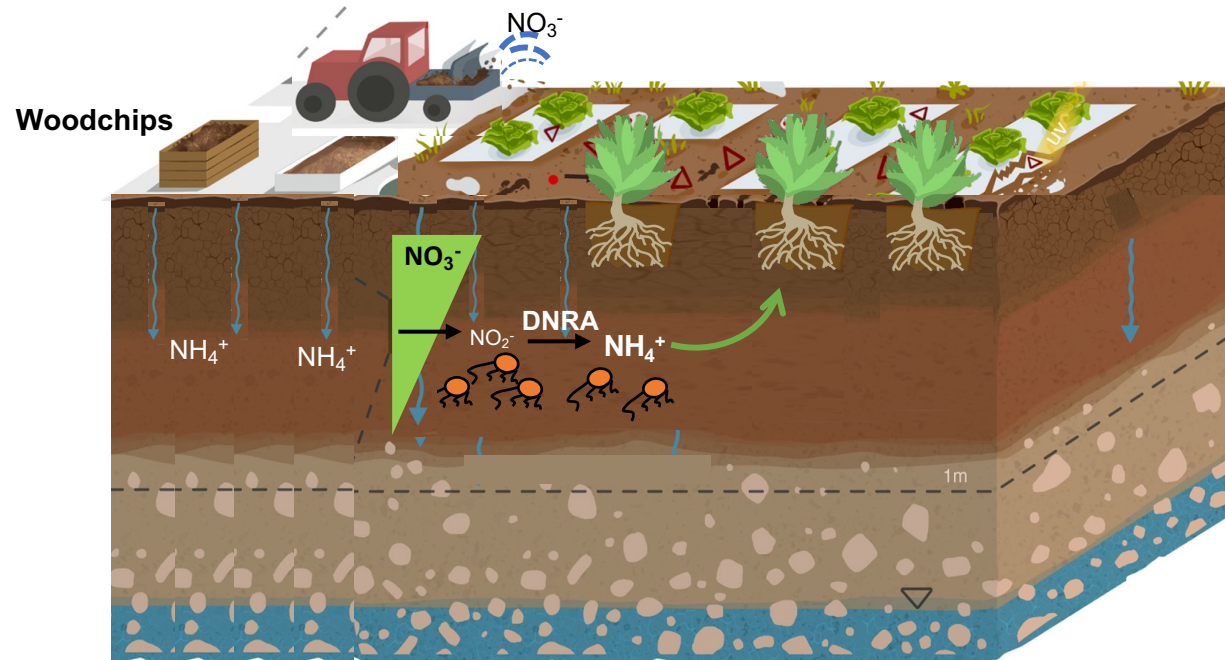


# Dissimilatory Nitrate Reduction to Ammonia by Microbes and their Application in Fertilizer Recovery



Marcela Tabares  
ESPP Fall Symposium  
October 17, 2022

