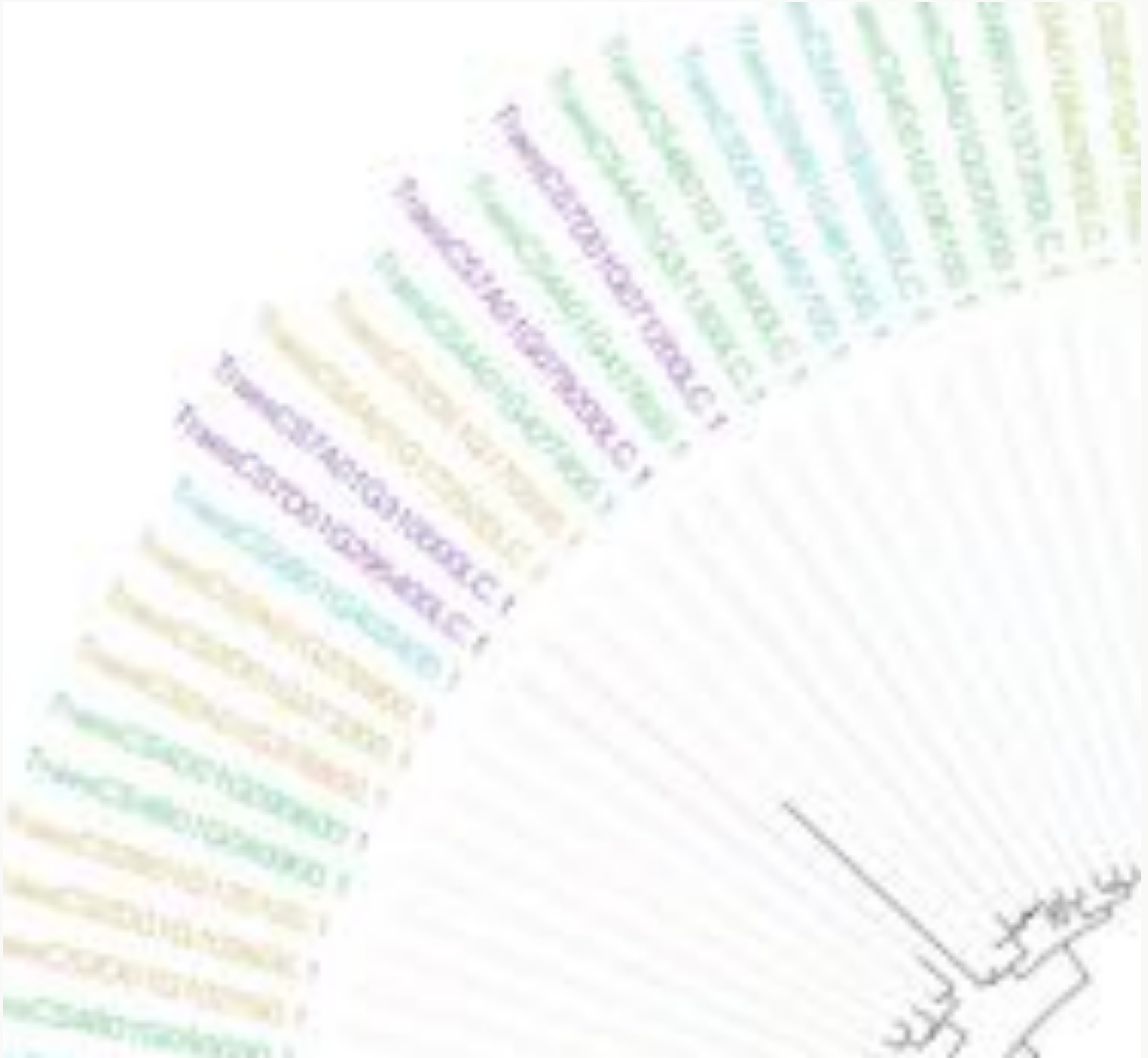
The wheat Serpinome



The wheat Serpinome



The wheat Serpinome



Wheat serpins are disease responsive

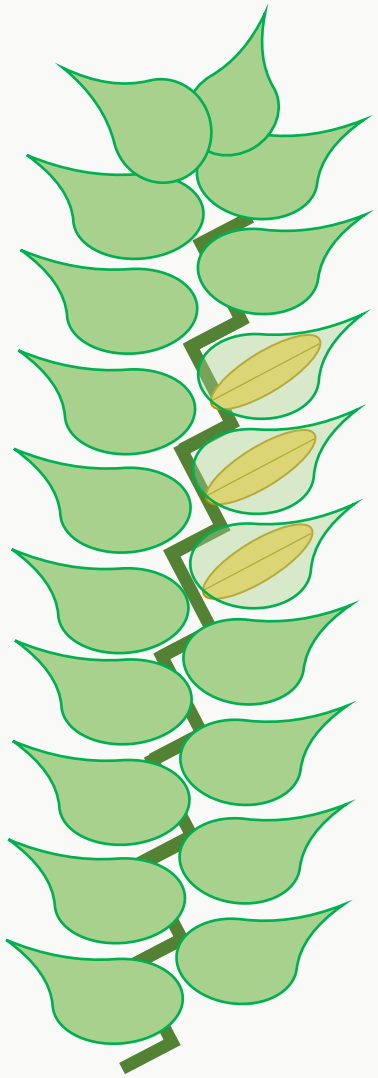
www.wheat-expression.com

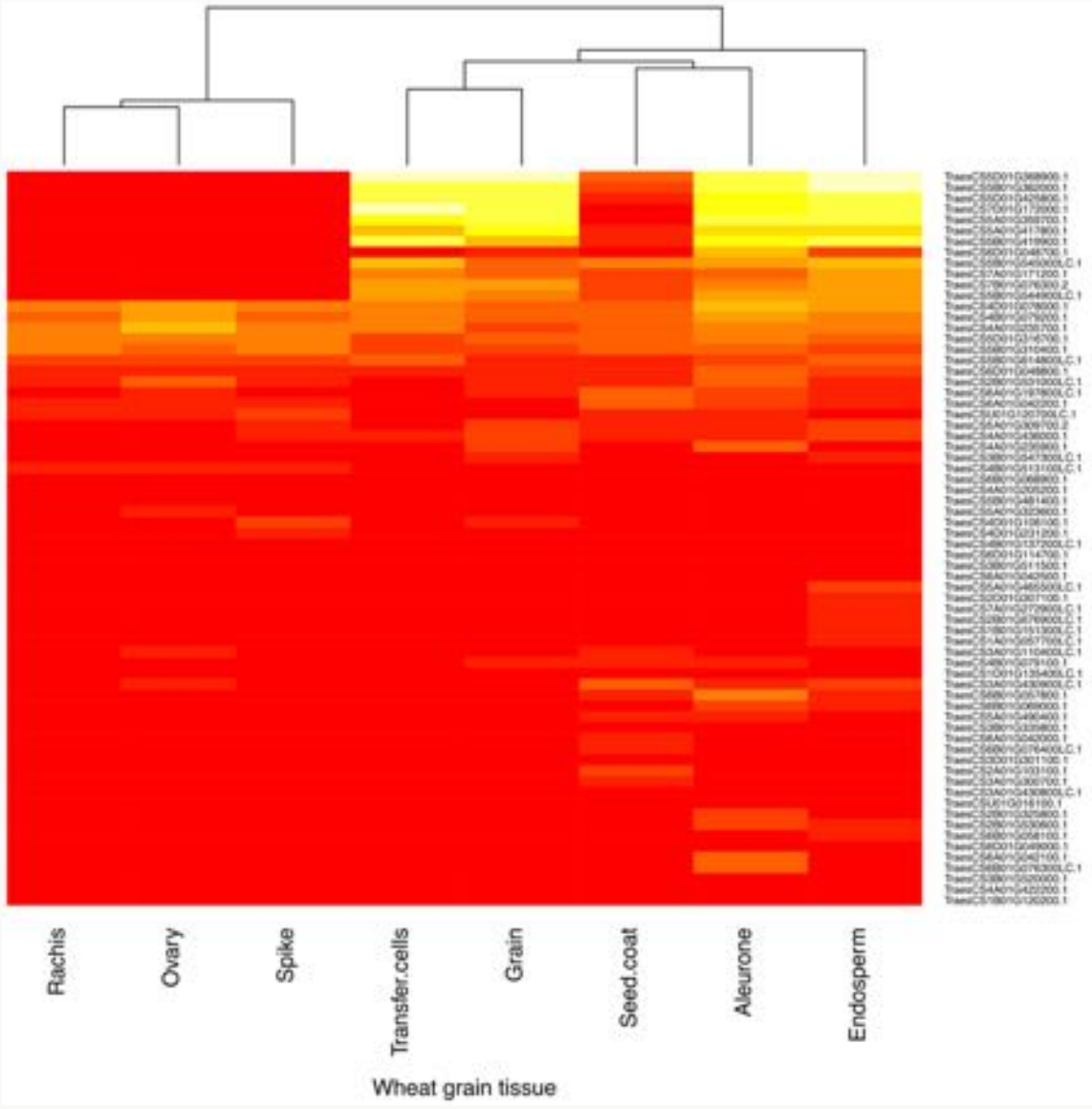
Serpin gene	Fungal pathogen					PAMP elicitor	
	Powdery Mildew	Head Blight	Crown rot	Stripe rust	Leaf blotch	Flg22	Chitin
TraesCS2B01G033100LC	-	4.76	-	-	-	-	-
TraesCS2B01G033300LC	-	3.86	-	-	-	-	-
TraesCS2B01G530600	-3.08	1.01	-	-	-	-	-
TraesCS3B01G335800	-	2.94	-	-	-	-	-
TraesCS3D01G301100	-	1.92	-	-	-	-	-
TraesCS4A01G205200	-	-	-	-	-	2.41	-
TraesCS4A01G235700	-1.29	-	-	-2.26	1.04	-	-
TraesCS4A01G422200	-	3.56	-	-	-	-	-
TraesCS4A01G436000	-	1.56	-	-	-	-	-
TraesCS4B01G079100	-	-	-1.71	-	-	-	-
TraesCS4B01G079200	-	-	-	-1.03	-	-	-
TraesCS4D01G090600	-	-	-	-	-	4.43	5.07
TraesCS4D01G106100	-	1.21	-	-	-	-	-
TraesCS4D01G231200	-2.32	-	-	-1.27	-	-	-
TraesCS5B01G402400	-	-	-	-	-	-	4.3
TraesCS5B01G492700LC	-	-	-	-	-	-2.86	-
TraesCS6B01G068900	-	1.1	-	-	-	-	-
