Plant microbiomes:

Hidden networks for biological plant protection

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Our Mission

AMBITION:
Microbial diversity for health

Our overall objective is to understand plant-microbiome interactions to improve human and ecosytems health

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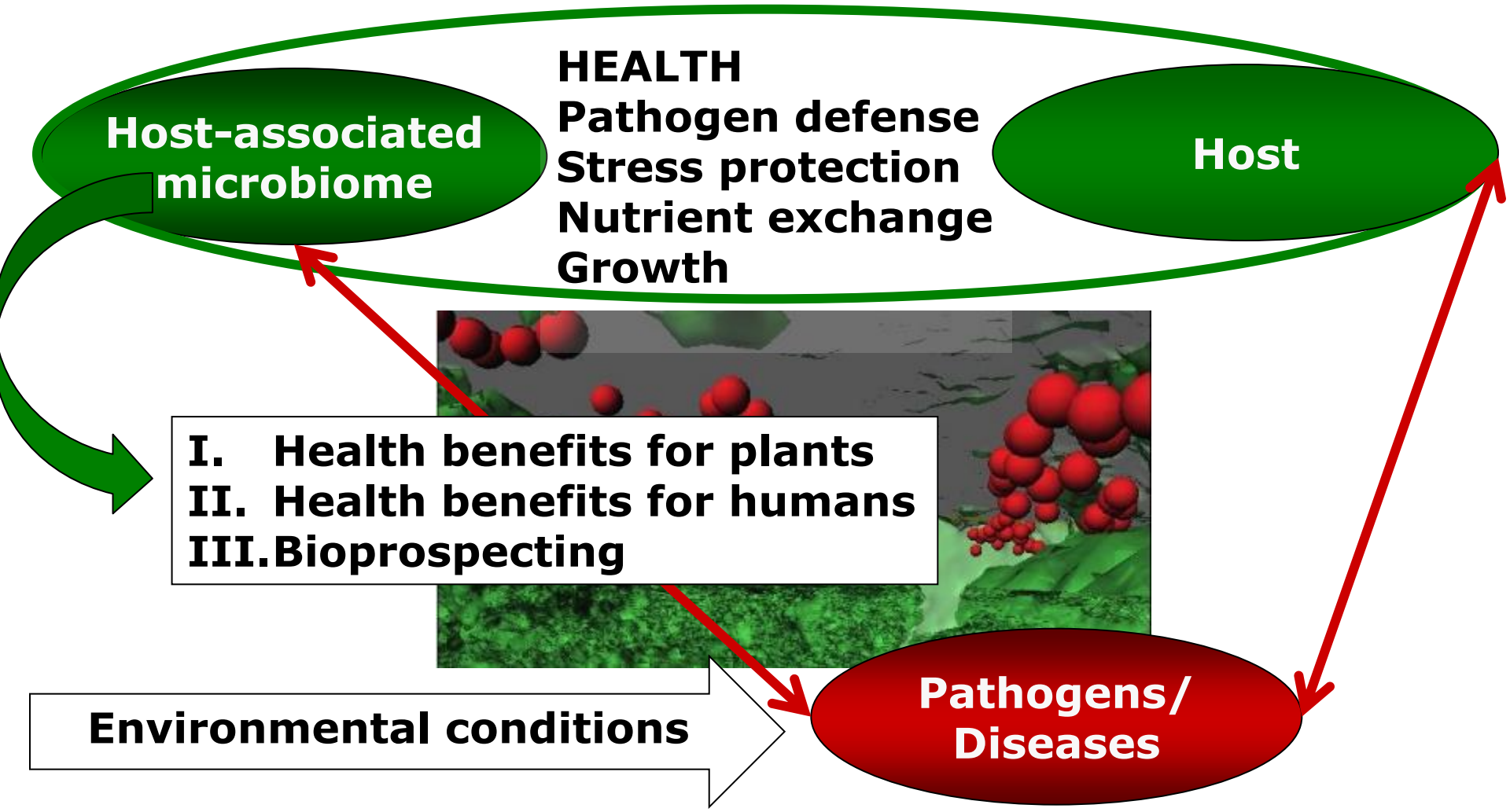
Holobionts and hologenomes are biological units



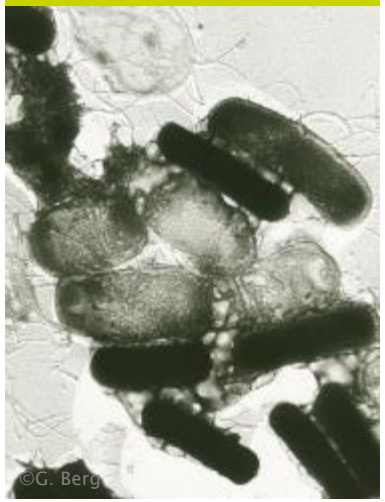
[Berg *et al.* Front.Microbiol. 2015; Berg *et al*. J. Exp. Botany 2015]