# Nitrate fertilizer leaches into waterways



Water Pollution

# Nitrate fertilizer leaches into waterways



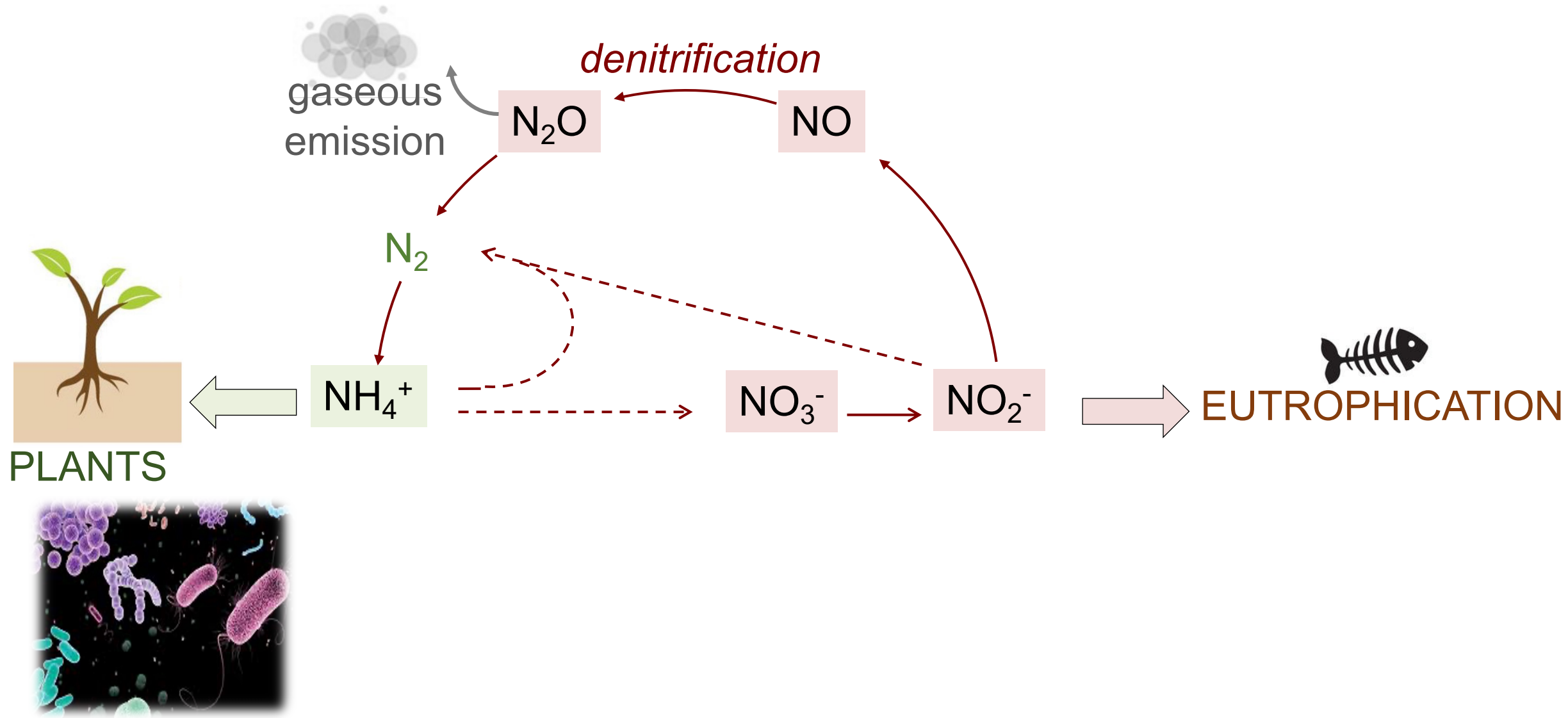
Irrigation



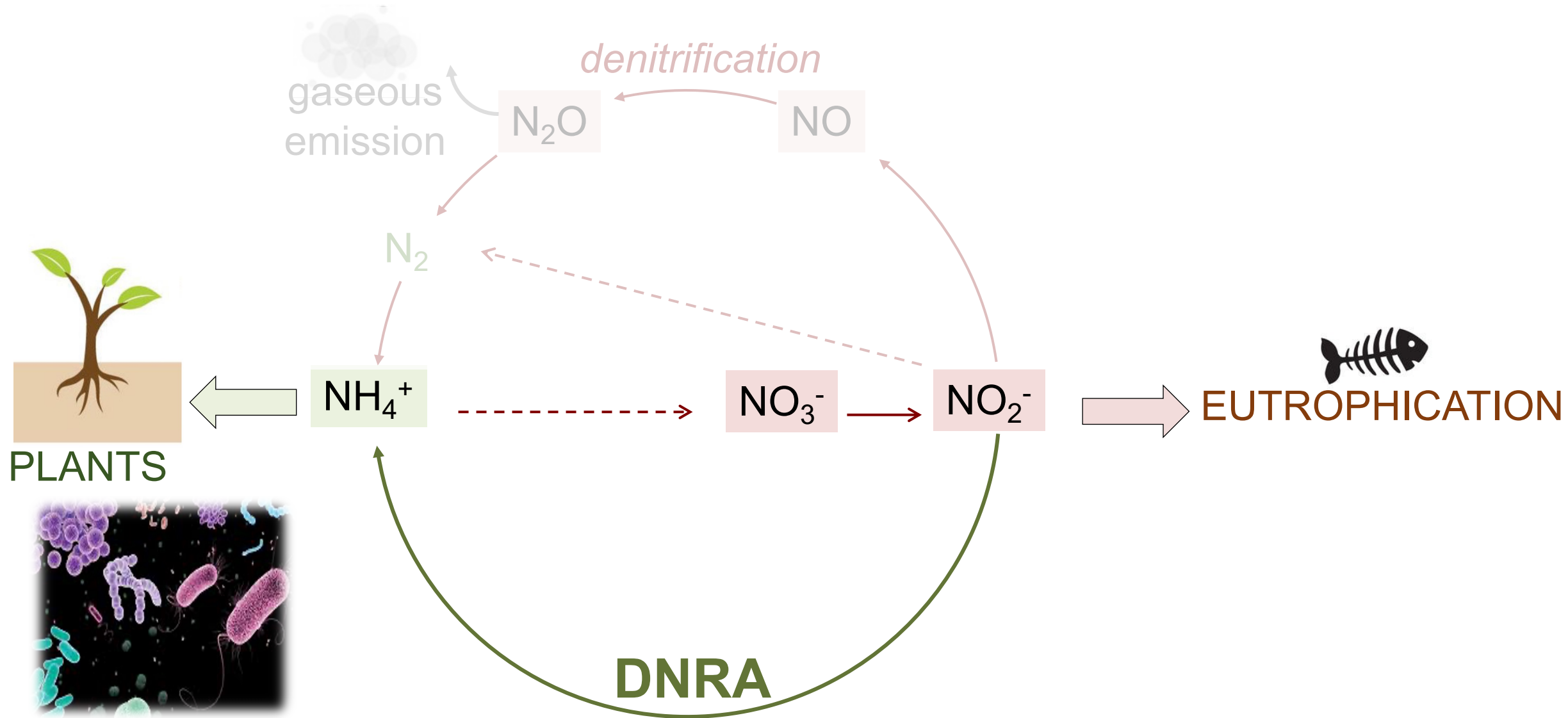
fertilizer reuse (?)