TraesCS6B01G152500	-	-	-	-	-	1.74	1.9
TraesCS6D01G048700	-	-	-	-	-	-	2.24
TraesCS6D01G114700	-	-	-	-	-	1.51	1.4

Serpin gene	Fungal pathogen					PAMP elicitor	
	Powdery Mildew	Head Blight	Crown rot	Stripe rust	Leaf blotch	Flg22	Chitin
TraesCS2B01G033100LC	-	4.76	-	-	-	-	-
TraesCS2B01G033300LC	-	3.86	-	-	-	-	-
TraesCS2B01G530600	-3.08	1.01	-	-	-	-	-
TraesCS3B01G335800	-	2.94	-	-	-	-	-
TraesCS3D01G301100	-	1.92	-	-	-	-	-
TraesCS4A01G205200	-	-	-	-	-	2.41	-
TraesCS4A01G235700	-1.29	-	-	-2.26	1.04	-	-
TraesCS4A01G422200	-	3.56	-	-	-	-	-
TraesCS4A01G436000	-	1.56	-	-	-	-	-
TraesCS4B01G079100	-	-	-1.71	-	-	-	-
TraesCS4B01G079200	-	-	-	-1.03	-	-	-
TraesCS4D01G090600	-	-	-	-	-	4.43	5.07
TraesCS4D01G106100	-	1.21	-	-	-	-	-
TraesCS4D01G231200	-2.32	-	-	-1.27	-	-	-
TraesCS5B01G402400	-	-	-	-	-	-	4.3
TraesCS5B01G492700LC	-	-	-	-	-	-2.86	-
TraesCS6B01G068900	-	1.1	-	-	-	-	-
TraesCS6B01G152500	-	-	-	-	-	1.74	1.9
TraesCS6D01G048700	-	-	-	-	-	-	2.24
TraesCS6D01G114700	-	-	-	-	-	1.51	1.4