I. Health benefits for plants

Model plants and crops

Threats to agriculture

Pathogens



Salinity

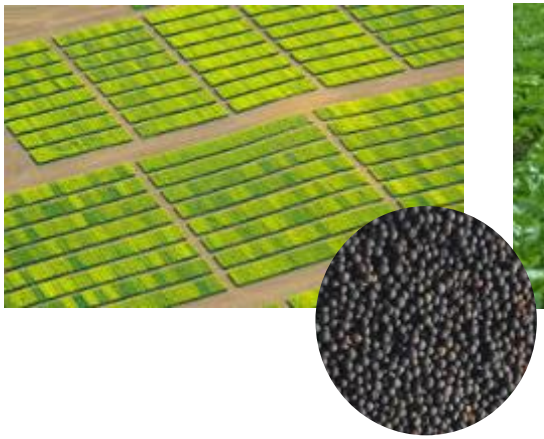
Cold

Drought

Diversity of crop varieties and microbiomes

Lettuce

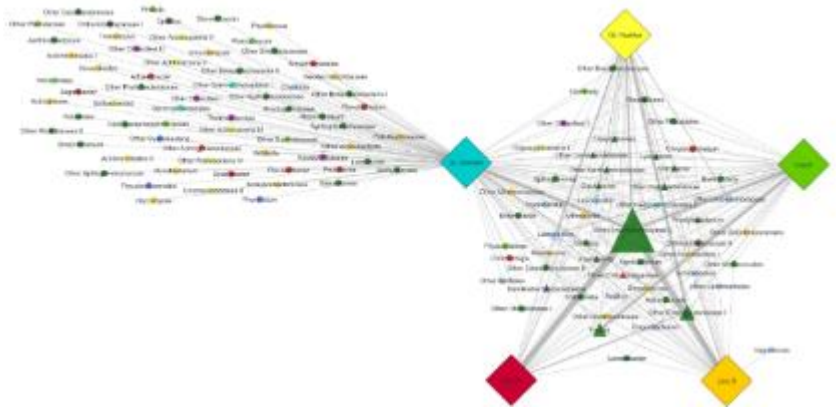
Oilseed rape



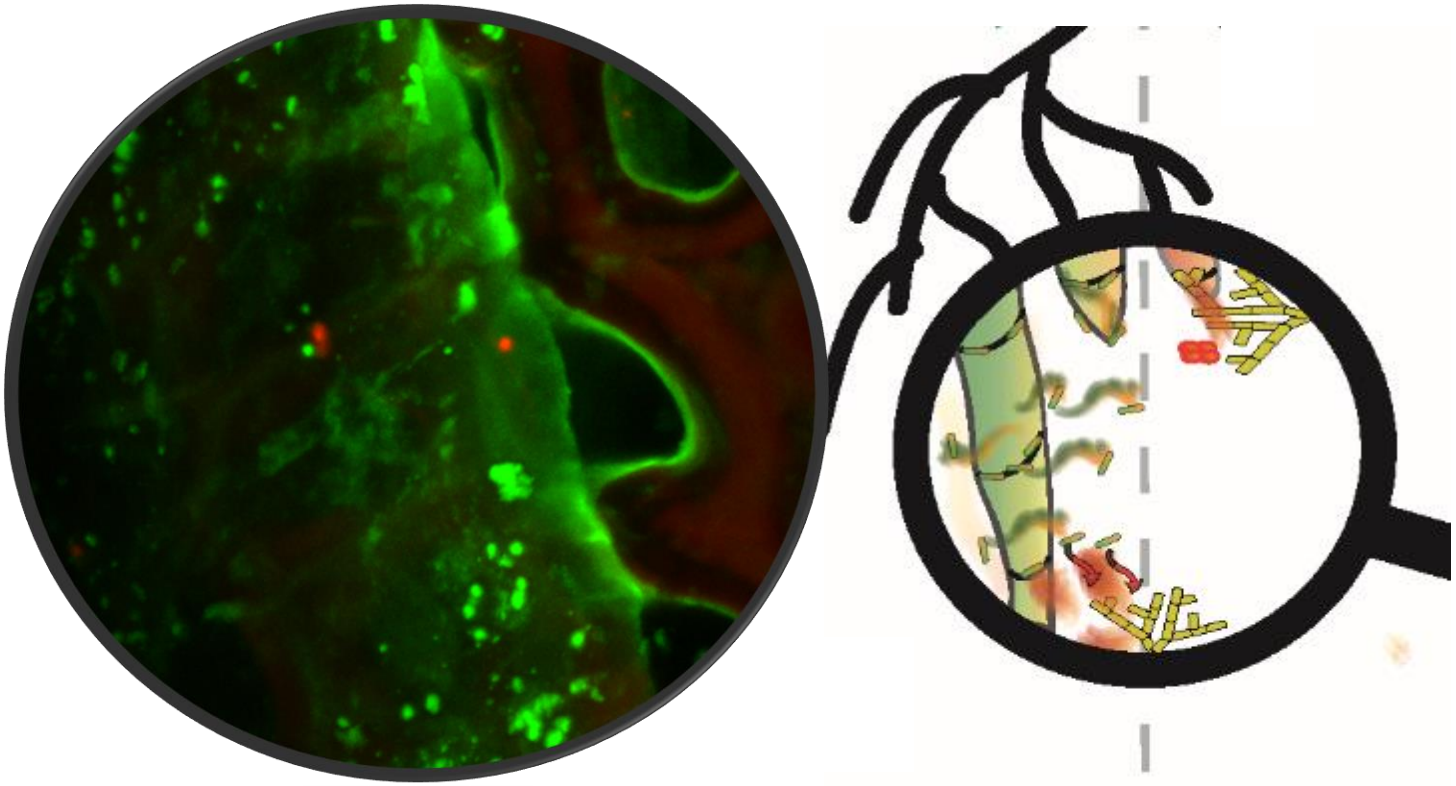
Sugar beet

Styrian Oilseed pumpkin

- Breeding affects the plant microbiome
- Significant differences between varieties
- Correlates with performance and resistences



Novel insights into the seed microbiome



BIOCOMES
New biological control products
for sustainable farming and forestr

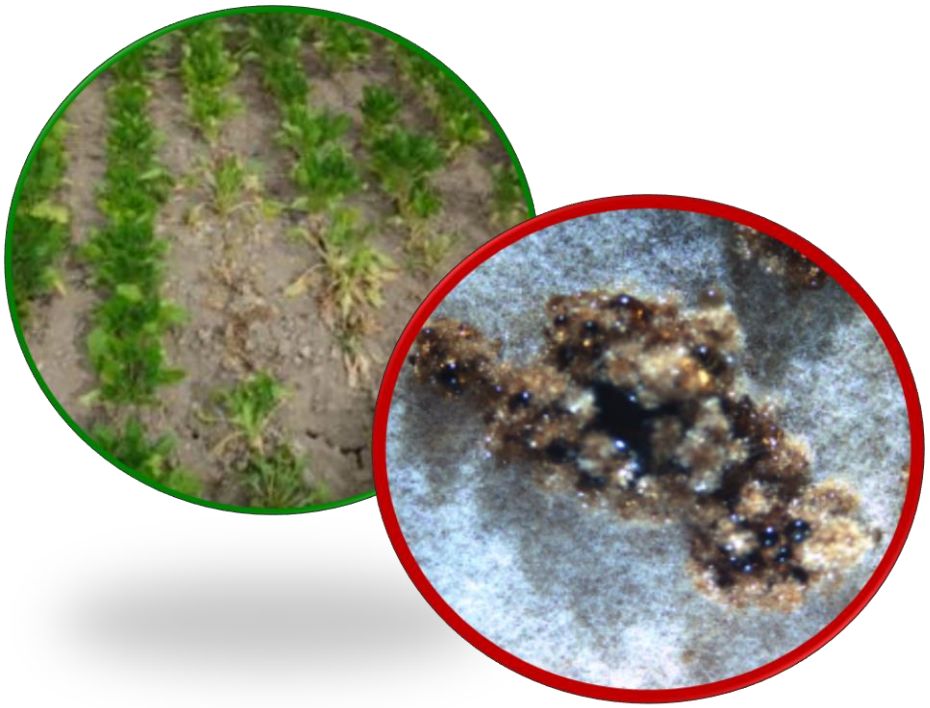
BestPass

MARIE CURIE ACTIONS

acib

FFG

Seeds transmit a core microbiome



Oilseed Rape
- ***Verticillium longisporum***
- ***Serratia & Paenibacillus***

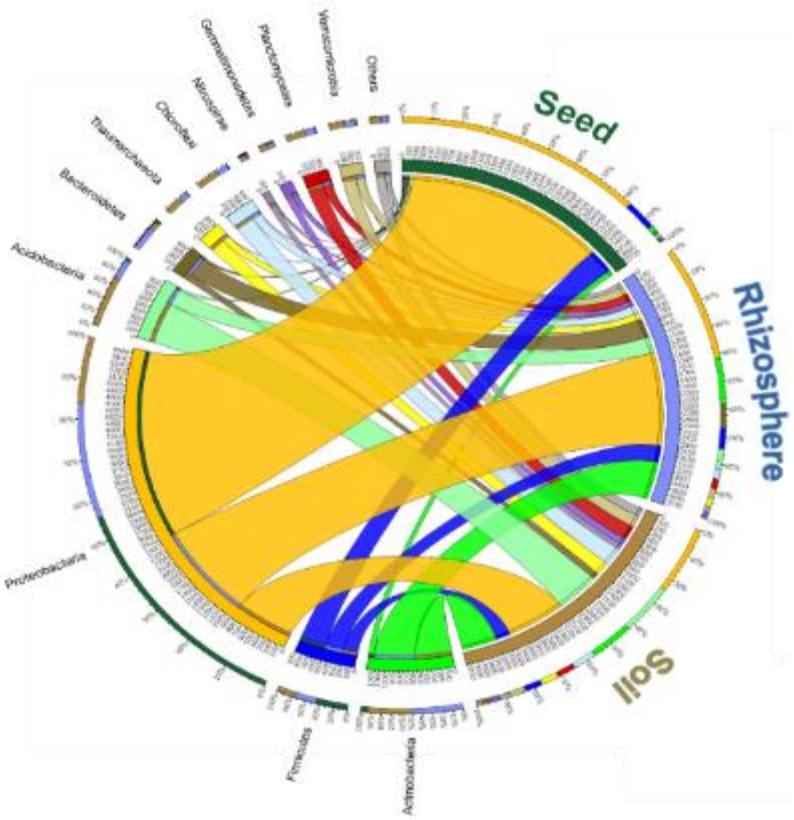
Sugar beet
- ***Rhizoctonia solani***
- ***Pseudomonas poae***

The microbiome correlates with resistance

[Rybakova *et al*. Microbiome 2017, Zachow *et al.,* unpublished data]

