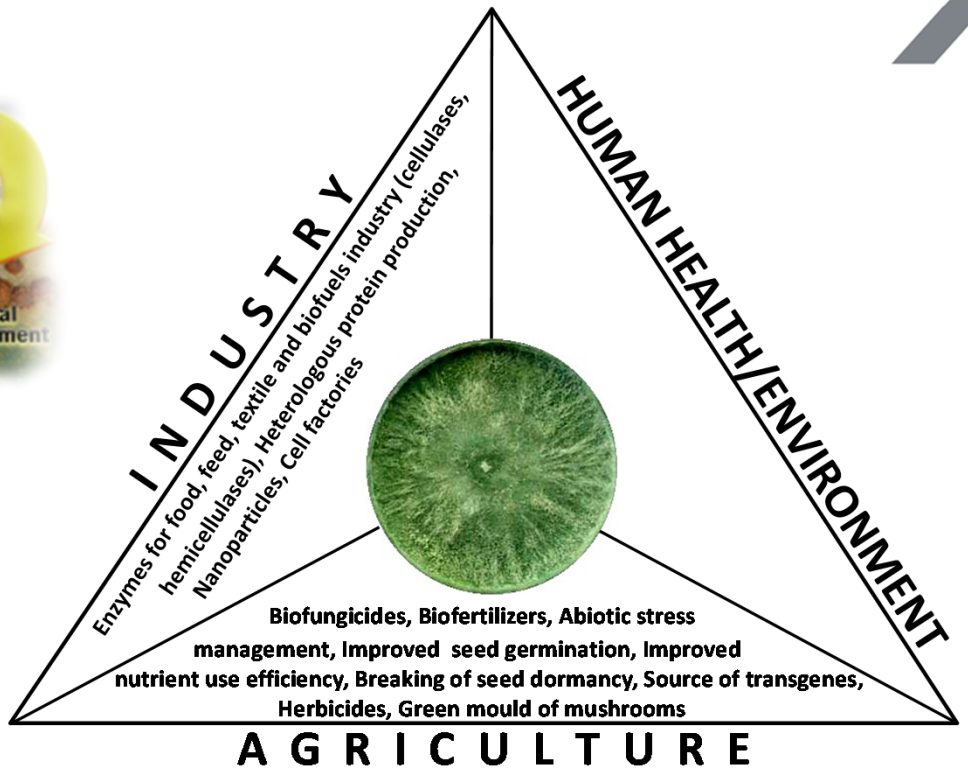


AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

Trichoderma species as biocontrol agents

Monika Schmoll
Health and Environment Department
Bioresources

Department Health and Environment
Bioresources

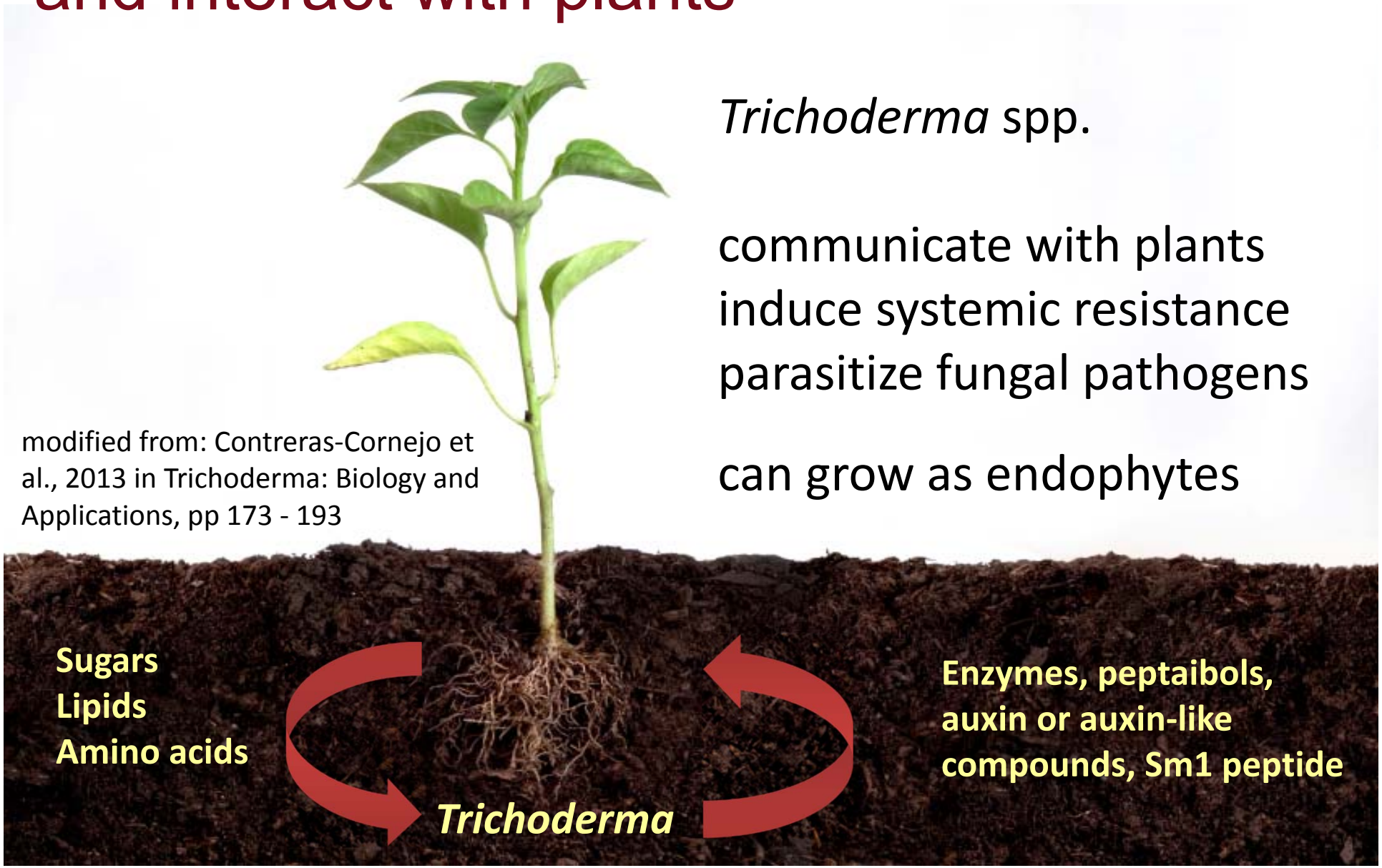
AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

University and
Research Center Tulln (UFT)

AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

Trichoderma spp. influence and interact with plants

AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY



Trichoderma spp.

communicate with plants
induce systemic resistance
parasitize fungal pathogens

can grow as endophytes

modified from: Contreras-Cornejo et al., 2013 in Trichoderma: Biology and Applications, pp 173 - 193