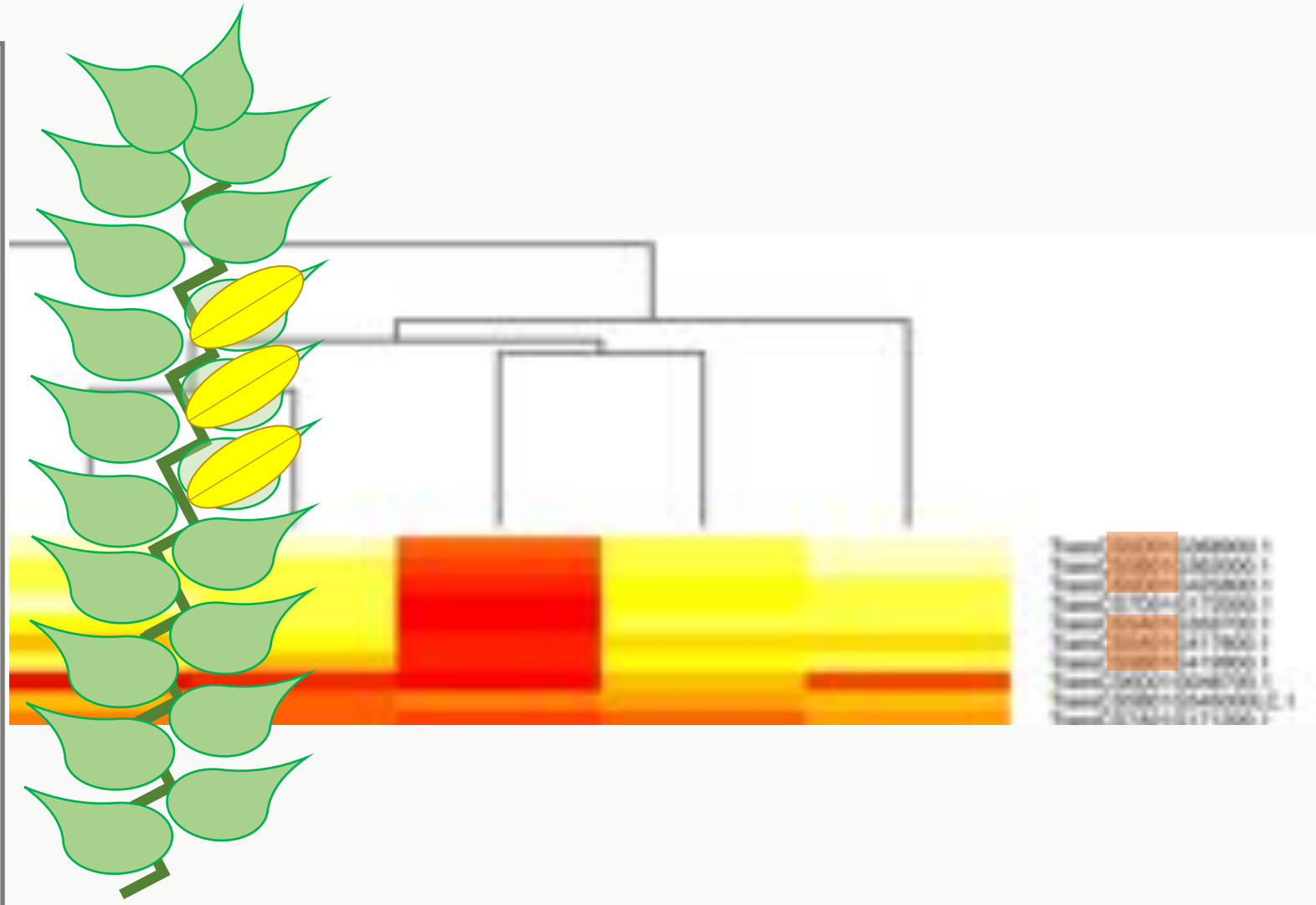
Wheat serpins are expressed in the grain