The seed microbiota was shaped by breeding

Type	Denomination	Pedigree	Geographic origin	Seed samples
Homozygous inbred lines	Line A - D	-	Austria	
Single cross hybrid	Gleisdorfer Diamant	Line A x Line B	Austria	
Three-way cross hybrids	GL Opal GL Rustikal	Gl. Diamant x Line C Gl. Diamant x Line D	Austria	
Population cultivar	GL Classic	-	Austria	
Single cross zucchini hybrid	Naxos	-	Netherlands	
Segregating breeding lines	Line E – I	-	Germany, Slovenia, China	

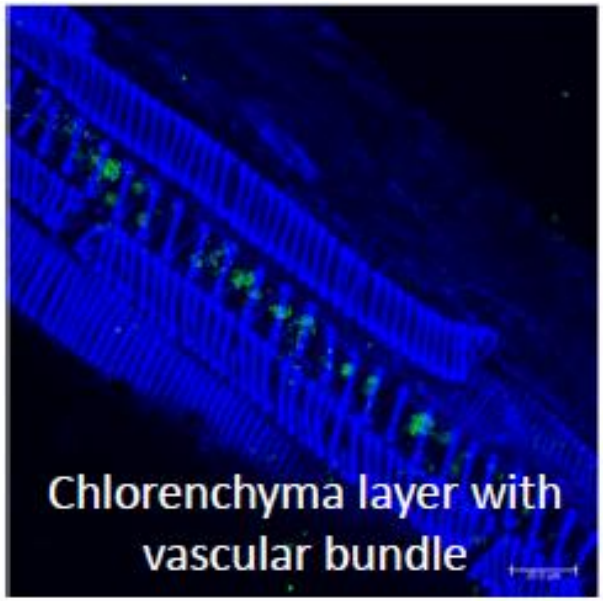


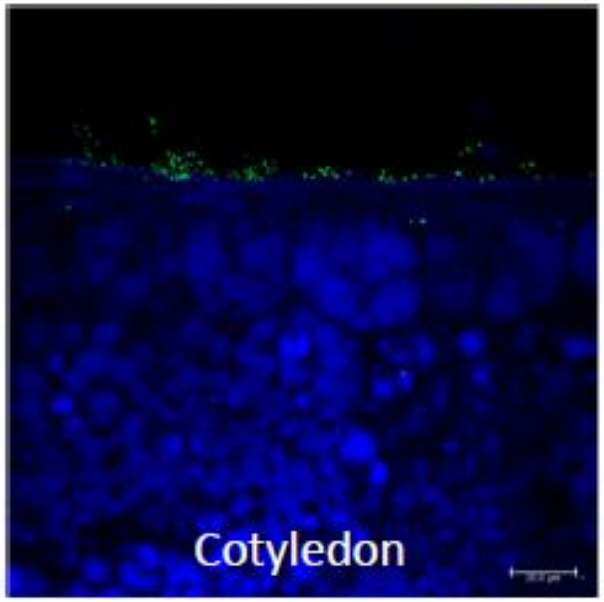
Oilseed pumpkin

- ***Erwinia carotovora***
  Enterobacteriaceae

[Adam *et al.* Plant and Soil 2016]

CONCLUSIONS I



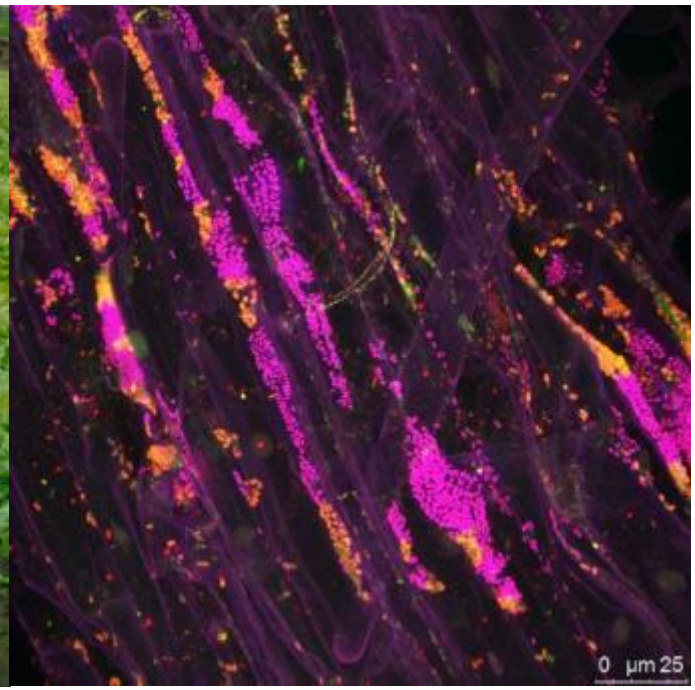


The seed microbiome was shaped by breeding.

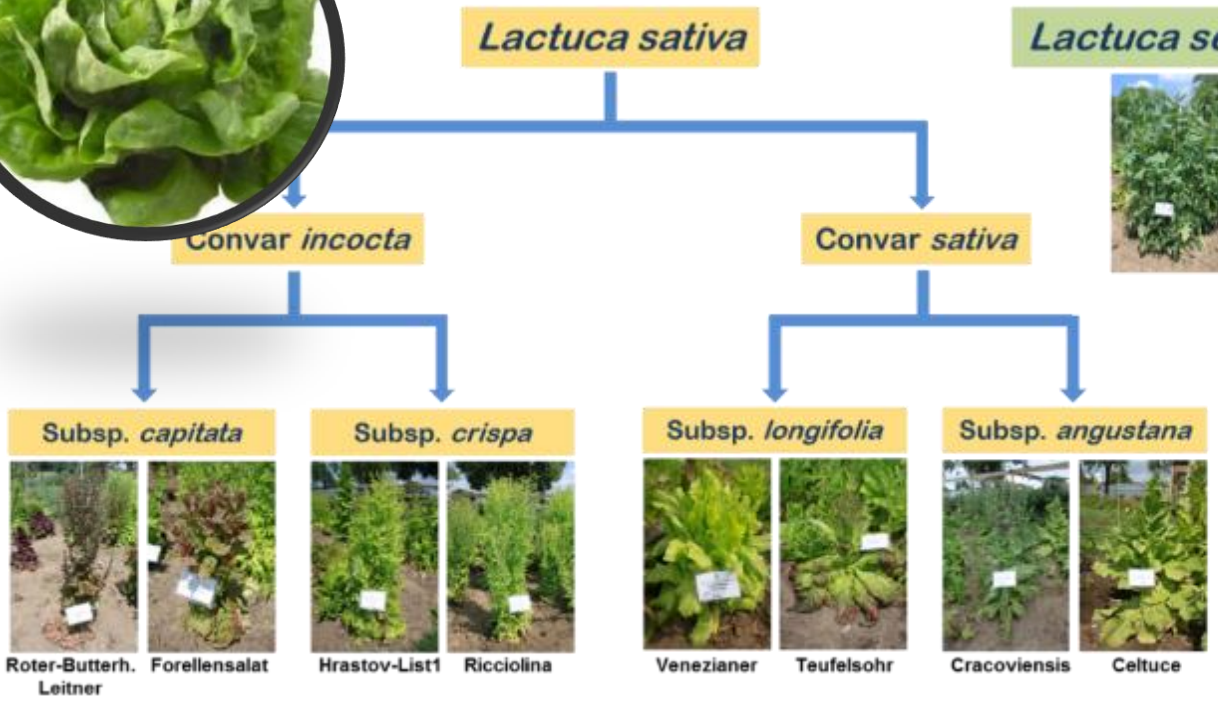
A healthy seed microbiome is:

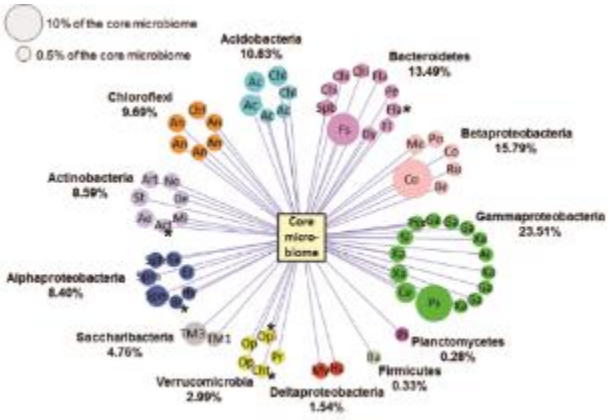
- ✓ **Highly diverse, rich and evenly structured**
- ✓ **Contain bacteria, archaea & fungi**
- ✓ **Contain microorganisms known for beneficial as well as for pathogenic interaction**
- ✓ **pathogen specific**
- ✓ **cultivar specific**

Phyllosphere microbiome
The lettuce project



Lettuce: The network for health

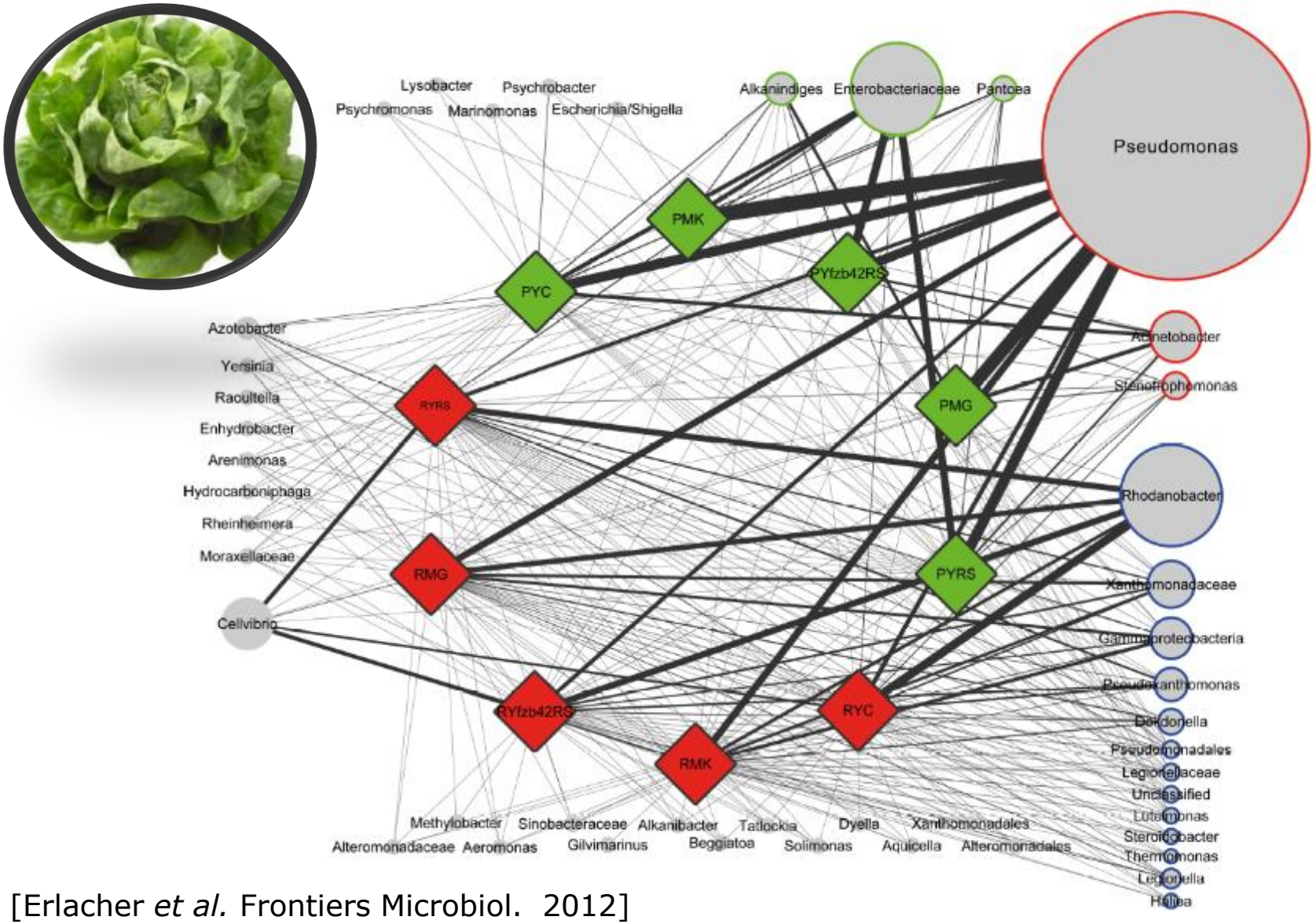




- significant differences at species and cultivar level
- 12.5% cultivar-specific bacteria; 49% core microbiome

Domestication (breeding) lead to bacterial diversification in lettuce root system.

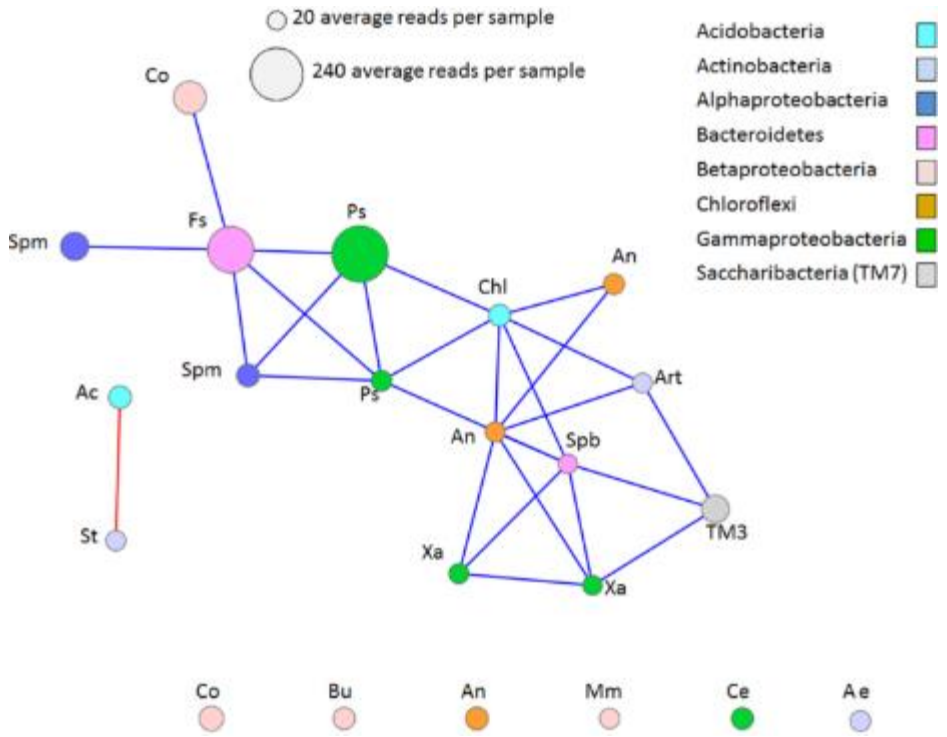
Lettuce: The network for health



[Erlacher *et al.* Frontiers Microbiol. 2012]

