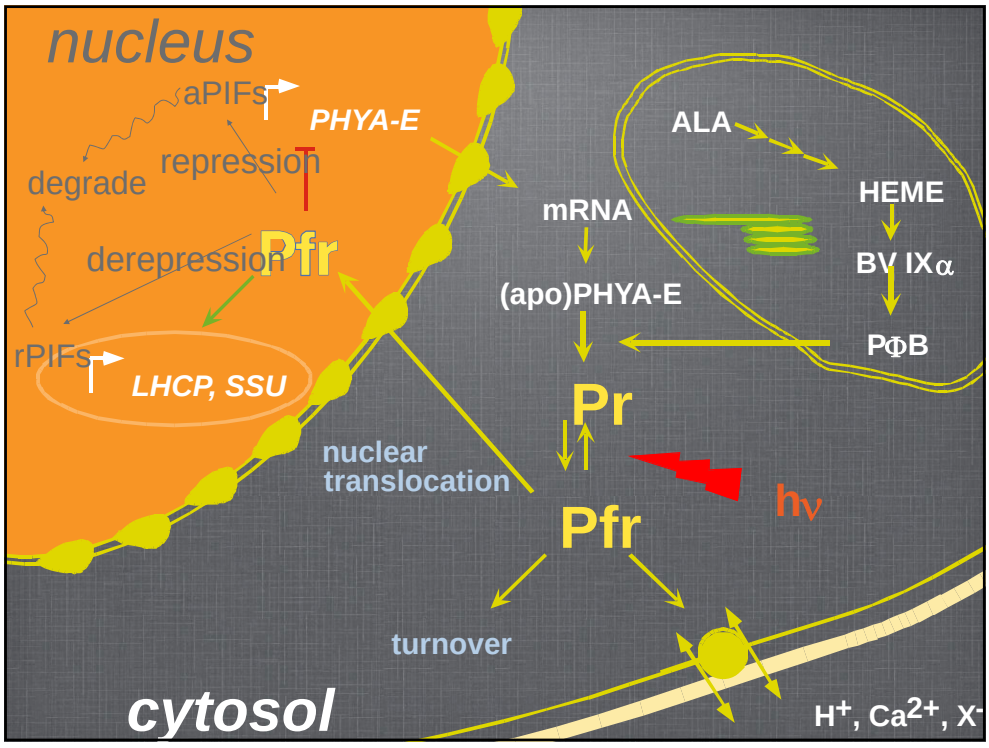
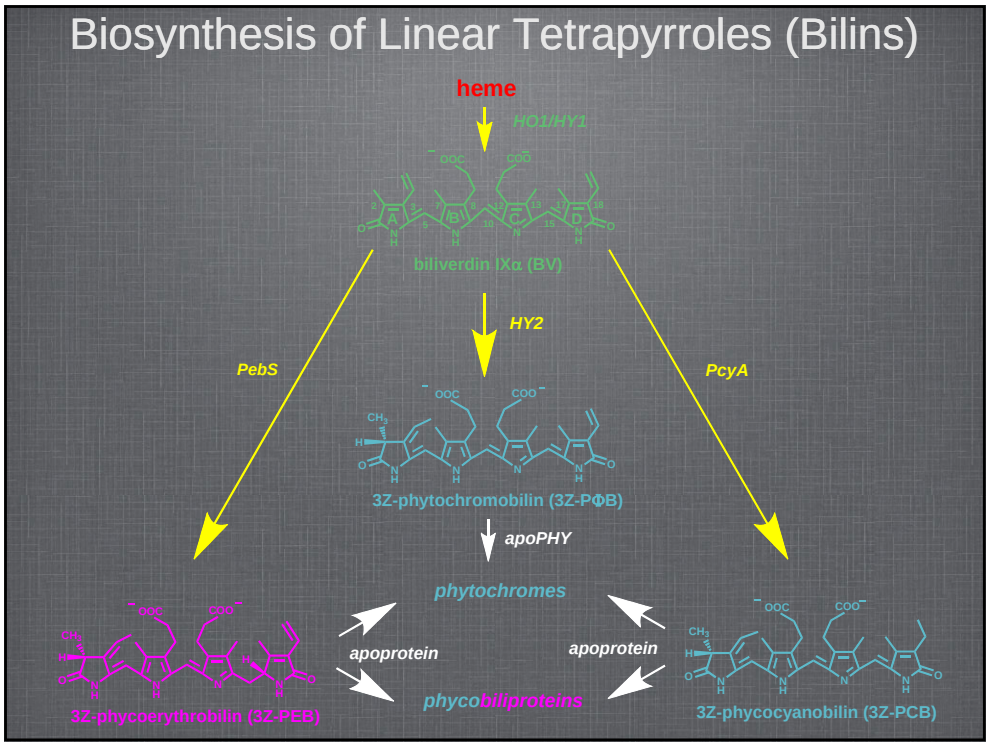