www.wheat-expression.com

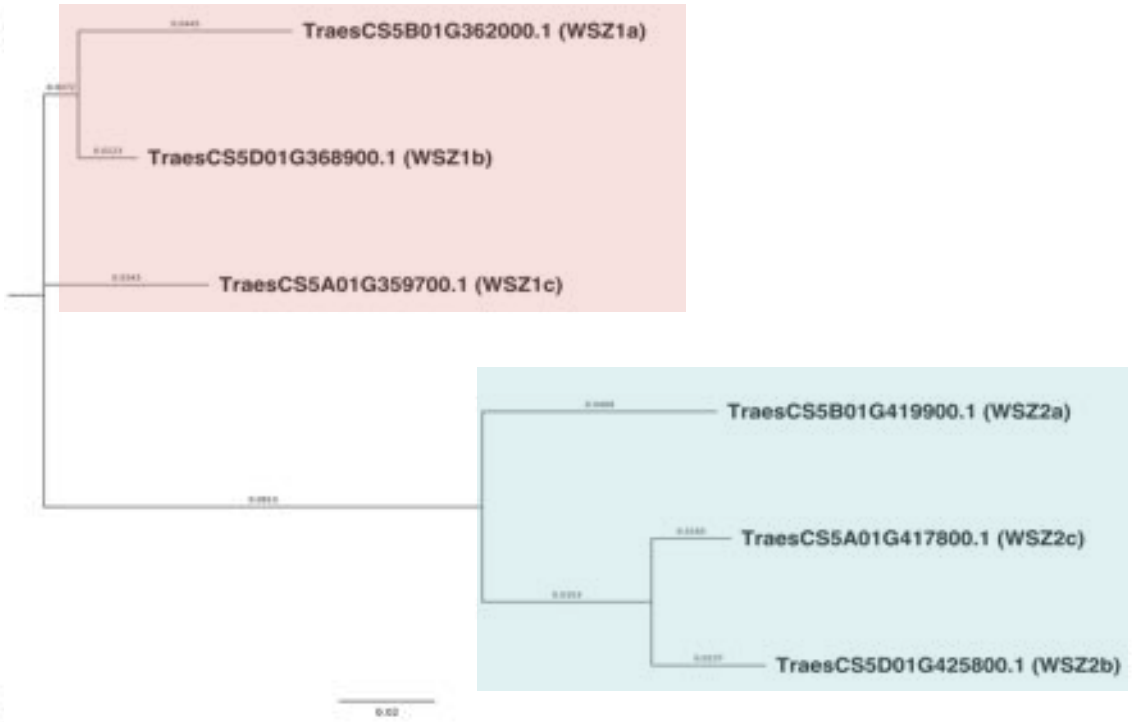


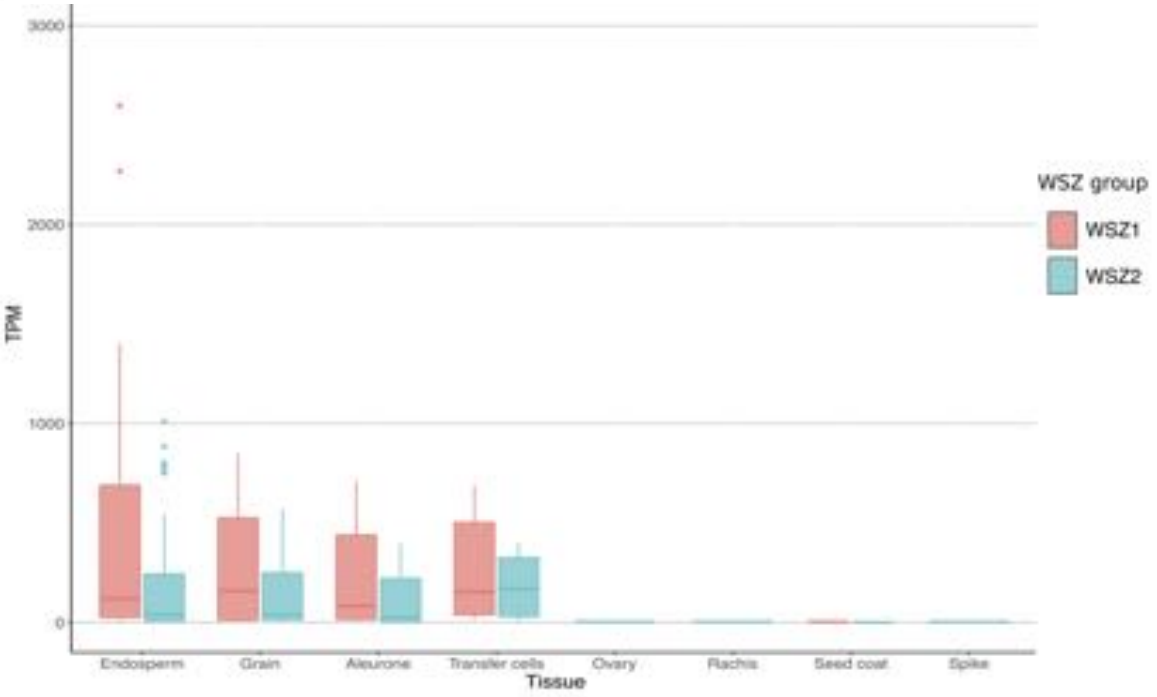


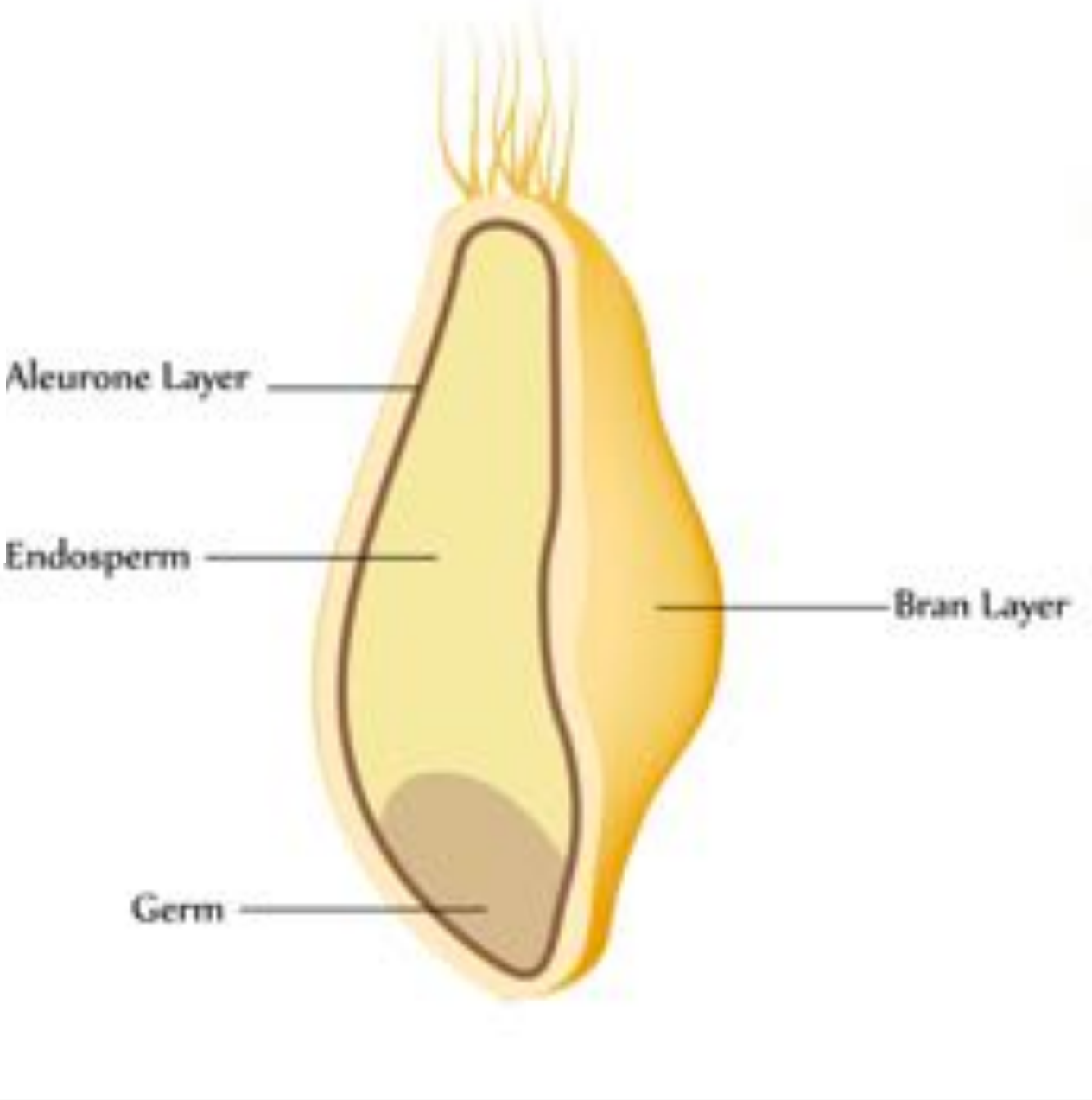
Wheat serpins are expressed in the grain