Trichoderma spp. improve plant health and vigour

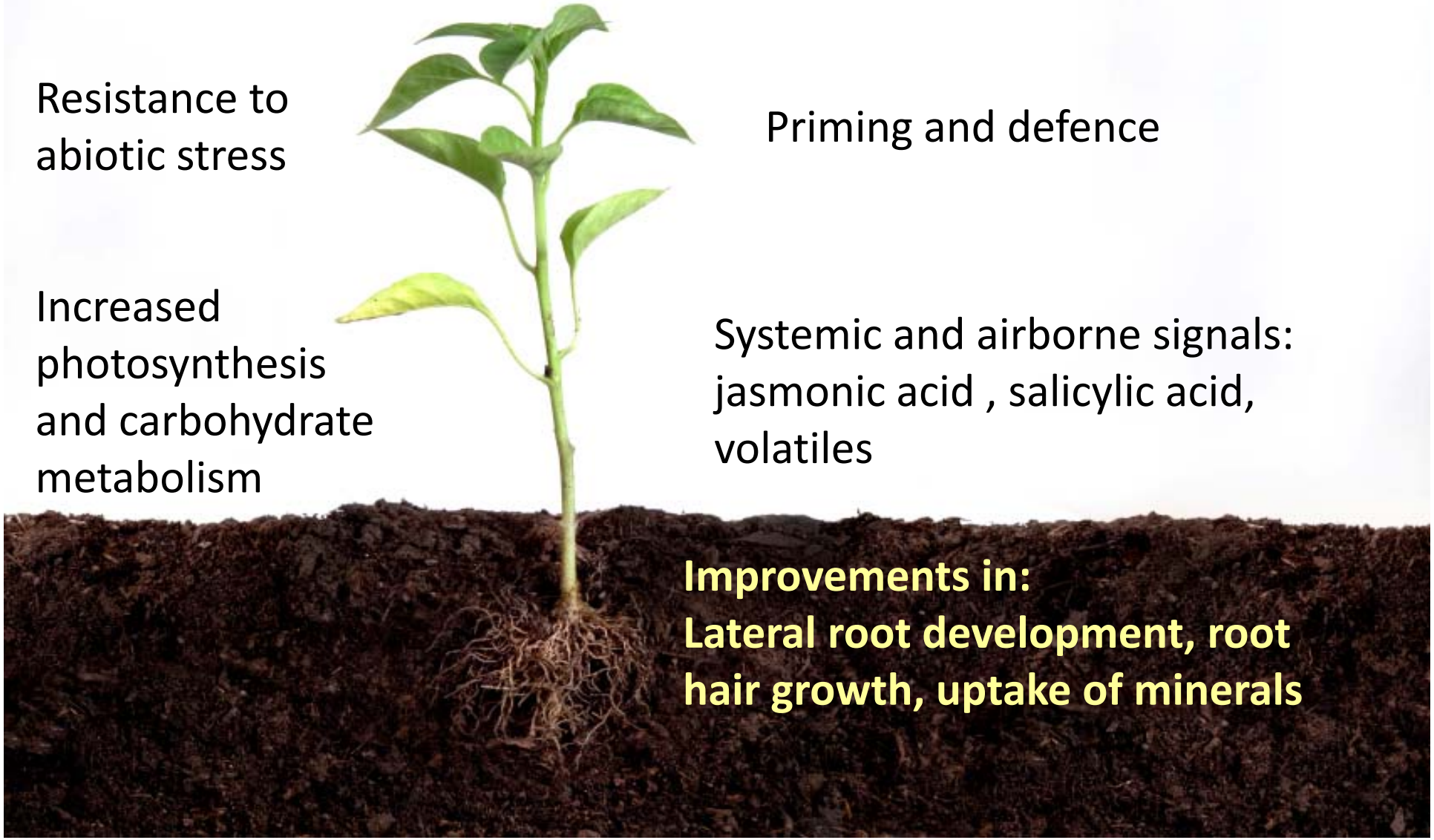
AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

Resistance to abiotic stress

Priming and defence

Increased photosynthesis and carbohydrate metabolism

Systemic and airborne signals: jasmonic acid , salicylic acid, volatiles



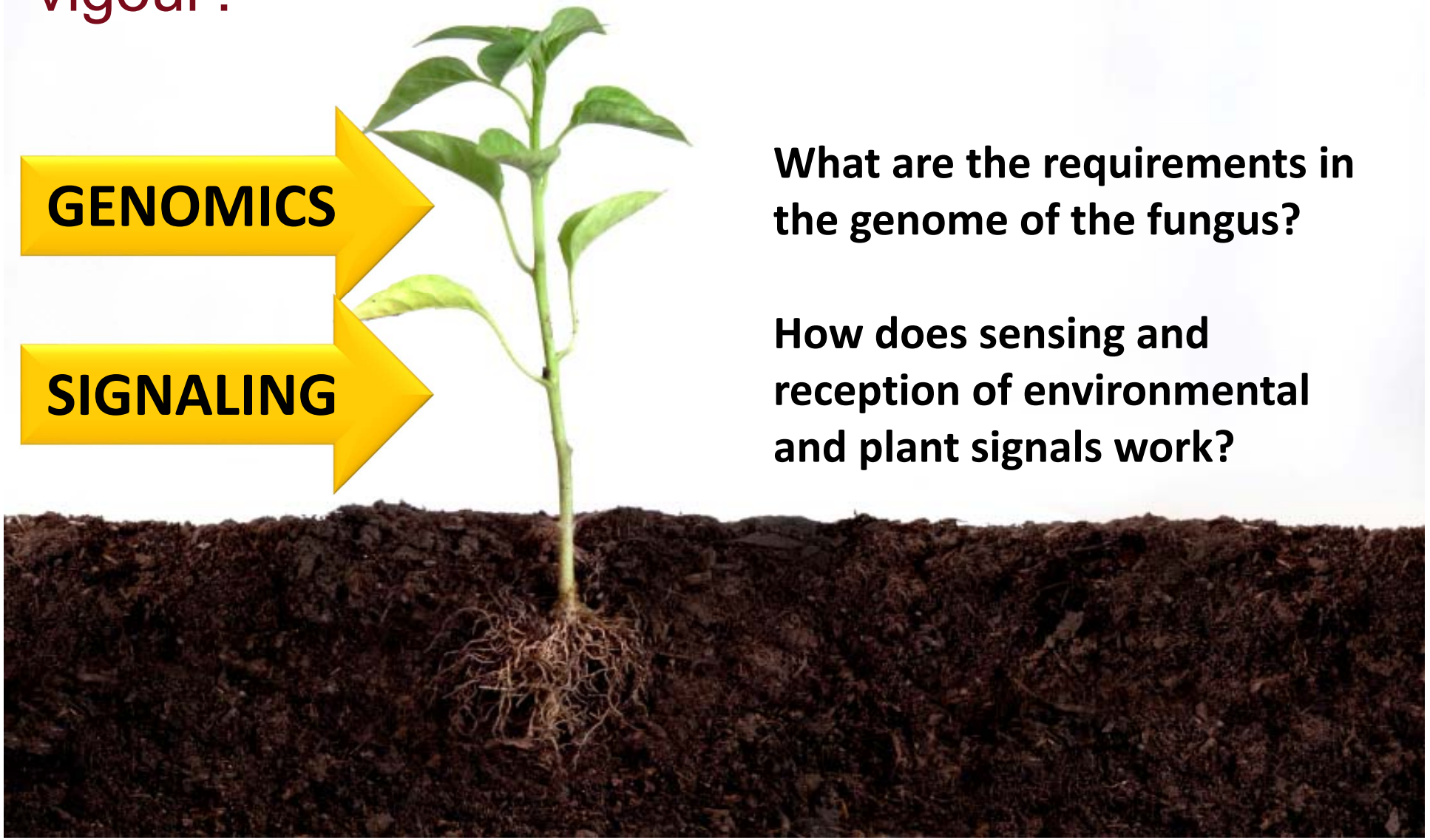
Improvements in:
Lateral root development, root hair growth, uptake of minerals

How do *Trichoderma* spp. achieve improvement of plant health and vigour?

AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

GENOMICS

SIGNALING

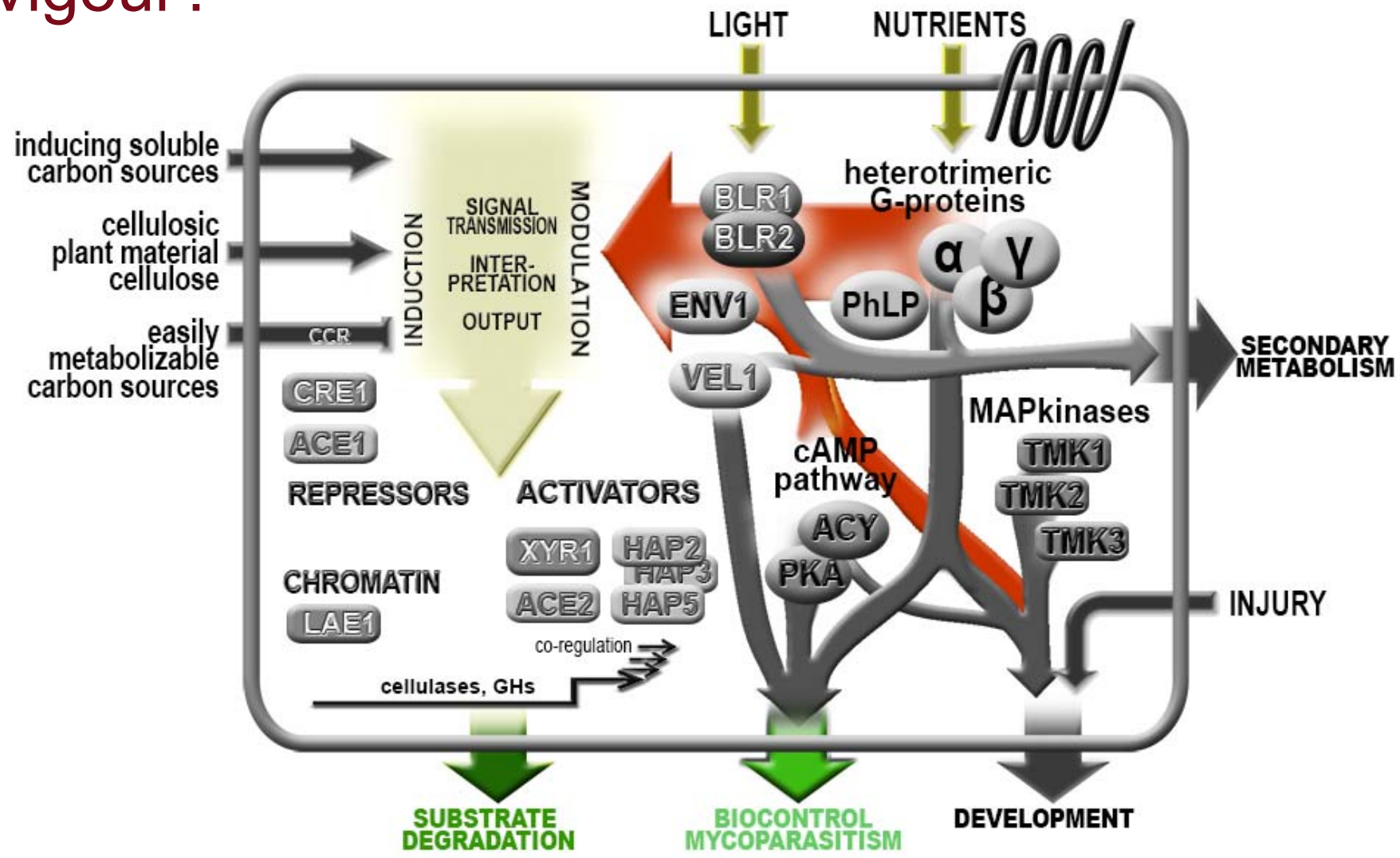


What are the requirements in the genome of the fungus?

How does sensing and reception of environmental and plant signals work?

How do *Trichoderma* spp. achieve improvement of plant health and vigour?

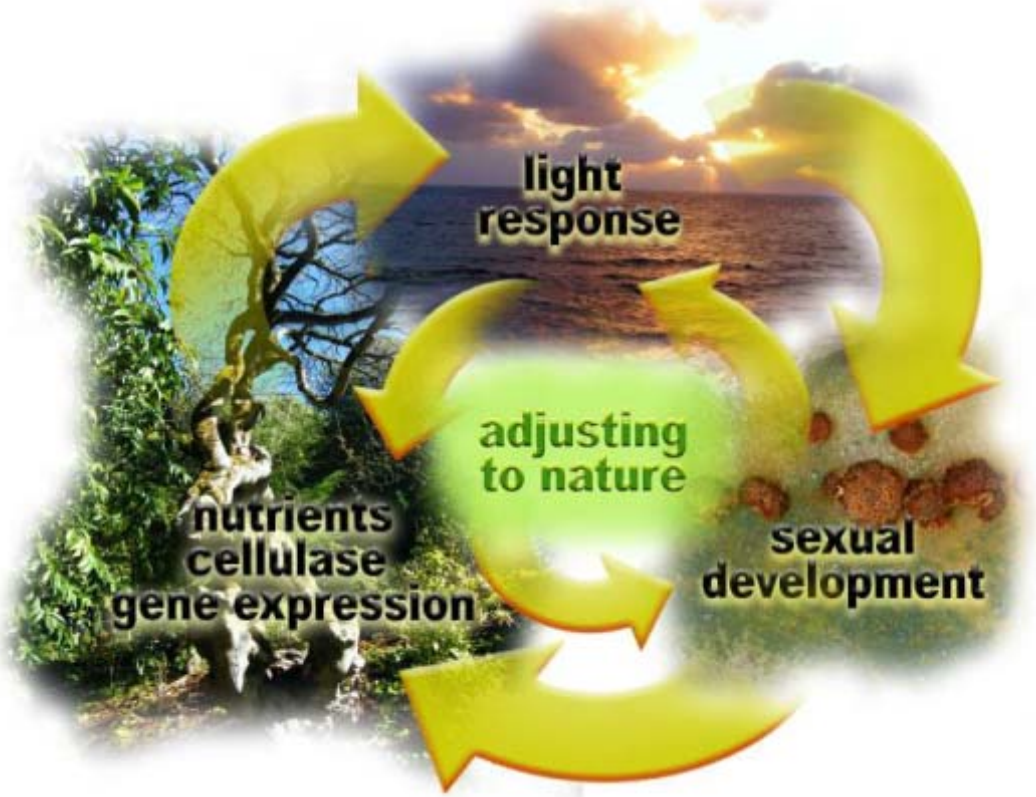
AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY



Fundamental determinants of life

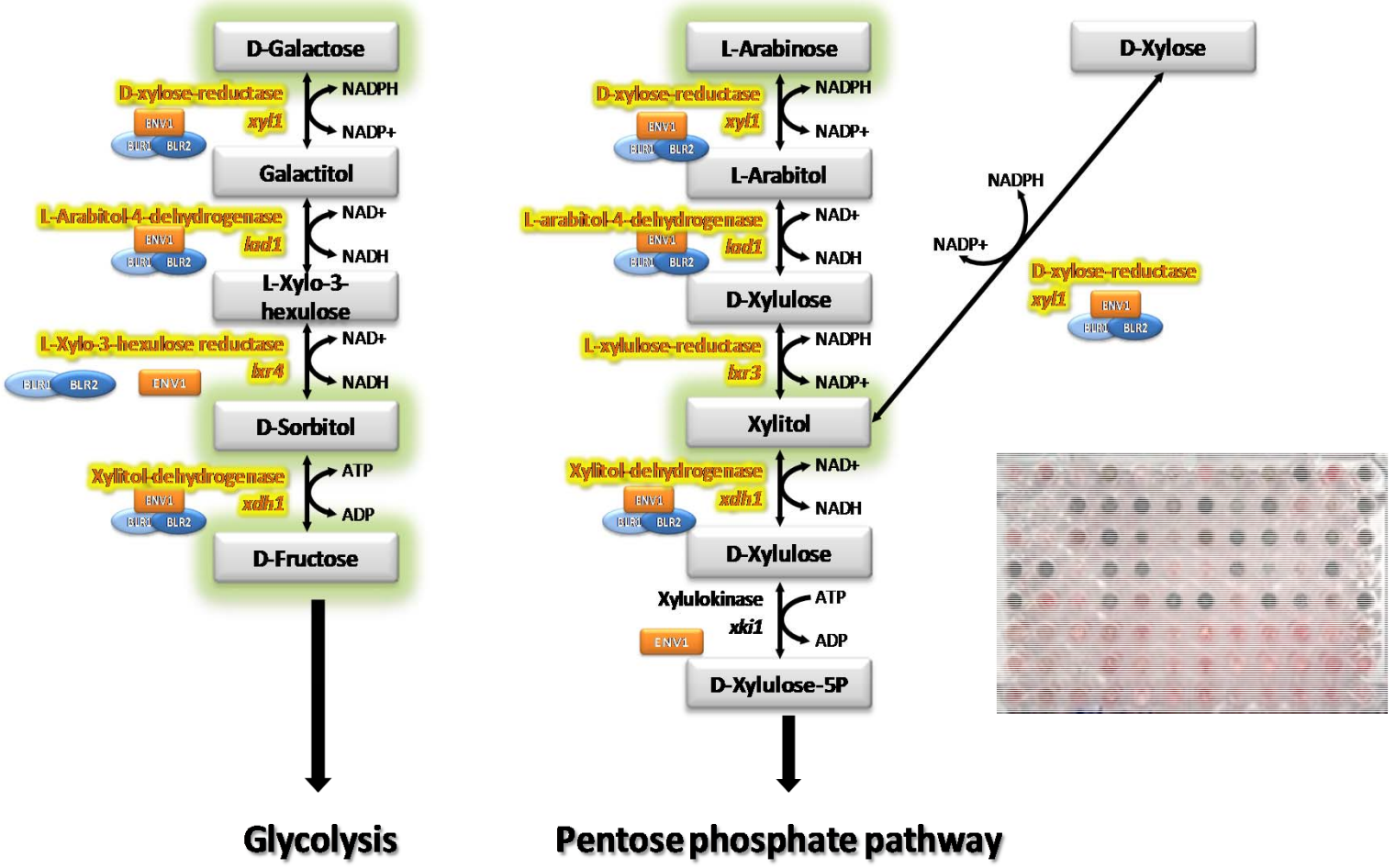
AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

Rotation of earth – night and day
Requirement for nutrients and reproduction



Competition in the ecological niche
Successful adaptation to a given habitat

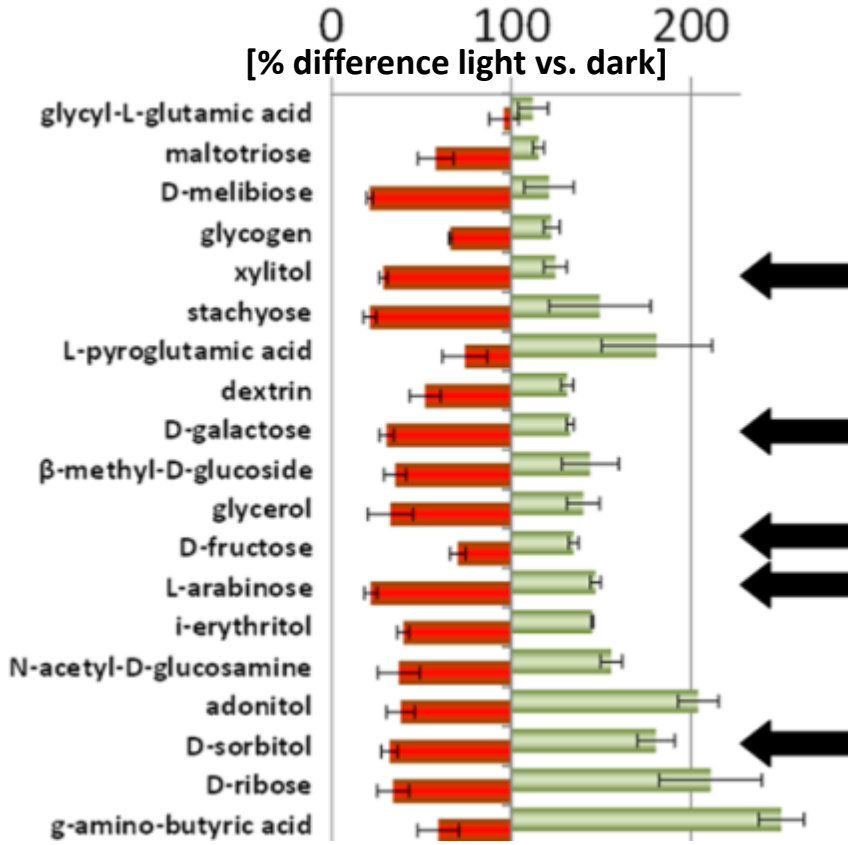
The light signalling machinery influences plant cell wall degradation