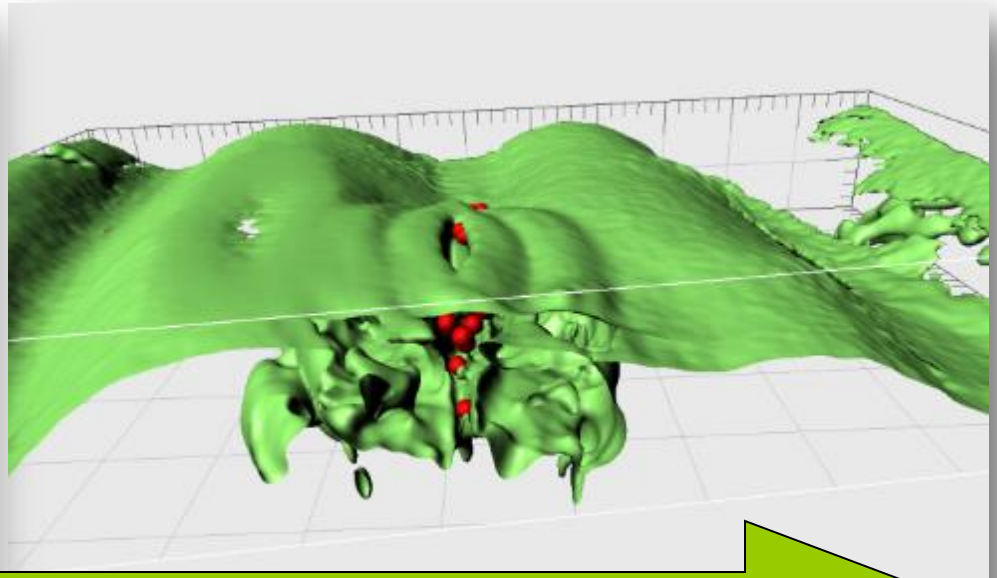
***Acinetobacter* and *Alkanindiges* are indicators of healthy plants**

Lettuce: The network for health

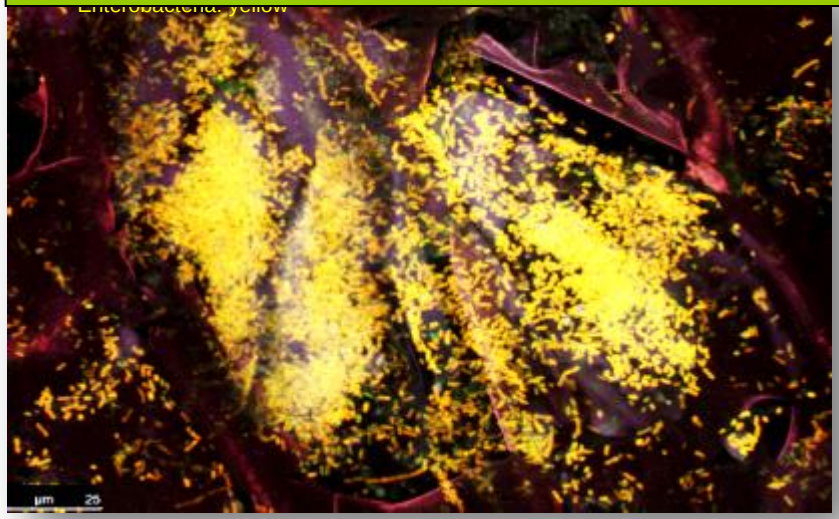


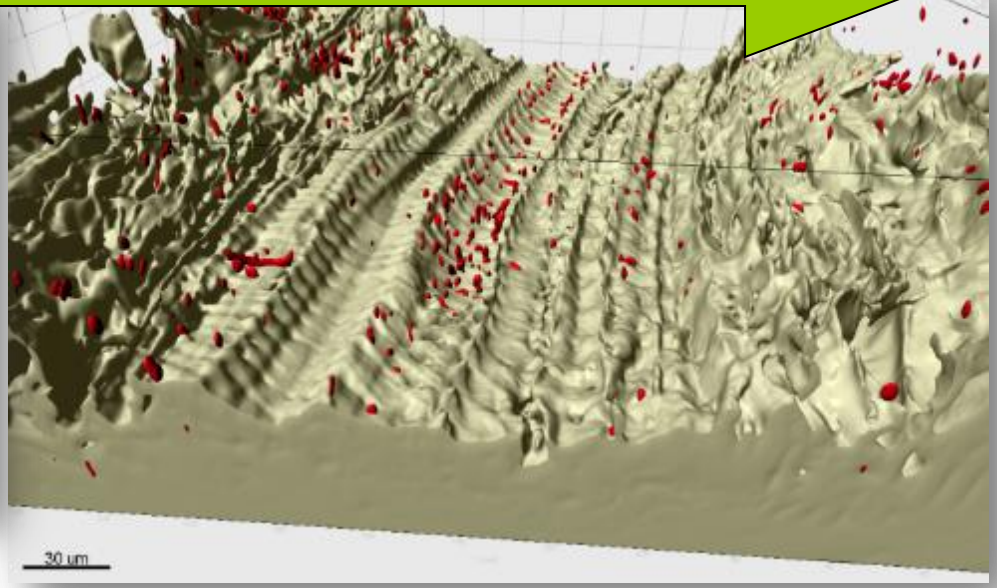
- **Loose network structure was observed – health relevant**
  - Susceptibility to pathogens?
  - Good establishment of
  - Biocontrol agents?

Vizualizing the lettuce microbiome



Natural vaccination by endophytes?



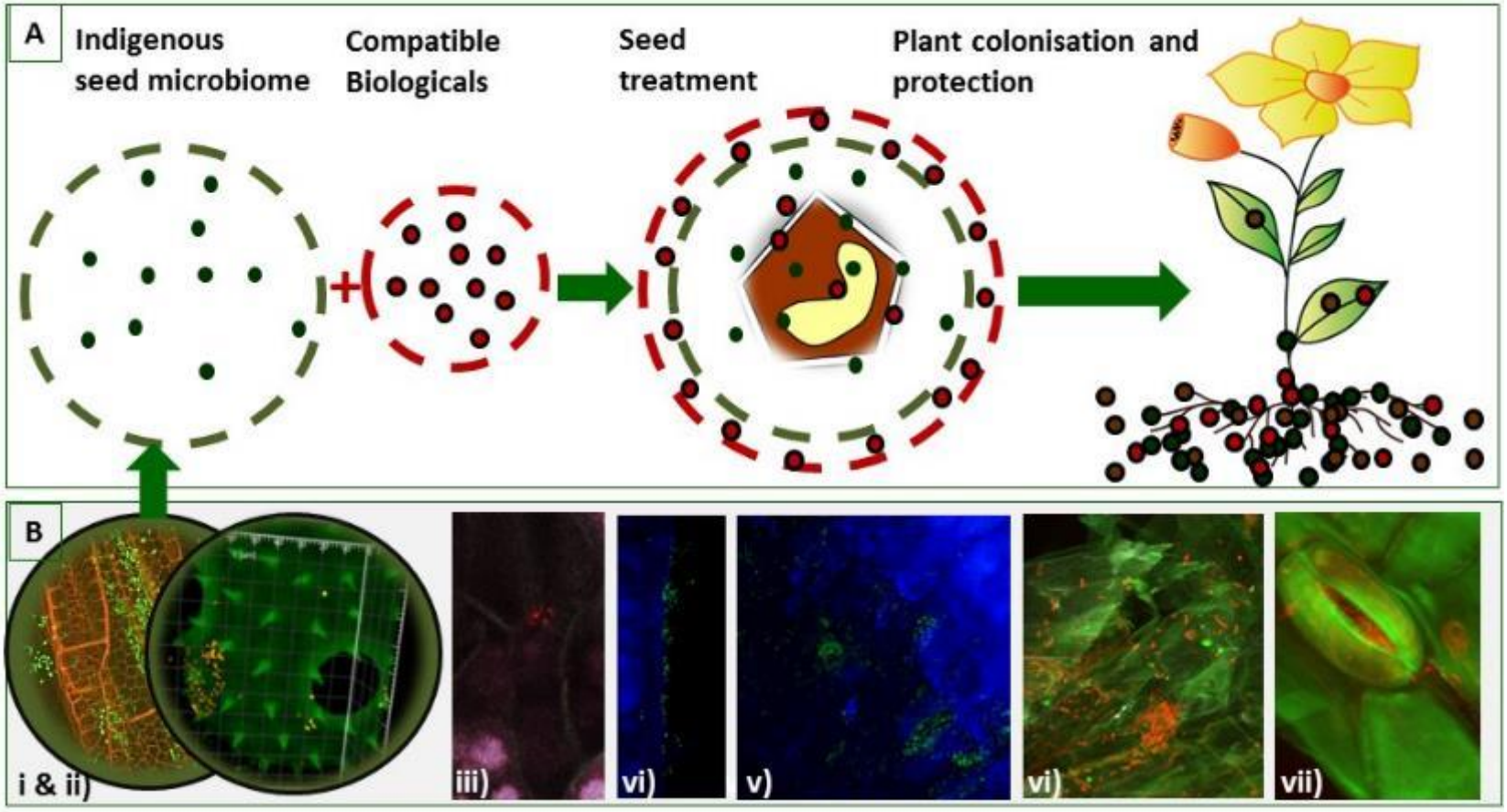


Can we design a healthy microbiome?