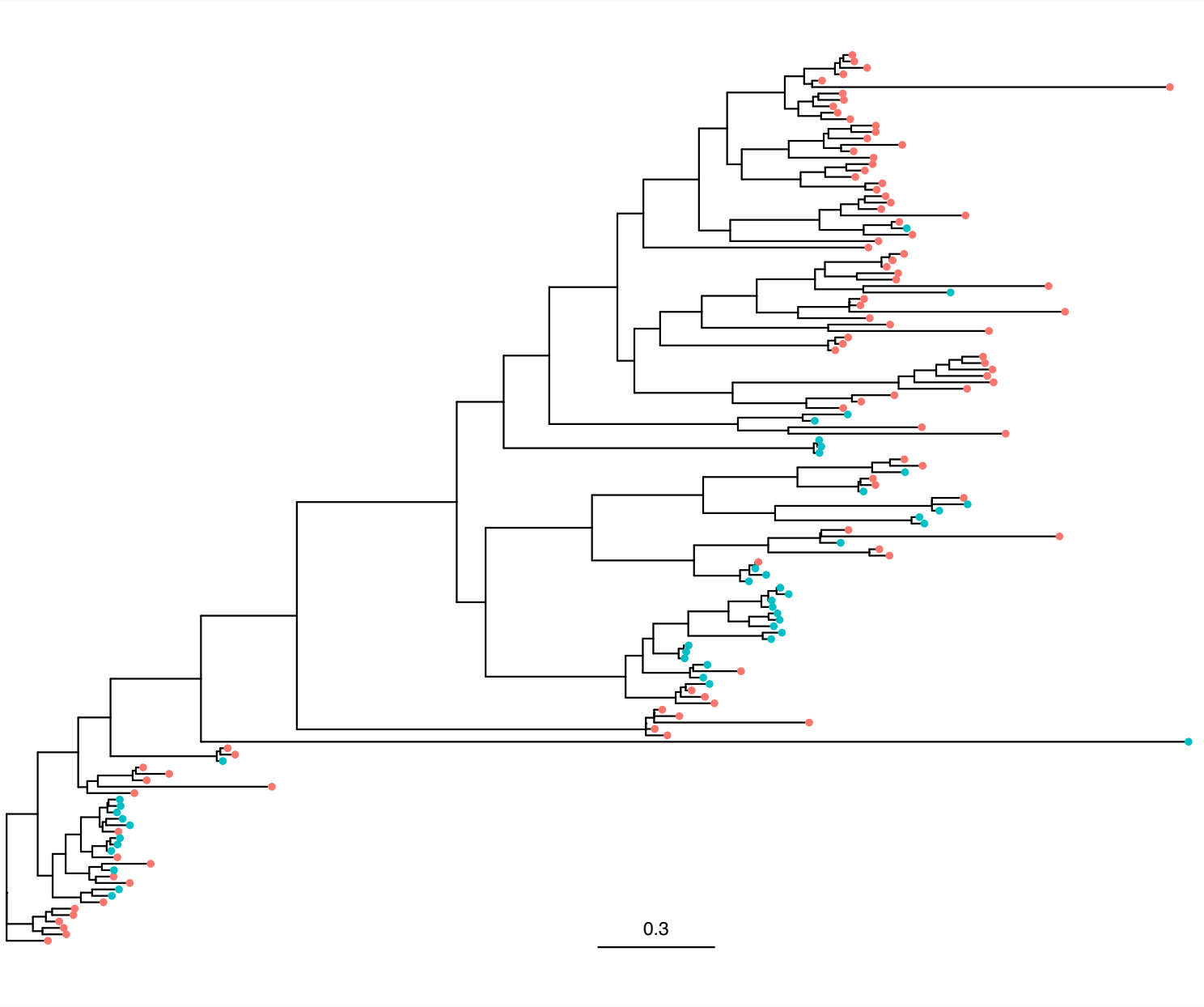
www.wheat-expression.com


TraesCS5B01G362000.1 (WSZ1a)
TraesCS5D01G368900.1 (WSZ1b)
TraesCS5A01G359700.1 (WSZ1c)
TraesCS5B01G419900.1 (WSZ2a)
TraesCS5A01G417800.1 (WSZ2c)
TraesCS5D01G425800.1 (WSZ2b)
0.02


3000
2000
1000
0
TPM
WSZ group
WSZ1
WSZ2
Endosperm
Grain
Aleurone
Transfer cells
Ovary
Rachis
Seed coat
Spike
Tissue