Water treatment solutions

# Microbial retention of N



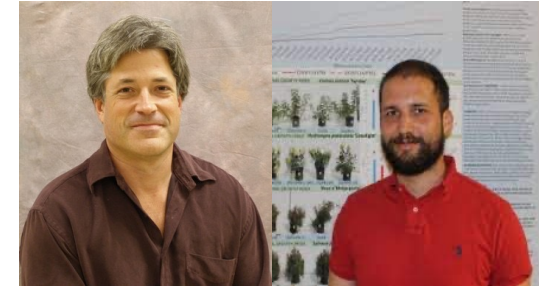
# Microbial retention of N



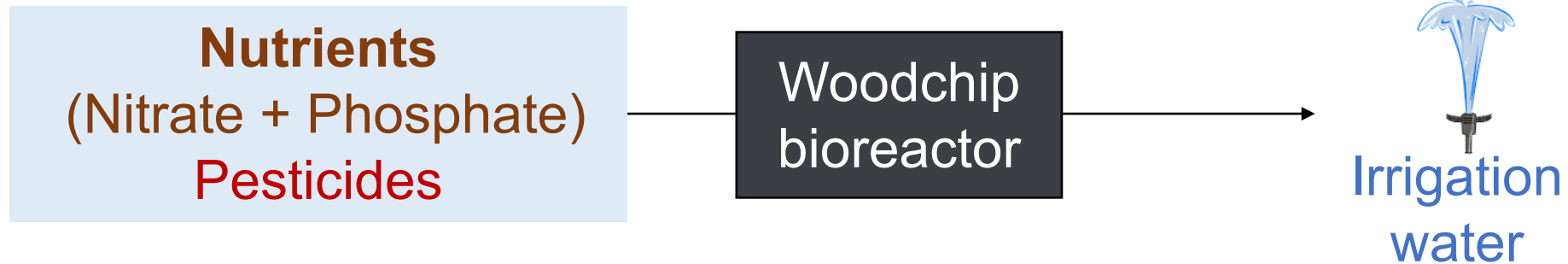
Dissimilatory Nitrate Reduction to Ammonia