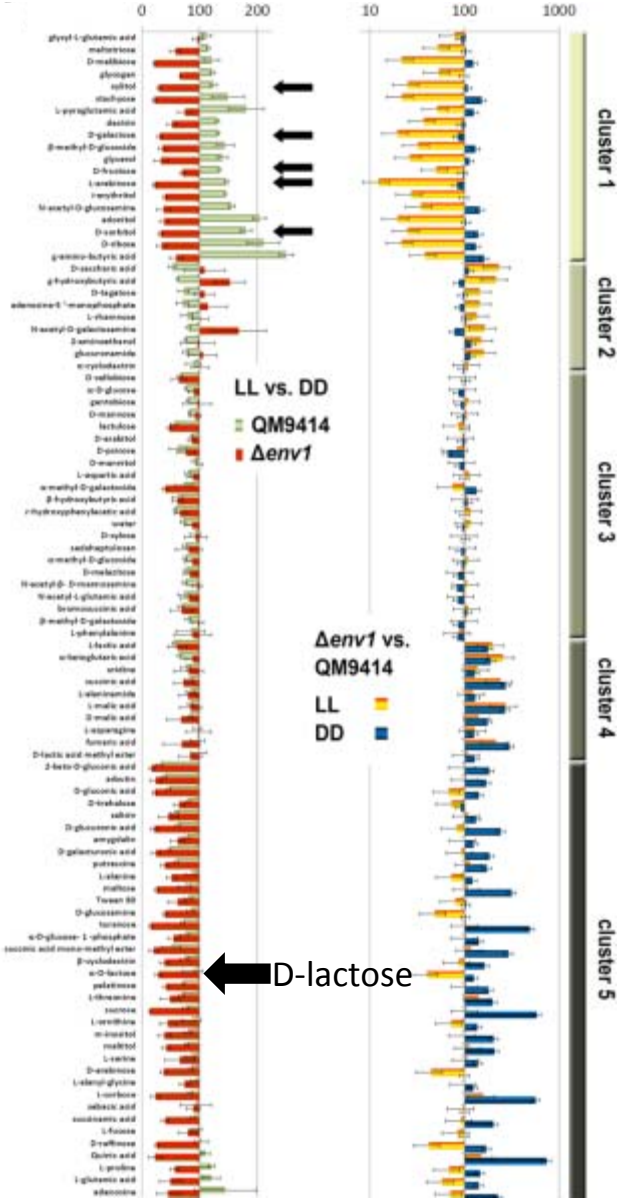


Tisch, D and Schmoll M 2013; Targets of light signalling in *Trichoderma reesei*; BMC Genomics, 14:657

The light signalling machinery influences plant cell wall degradation

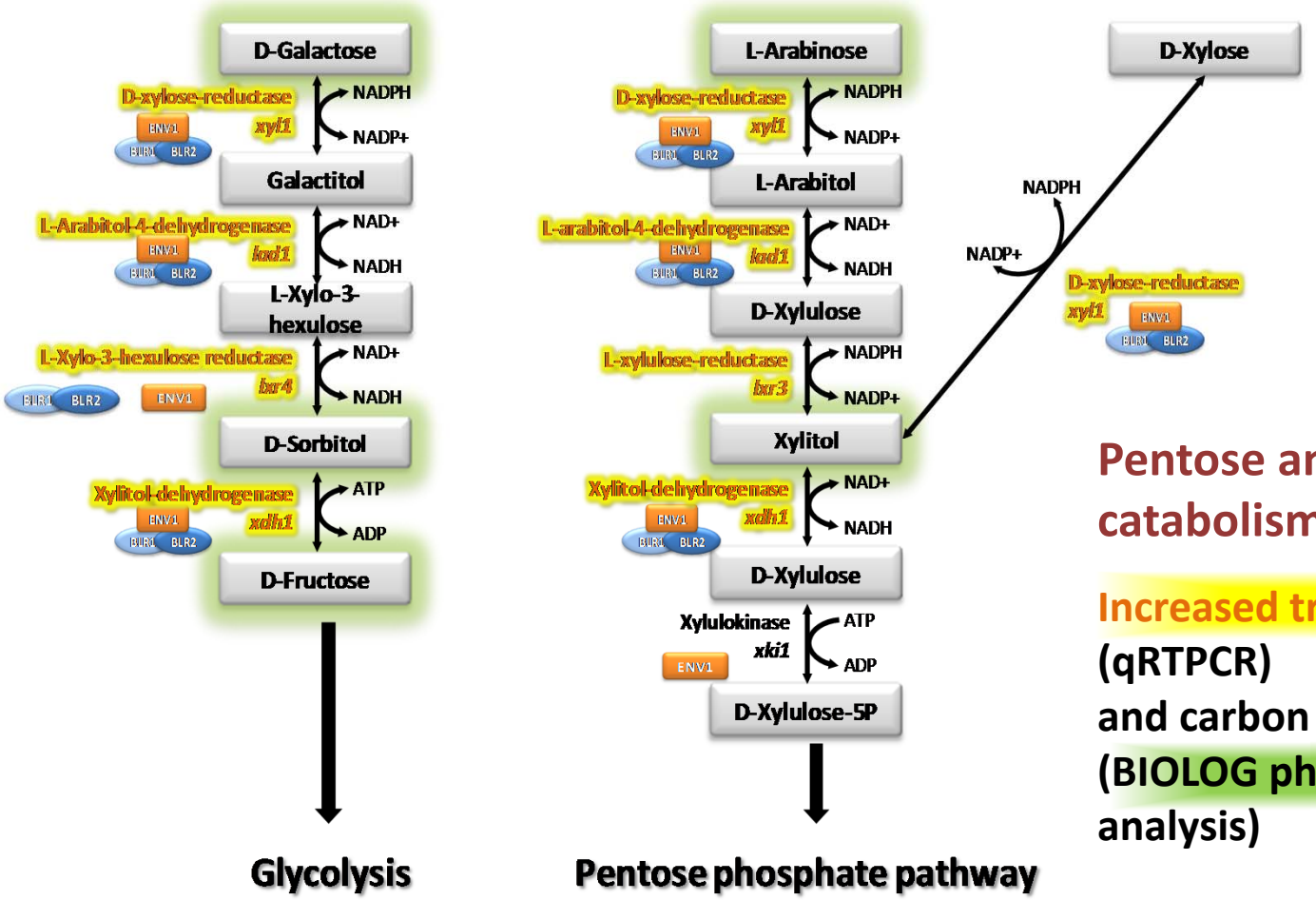
AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY





Tisch and Schmoll, 2013, BMC Genomics 14:657

The light signalling machinery influences plant cell wall degradation



Pentose and D-galactose catabolism in light

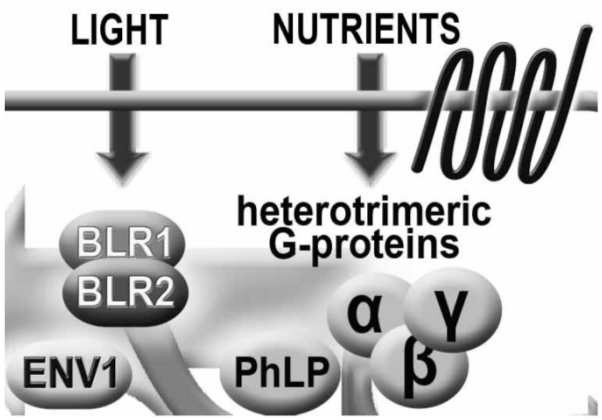
Increased transcript levels (qRTPCR) and carbon utilization (BIOLOG phenotype analysis)

Transcript levels of all highlighted enzymes are positively influenced by light.
xyl1, *lad1*, *xdh1* are targets of BLR1-BLR2-ENV1 in light, *lxr4* is a target of BLR1-BLR2, but is controversially regulated in dependence of ENV1. *lxr3* is influenced by light but most probably not via BLR1-BLR2 or ENV1 in light, but is a target of ENV1 in darkness. *xki1* is a target of ENV1 in light.