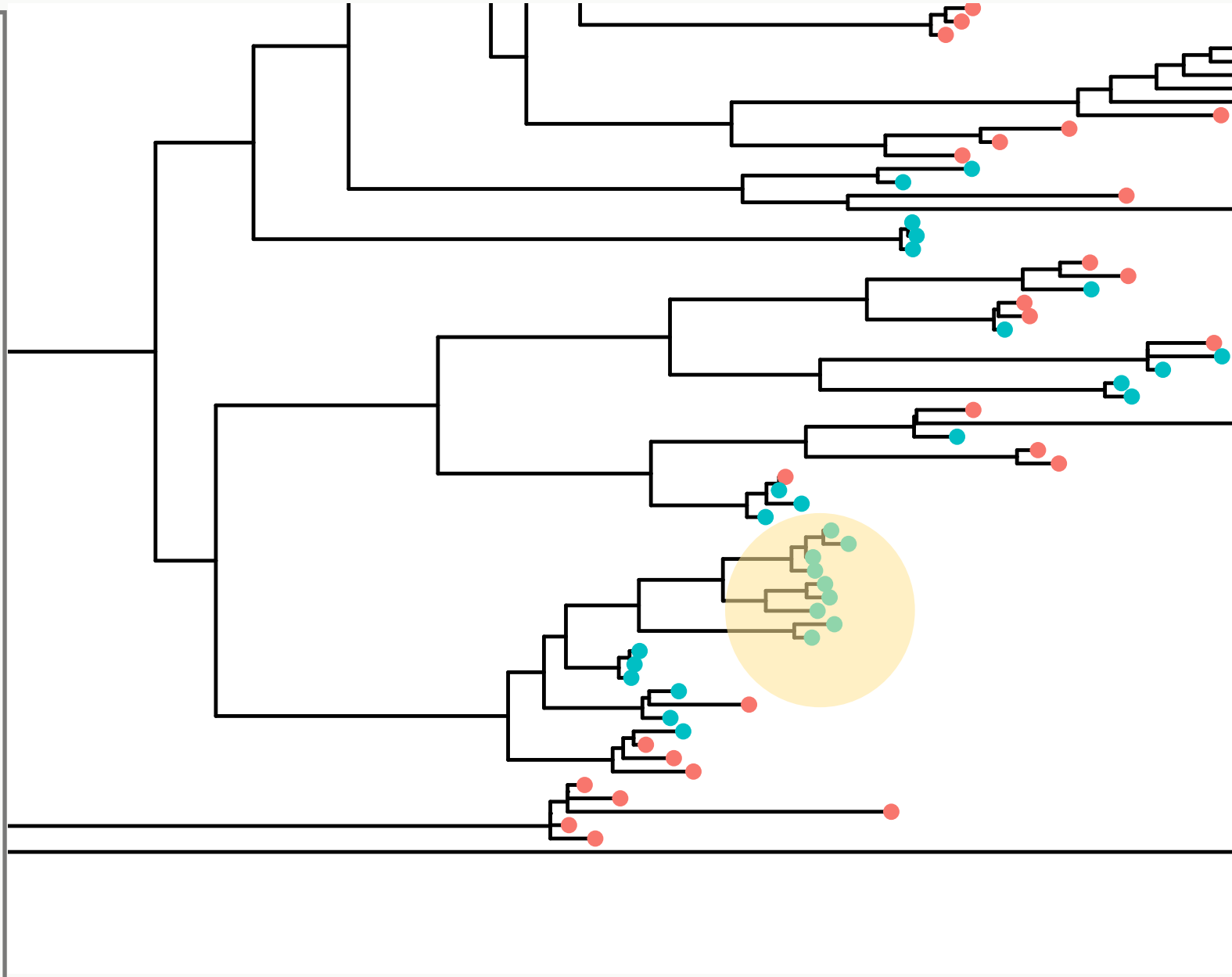

Aleurone Layer
Endosperm
Bran Layer
Germ

The wheat serpinome shows functional divergence



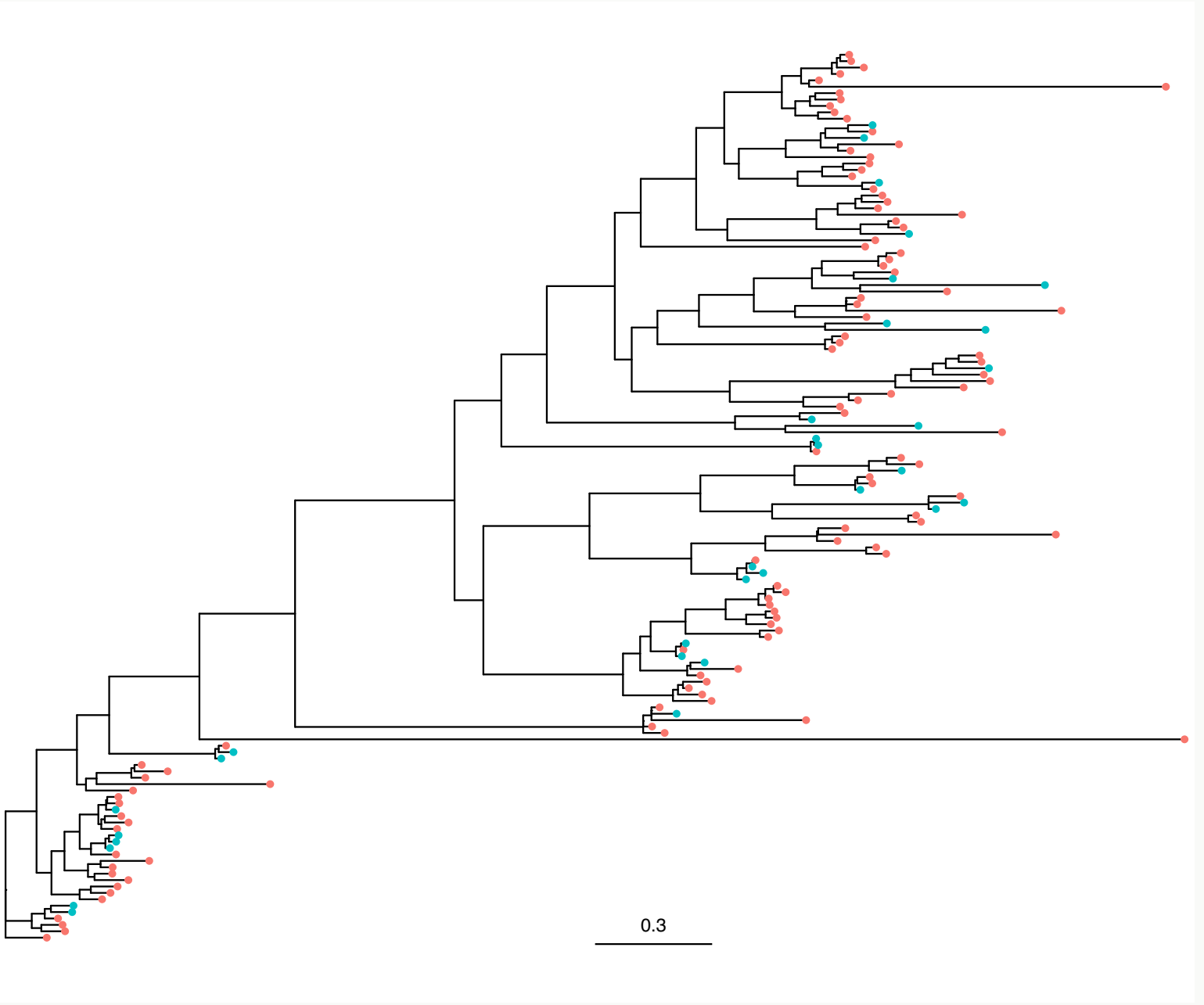
The wheat serpinome shows functional divergence