✓ **Targeted studies of plant traits + plant microbiomes**

IMPLICATIONS I – BIOCONTROL/BREEDING

- ✓ **Targeted complementation of plant traits + biologicals**
- ✓ **Targeted breeding and biocontrol strategies**

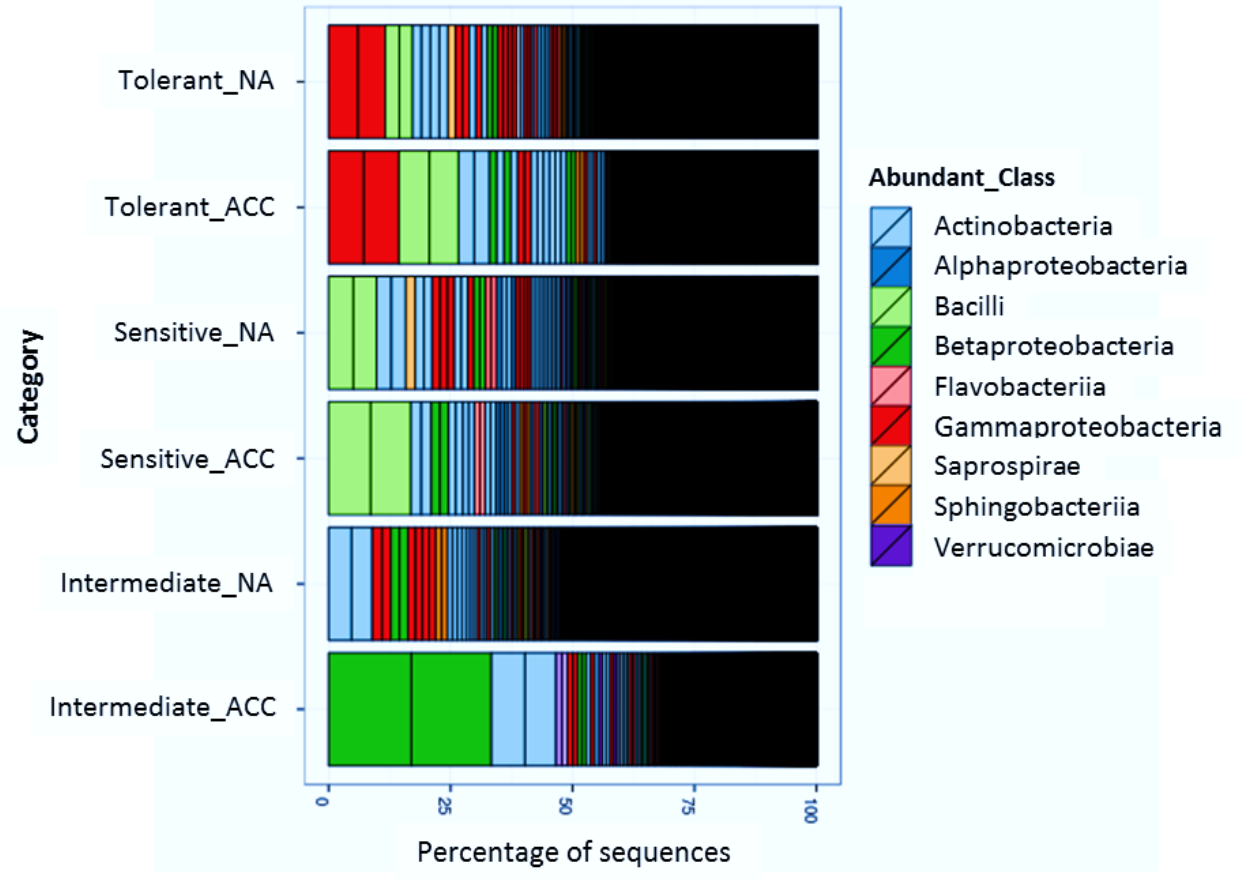


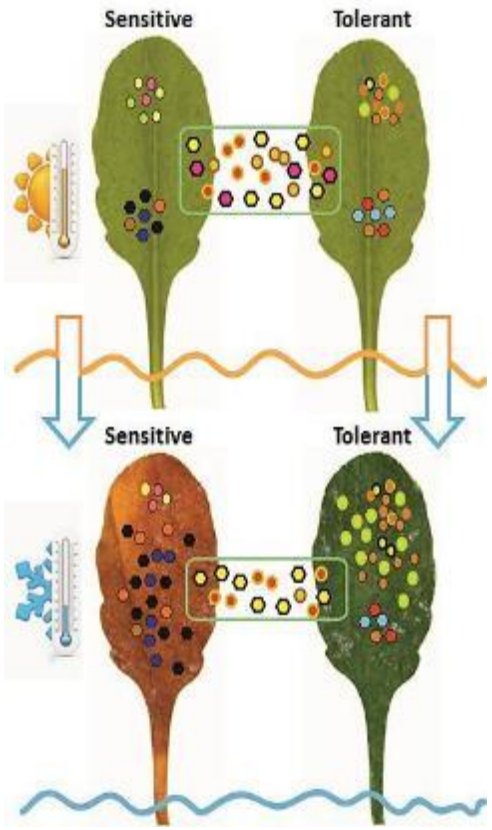
[Berg & Raaijmakers, ISME J 2018]

Microbial stress protection

Bacterial anti-freezing agents

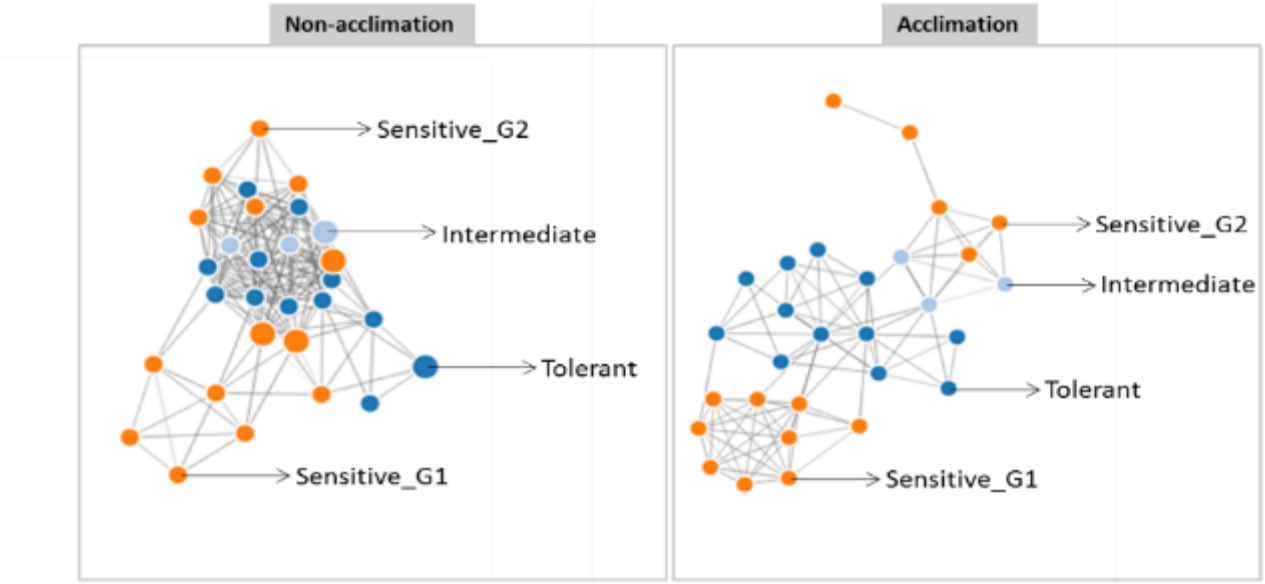
Cold acclimation in *Arabidopsis thaliana* ecotypes