Gene regulation patterns on different carbon sources and in mutants

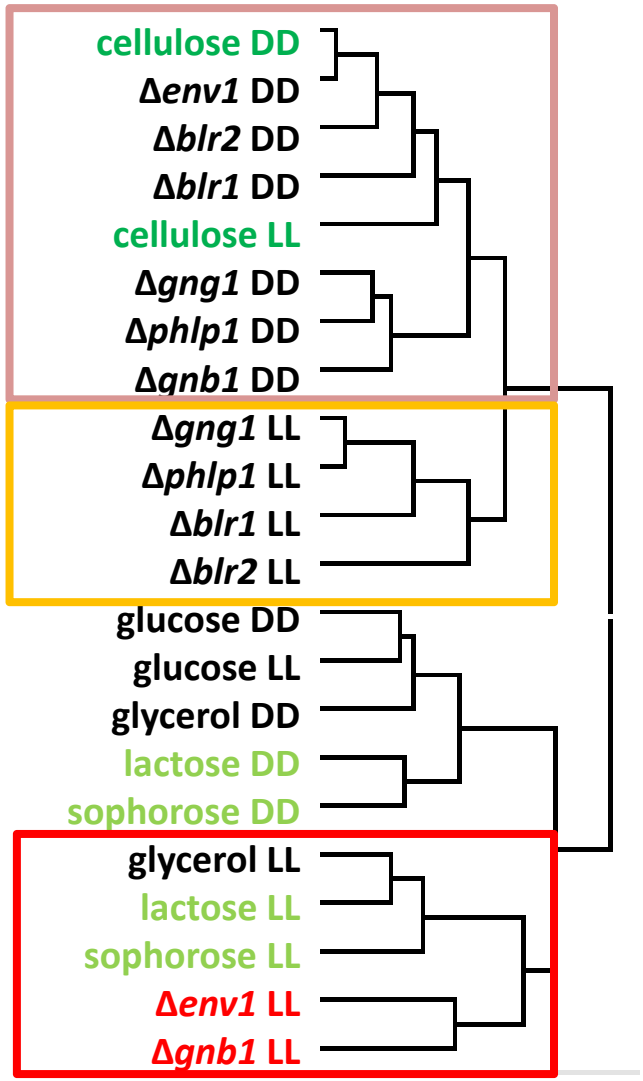
AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

SENSING
G-PROTEIN COUPLED RECEPTORS



Is there a difference in sensing?

How similar are the transcript patterns of G-protein coupled receptors?



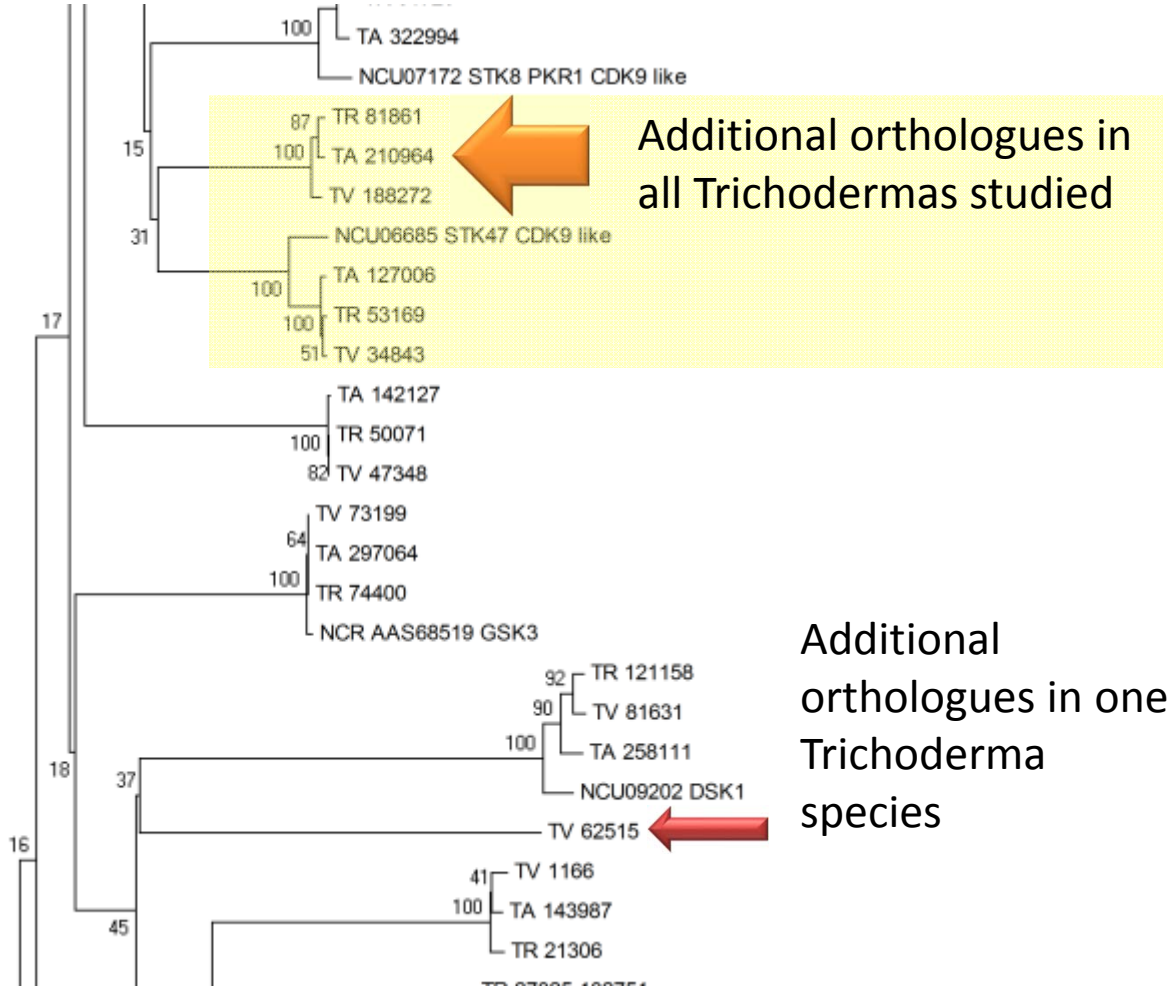
Transcriptome analysis of *T. reesei* under different conditions and **hierarchical clustering**

cellulose specific transcript patterns of GPCRs lost in Δ*env1* LL and Δ*gnb1* LL

Signaling and the genome of fungi

AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

CMGC kinases – an example for the „currency of signaling“



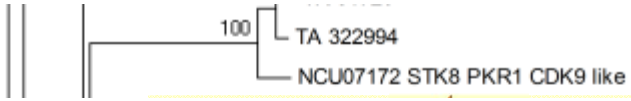
Additional orthologues in all Trichodermas studied

Additional orthologues in one Trichoderma species

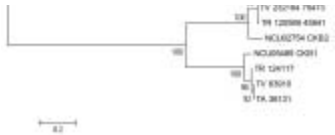
Schmoll et al., 2016 The genomes of three uneven siblings – footprints of the lifestyle of three Trichoderma species, MMBR, *in revision*

Signaling and the genome of fungi

CMGC kinases – an example for the „currency of signaling“



Construction of a *T. reesei* knock-out library in progress:
Protein kinases
Protein phosphatases
G-protein coupled receptors



Schmoll et al., 2016 The genomes of three uneven siblings – footprints of the lifestyle of three Trichoderma species, MMBR, *in revision*