Grain serpins are conserved in function



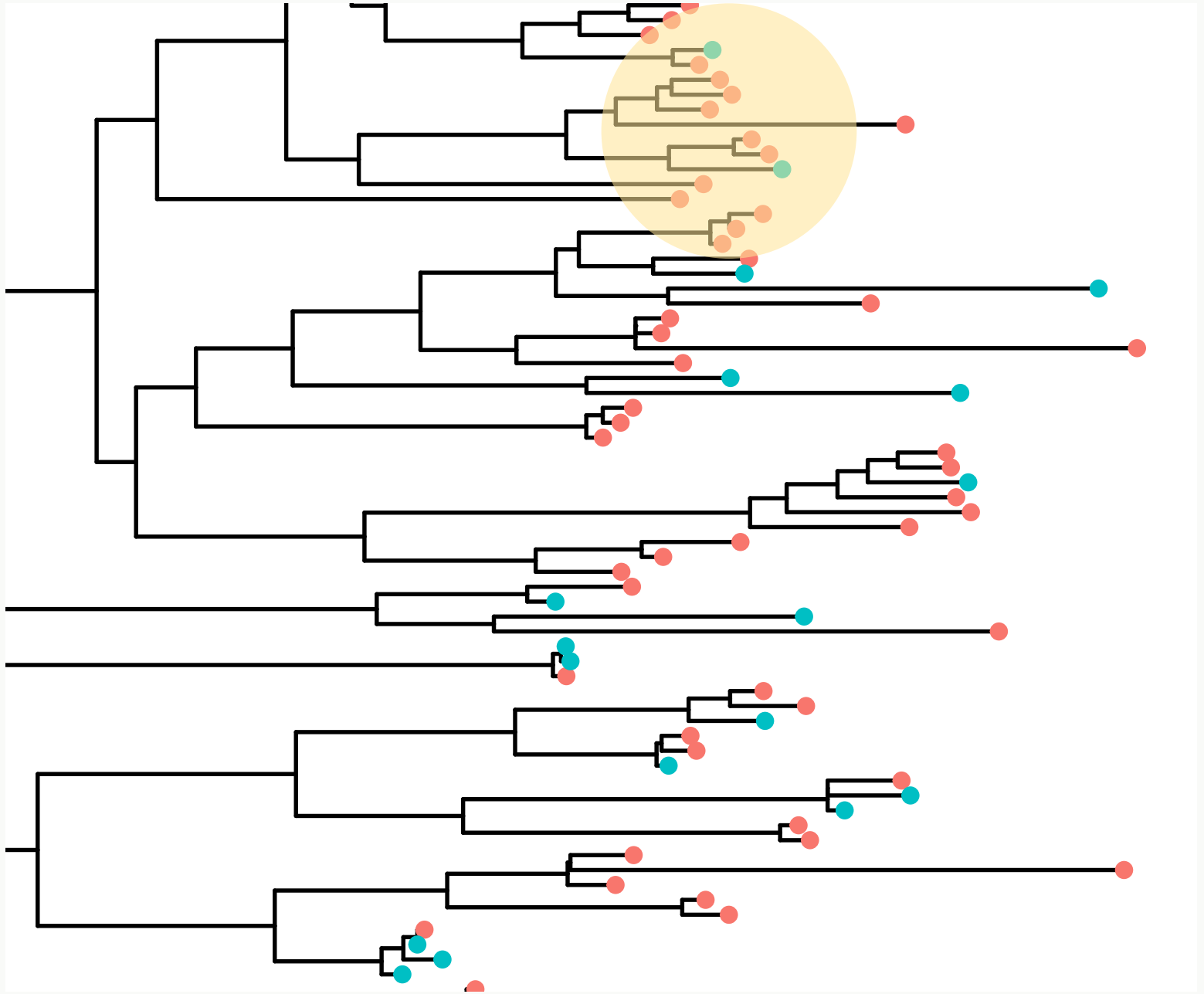
The wheat serpinome shows functional divergence