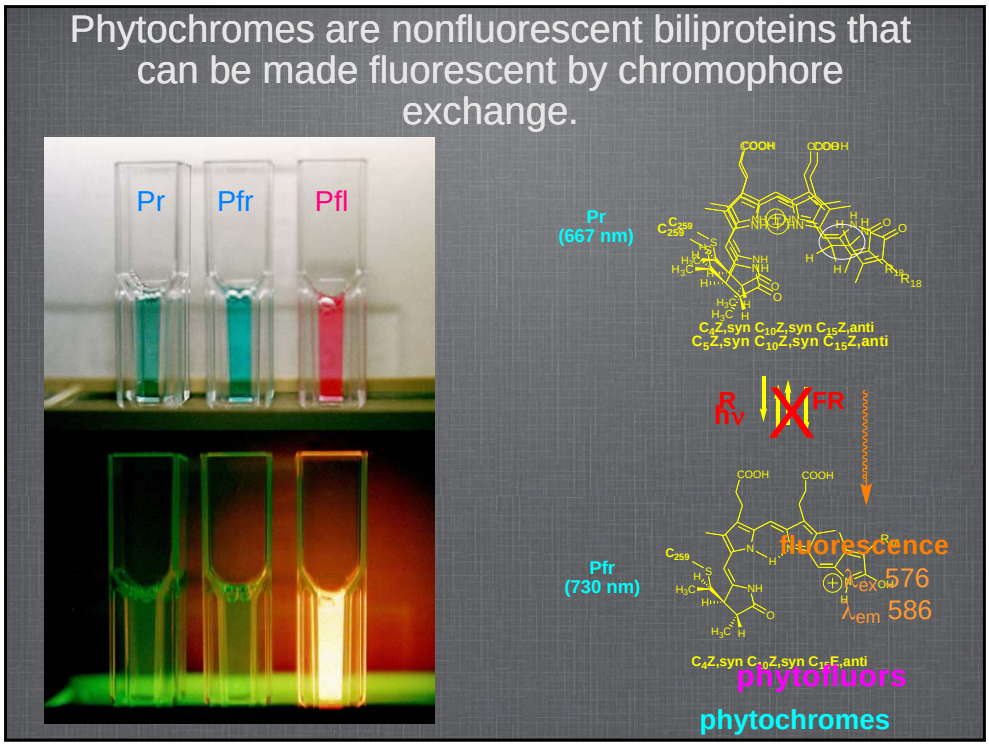
Manipulation of Phytochrome-Mediated Signaling in Transgenic Plants