- **During cold acclimation microbiome composition and diversity as well as the core changed drastically.**
- **Each ecotype group was characterized by a specific, statistically significant response to the cold.**
- **We identified also specific and unique bacterial genera in tolerant ecotypes, e.g. *Sphingomonas* and *Buchnera.***

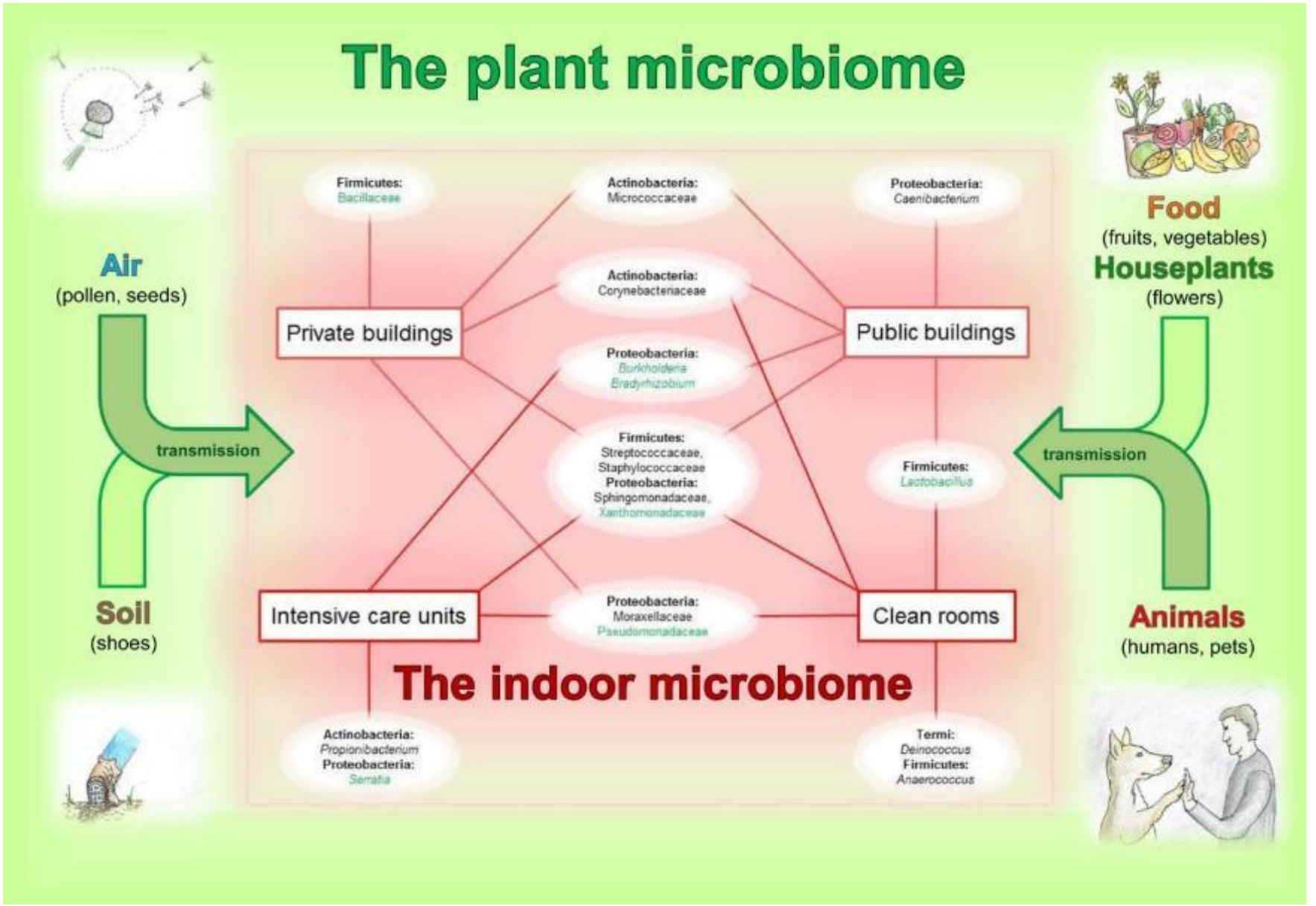
Cold acclimation in *Arabidopsis thaliana* ecotypes



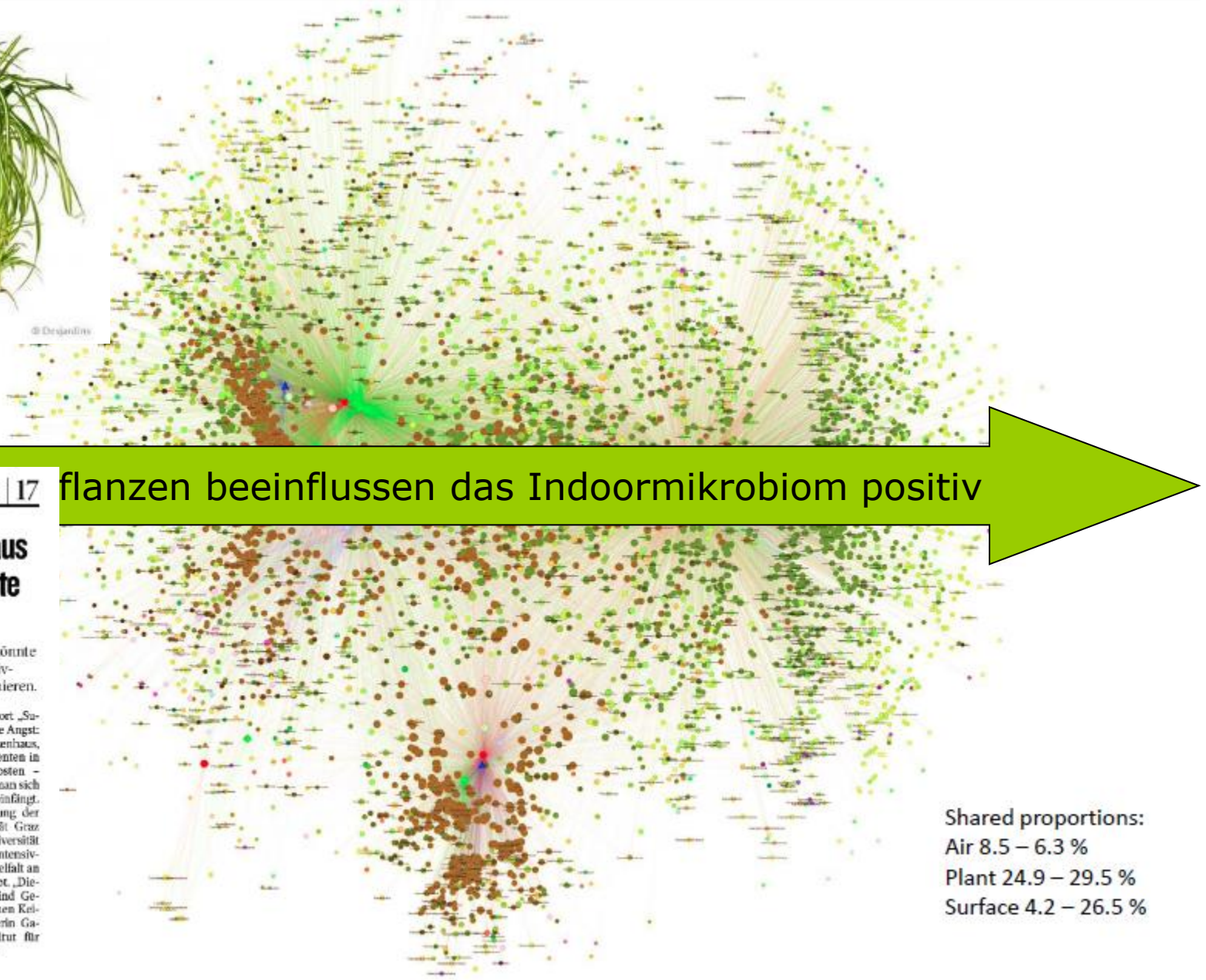
The *Arabidopsis* microbiome project

Mohammad Etemadi
Henry Müller
Dirk Hincha
Ellen Zuther (MPI Golm)