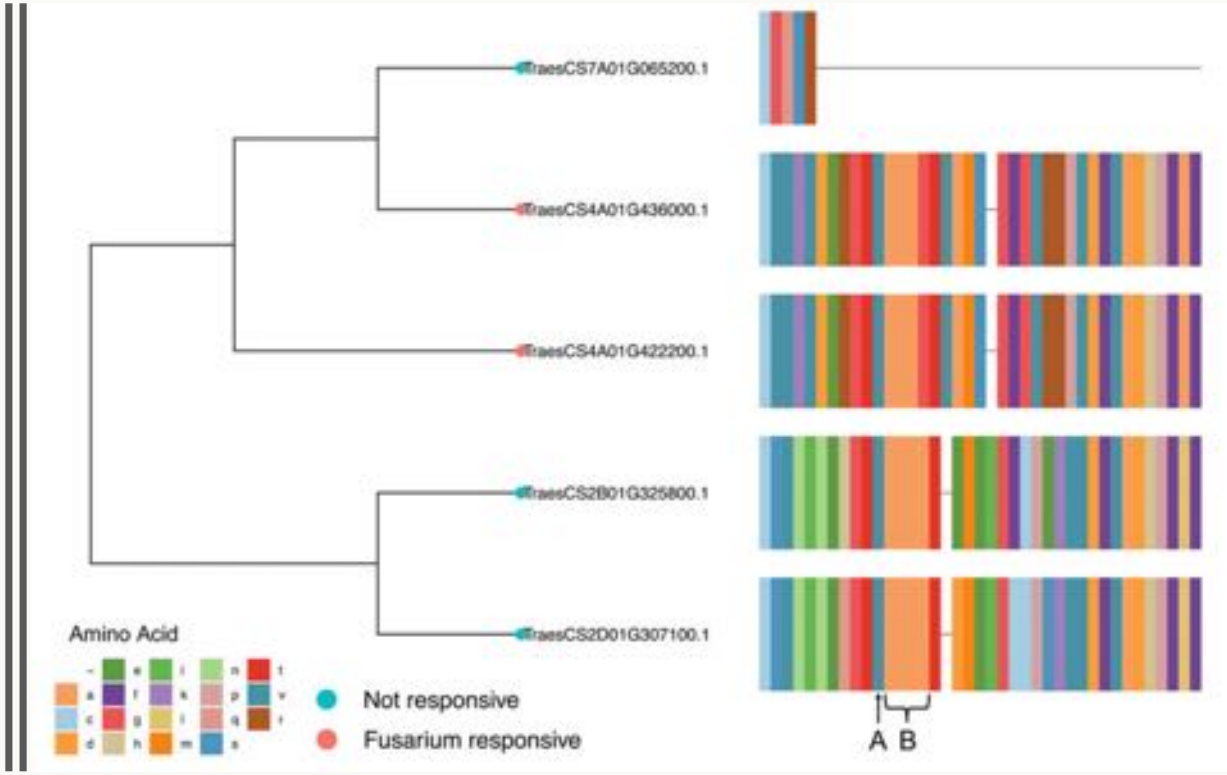
Disease serpins are diverse in function



The wheat serpinome shows functional divergence

Disease serpins are diverse in function





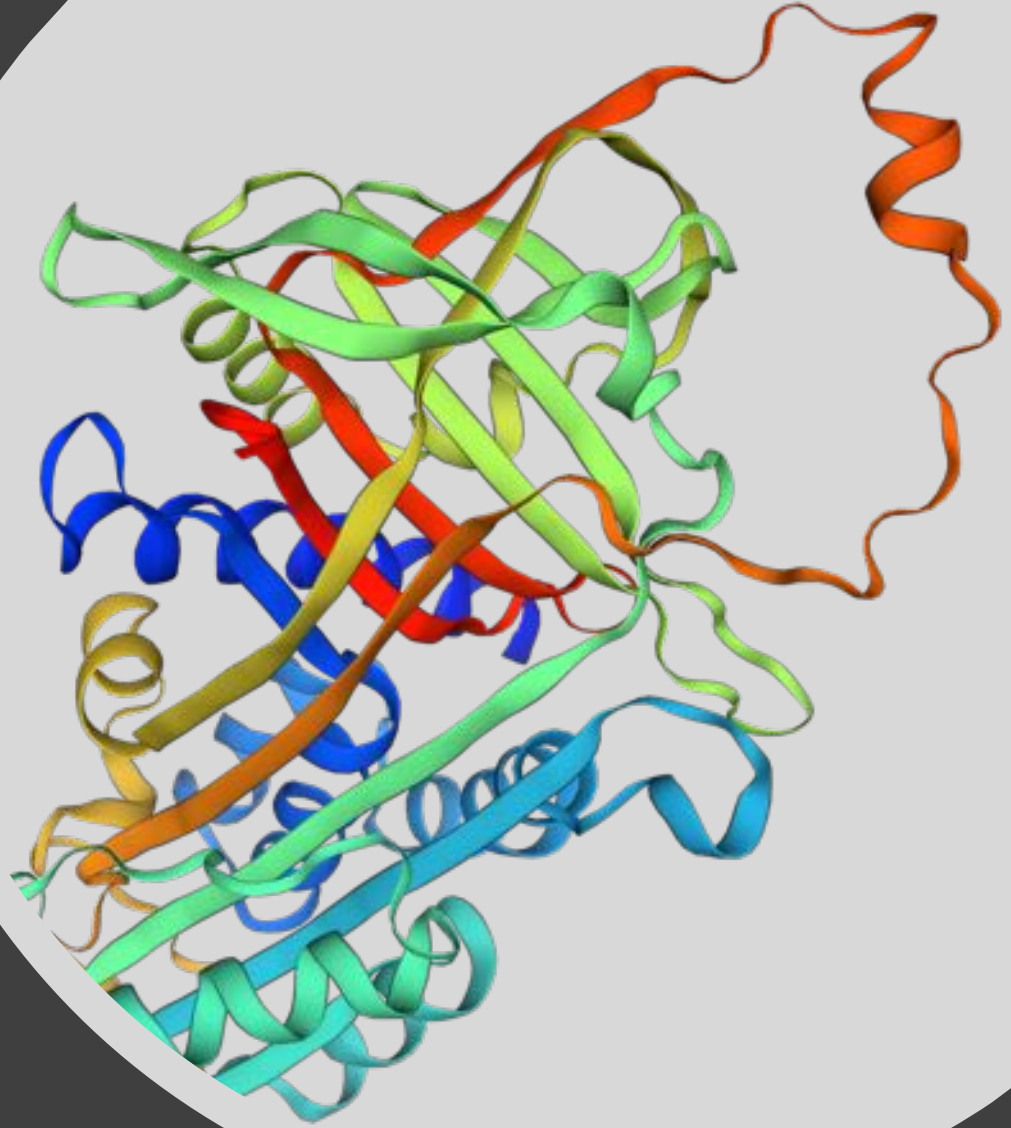
The RCL sequence governs function

Conclusions and future questions

- **Serpins are responsive to fungal pathogens in wheat**
  - Did the serpins evolve to inhibit fungal proteases?
  - Which proteases do they interact with?
  - Are these proteases important for fungal virulence?

- **Serpins are expressed in the developing grain in wheat**
  - Can we exploit this to accelerate yield gains in wheat?
  - Is there any useful allelic diversity present in elite wheat?

- **Do pleiotropic serpins contribute to trade-offs?**
  - Is the role in the grain compromised by a disease response?



Thank you

- **The International Wheat Genome Sequencing Consortium**

- Prof. Fiona Doohan
- Prof. Lars S. Jermiin
- The Doohan group at UCD