Timothy Butterfield, Wei Hu and J. Clark Lagarias
Department of Molecular & Cellular Biology
University of California, Davis

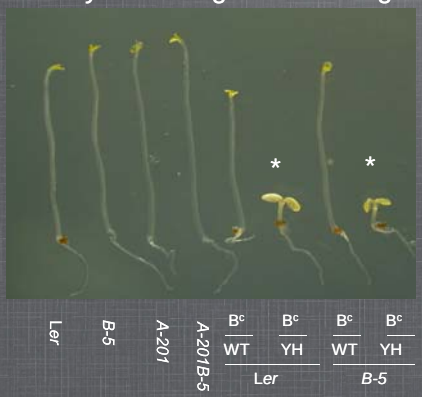



Biosynthesis of Linear Tetrapyrroles (Bilins)
heme
HO1/HY1
biliverdin IXα (BV)
HY2
PebS
PcyA
3Z-phytochromobilin (3Z-PΦB)
apoPHY
phytochromes
apoprotein
apoprotein
phycobiliproteins
3Z-phycoerythrobilin (3Z-PEB)
3Z-phycocyanobilin (3Z-PCB)

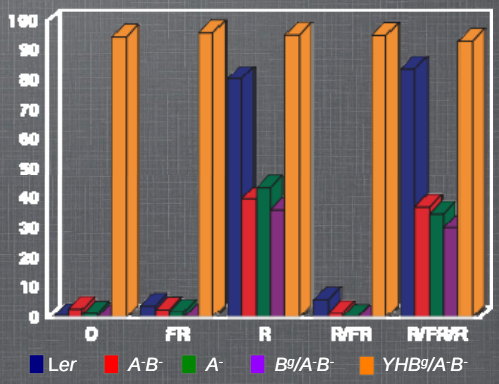

Phytochromes are nonfluorescent biliproteins that can be made fluorescent by chromophore exchange.
Pr
Pfr
Pfl
Pr
(667 nm)
C4Z,syn C10Z,syn C15Z,anti
C5Z,syn C10Z,syn C15Z,anti
R
hν
FR
Pfr
(730 nm)
fluorescence
λexc 576
λem 586
C4Z,syn C10Z,syn C15E,anti
phytofluors
phytochromes

YH alleles of phy are dominant, constitutively active, light-independent point mutations.

Six-day-old dark-grown seedlings



Seed germination



Su & Lagarias, *Plant Cell* 19: 2124 (2007)

YH alleles of phyB modify plant growth and development across species boundaries.

Arabidopsis thaliana

Su & Lagarias 2007 Plant Cell 19:2124

Nicotiana tabacum (Maryland Mammoth)

Tobacco images Courtesy of W. Hu

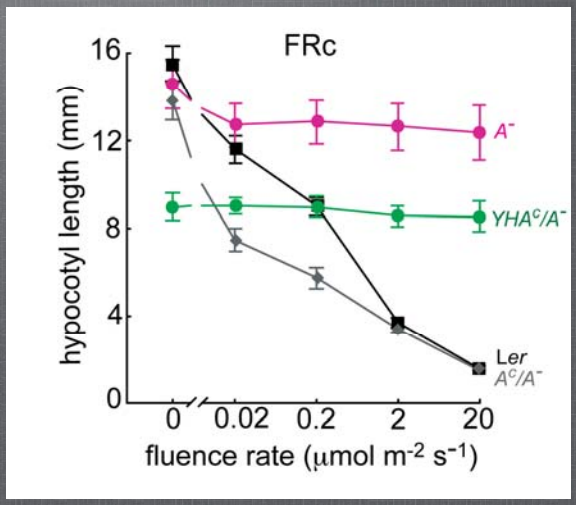
Long Term Objective

Selectively modify crop plant physiology with mutant phytochrome and cyanobacterial bilin synthase transgenes.

Do phyA-E regulate the same signaling networks?

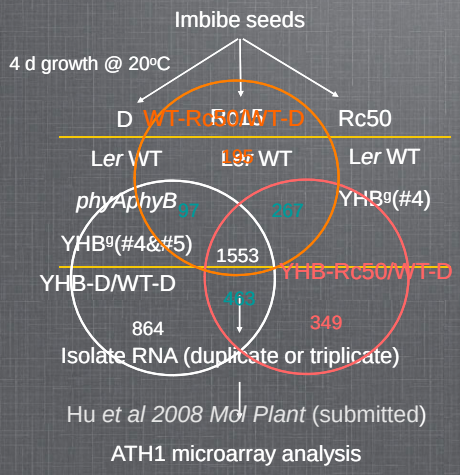
Can we selectively modify growth and developmental traits by expression of light-independent alleles of phytochromes?