Heterotrimeric G-protein signaling in *Trichoderma reesei*

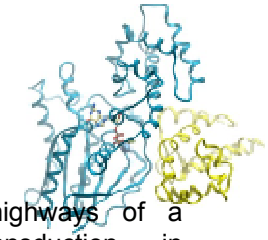
3 G-alpha subunits
1 G-beta subunit
1 G-gamma subunit

complex regulation of G-protein signaling:
2 **Phosducin** like proteins

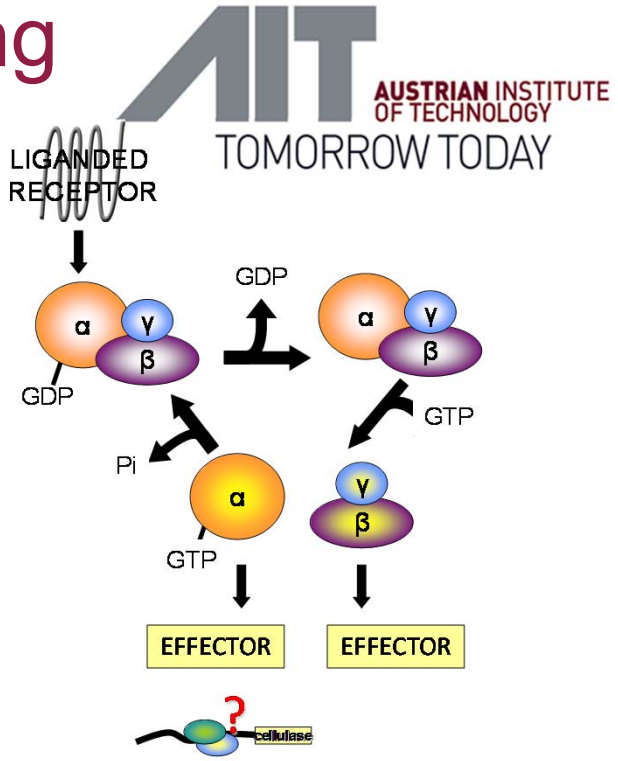
4 **Regulators of G-protein signaling** (RGS)
3 GprK-type GPCRs containing RGS domains

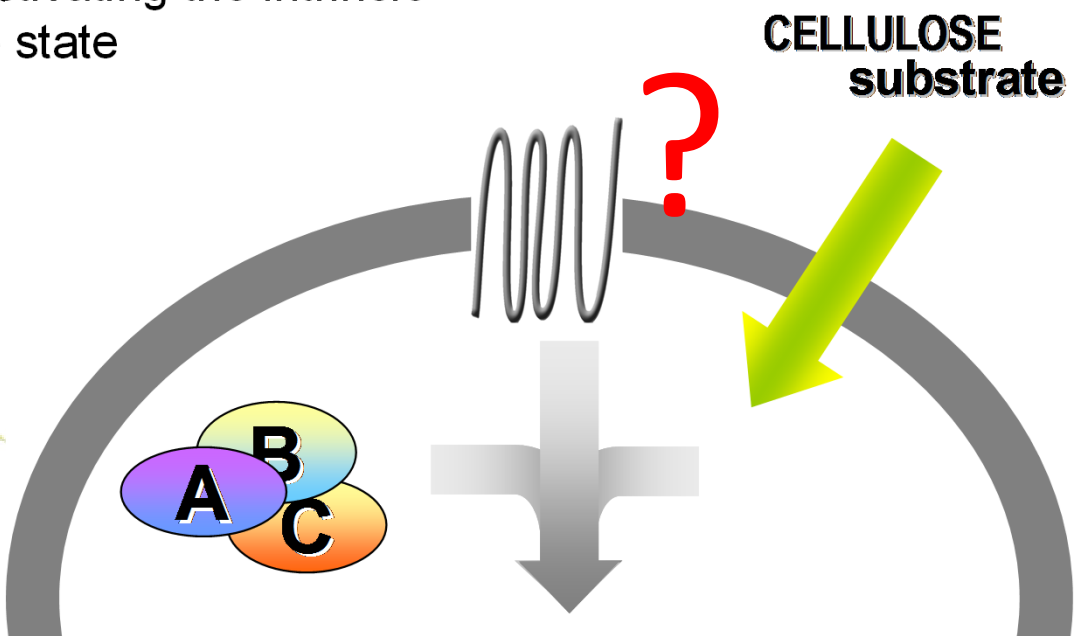
RGS-proteins terminate signals by activating the intrinsic GTPase domain ➔ return to inactive state

the expected carbon sensor GPCR characterized in *Neurospora* was not detected!

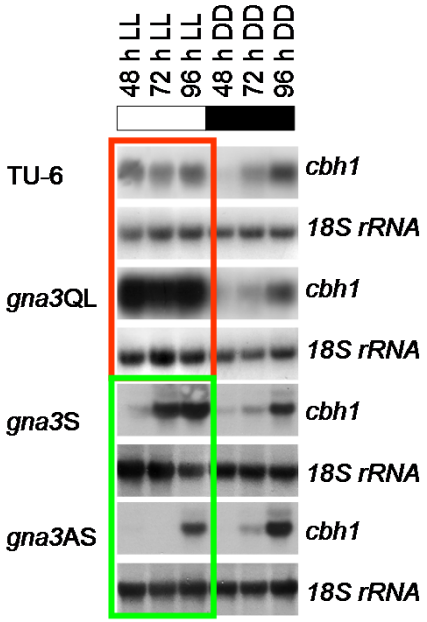


Schmoll, M. (2008) The information highways of a biotechnological workhorse--signal transduction in *Hypocrea jecorina*. *BMC Genomics* 9, 430.





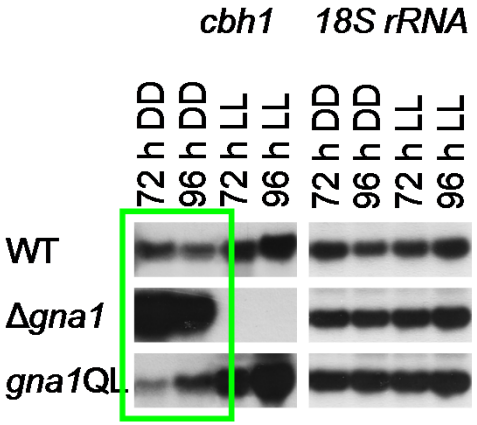
Heterotrimeric G-protein signaling in *Trichoderma reesei*



Schmoll M, Schuster A, Silva RdN and Kubicek CP. (2009). Eukaryot Cell, Mar 8 (3): 410 - 20