Indoor Microbial diversity and biological control



Indoor Microbial diversity and biological control



flanzen beeinflussen das Indoormikrobiom positiv

STEIERMARK | 17

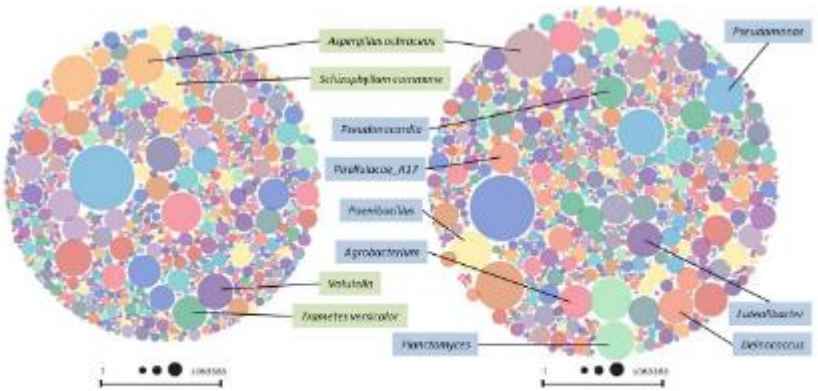
Krankenhaus braucht gute Bakterien

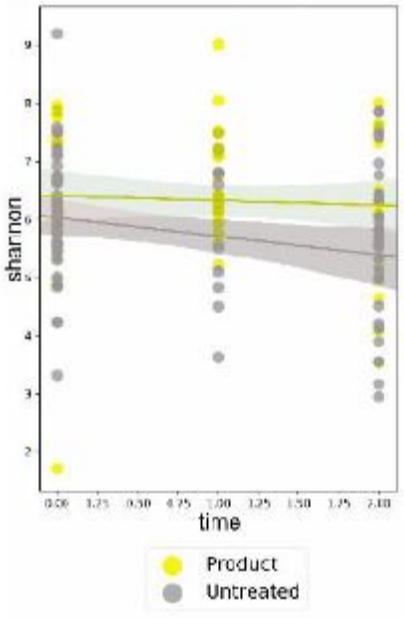
Grazer Forschung könnte Hygiene auf Intensivstationen revolutionieren.

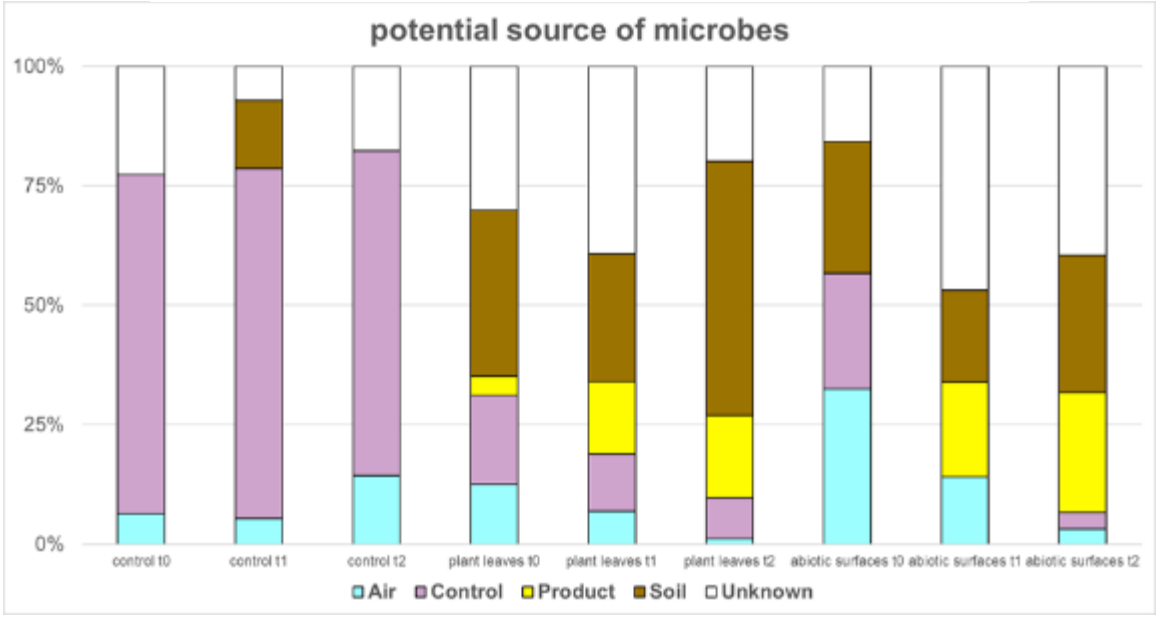
GRAZ. Unter dem Reizwort „Superkeime" verbreiten sie Angst: Keime aus dem Krankenhaus, die jährlich 37.000 Patienten in Europa das Leben kosten – durch Infektionen, die man sich erst im Krankenhaus einfängt. Aber: Eine Untersuchung der Technischen Universität Graz mit der Medizin-Universität Graz zeigt, dass es in Intensivstationen eine große Vielfalt an nützlichen Bakterien gibt. „Diese Mikroorganismen sind Gegenspieler zu gefährlichen Keimen", sagt Projektleiterin Gabriele Berg vom Institut für Umweltbiotechnologie.

Shared proportions:
Air 8.5 – 6.3 %
Plant 24.9 – 29.5 %
Surface 4.2 – 26.5 %

Indoor Microbial diversity and biological control







Individual networks & microbiome connections

Vision: Healthy food for our health

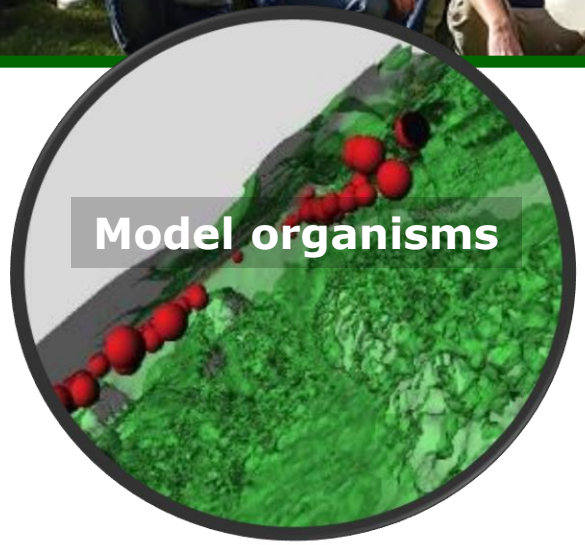
Shared proportions:
Air 8.5 – 6.3 %
Plant 24.9 – 29.5 %
Surface 4.2 – 26.5 %

[**Microbiome connections:** Davis *et al.* Nature 2014; Qian *et al.* Indoor Air 2012; Mahnert *et al.* Frontiers Microbiol 2015]

The power of networking

acib austrian centre of industrial biotechnology

BioTechMed GRAZ



NAWI Graz 10 YEARS

Translation: Start Ups