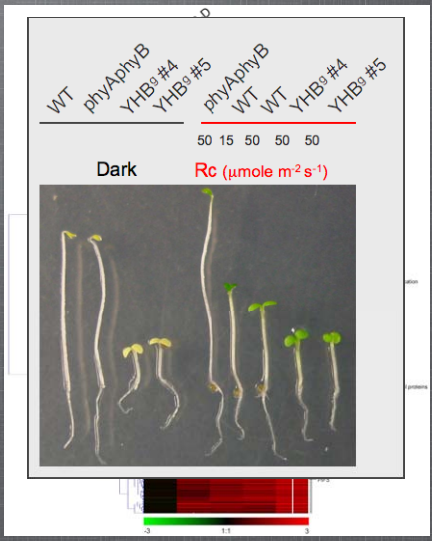
YHA is a constitutively active, FR-insensitive phy with characteristics unique from YHB.



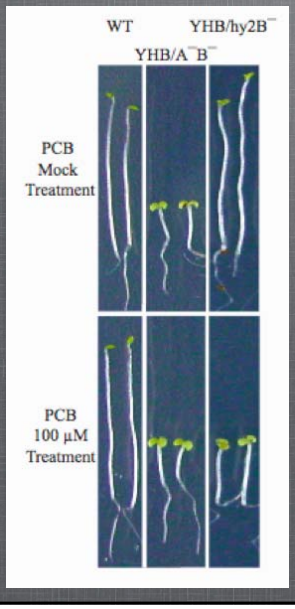
Su & Lagarias, *Plant Cell* 19: 2124 (2007)

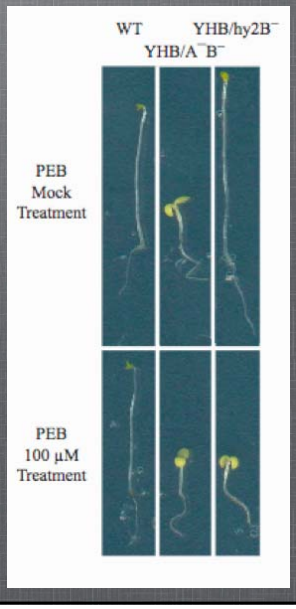
YHB-D expression is qualitatively similar to, but quantitatively stronger than, WT and YHB expression under Rc.



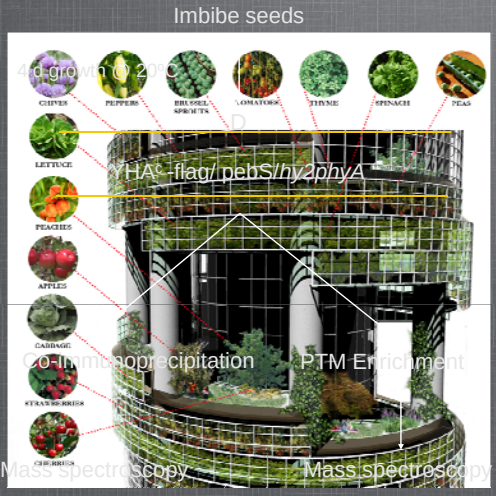


YH phys and a phycoerythrobilin together generate a selective, inducible system.

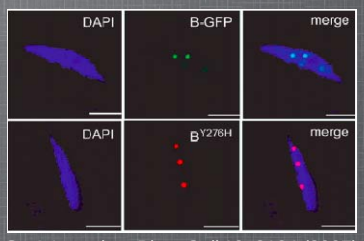




YH phys and cyanobacterial chromophores can be used as unique tools to study and regulate phy activity.



http://www.verticalfarm.com/Designs.aspx



Su & Lagarias, *Plant Cell* 19: 2124 (2007)

Acknowledgements & Funding

Lagarias Lab:

Clark Lagarias
Wei Hu
Nathan Rockwell
Lixia Shang
Shelley Martin
Keenan Taylor

Affiliations & Funding

- UC Davis Plant Biology Graduate Group
- UC Davis Section of Molecular & Cellular Biology
- US National Institutes of Health
- Designated Emphasis in Biotechnology
- CREATE-IGERT (NSF DGE-0653984)

CREATE IGERT
COLLABORATIVE RESEARCH & EDUCATION IN AGRICULTURAL TECHNOLOGIES & ENGINEERING

NATIONAL INSTITUTES OF HEALTH