Constitutive activation of the G-alpha protein

increased transcript levels of *cbh1* in constant light upon growth on cellulose



strong upregulation of *cbh1* transcript upon deletion of *gna1*

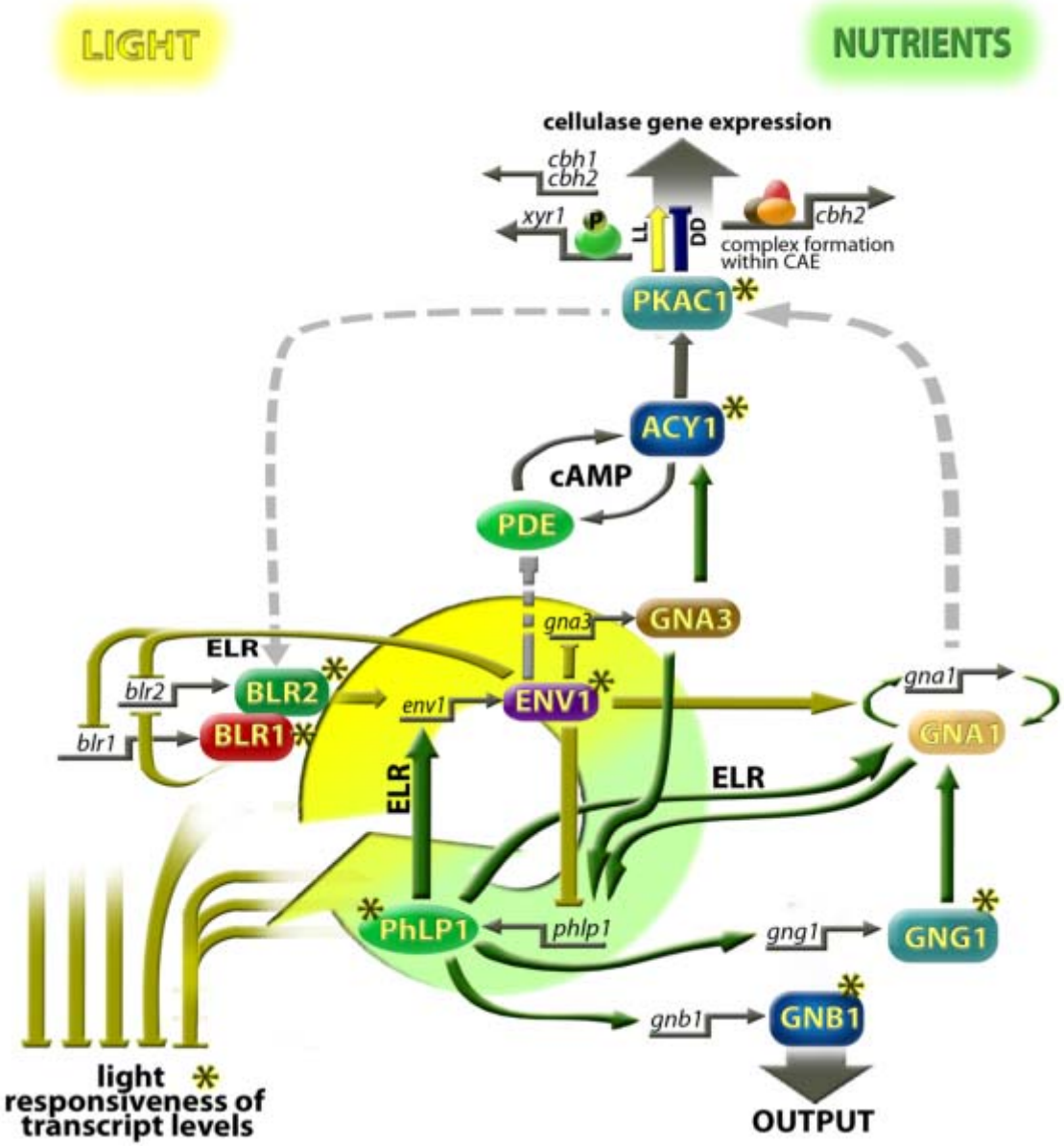
Seibel, C., et al. (2009) BMC Biology 7,58

The G-α proteins GNA1 and GNA3 are involved in light-dependent cellulase gene regulation

No inducer independent cellulase expression
GNA1 and GNA3 do not transmit the cellulose signal

The integrated signalling network

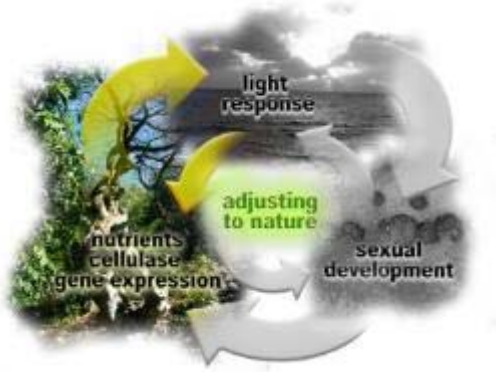
AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

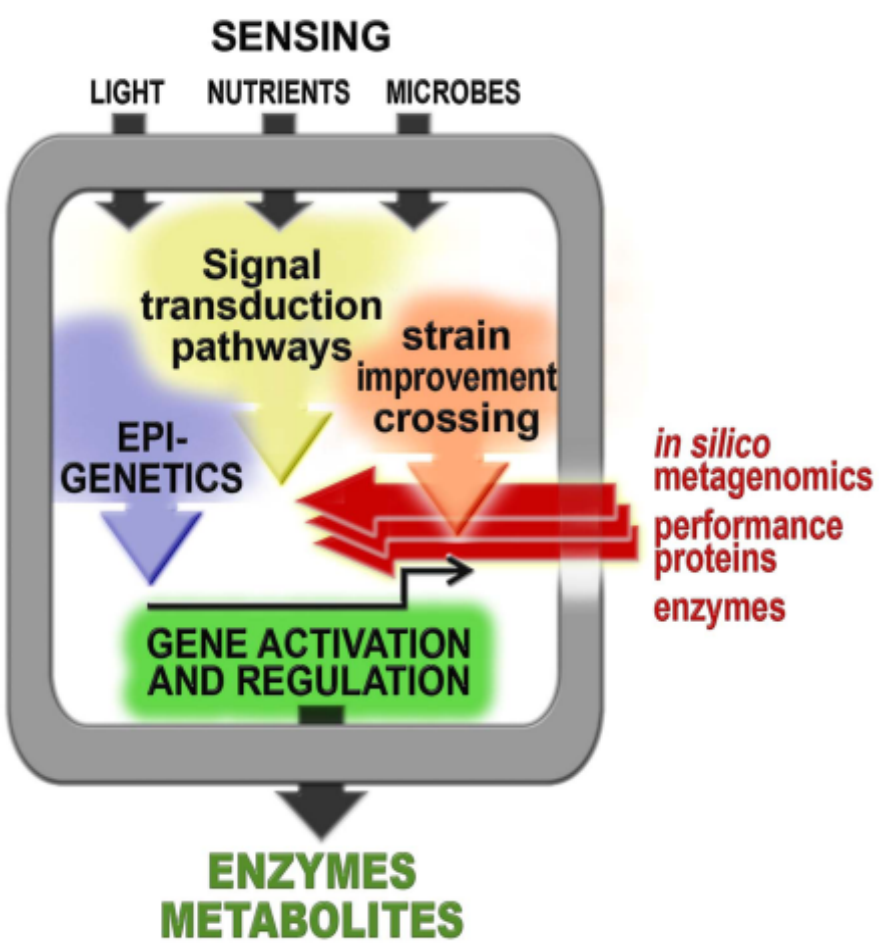


Light response
(BLR1, BLR2, ENV1)

and **nutrient signalling**
(heterotrimeric G-proteins,
cAMP pathway)

are interconnected





Understanding plant – fungus interactions for a sustainable future in agriculture

AUSTRIAN INSTITUTE OF TECHNOLOGY

your ingenious partner

Monika Schmoll, PhD, habil
monika.schmoll@ait.ac.at