# How do we clean the water?

## Woodchip bioreactors to treat agricultural run offs

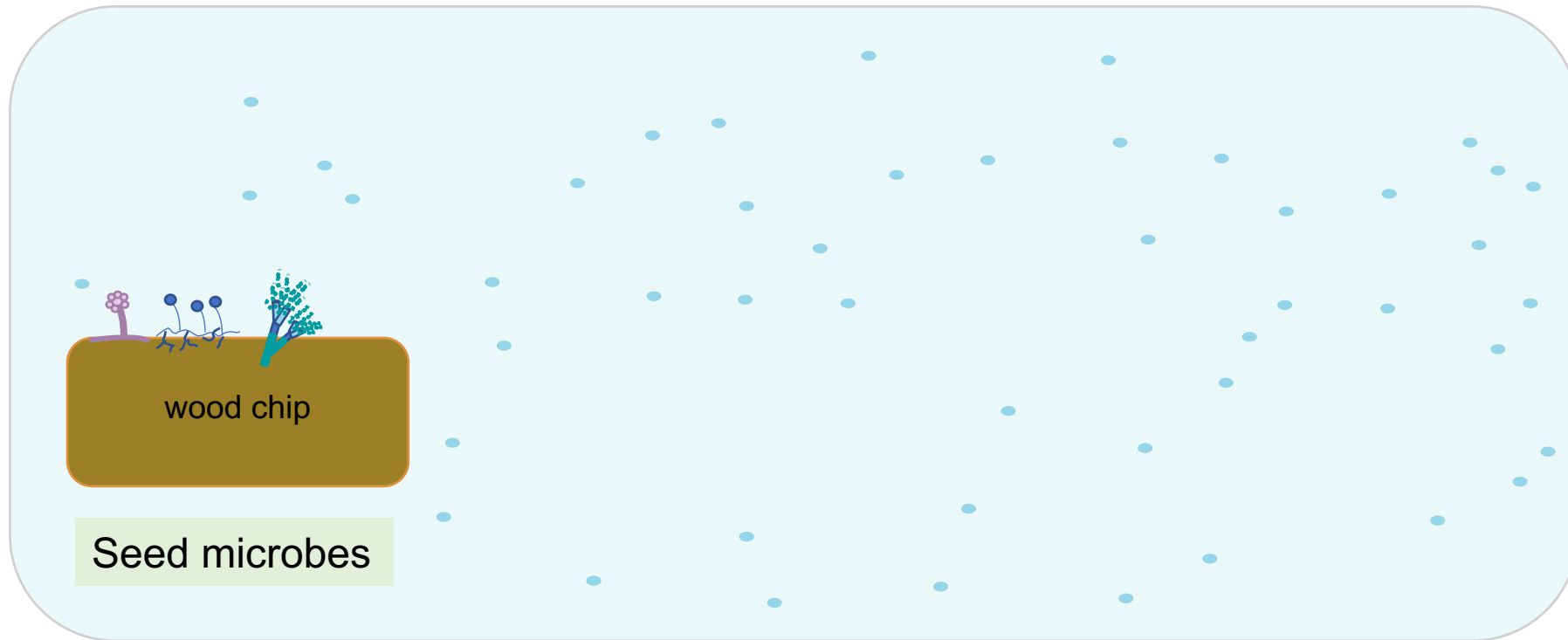


Dr. Fernandez Dr. Abdi

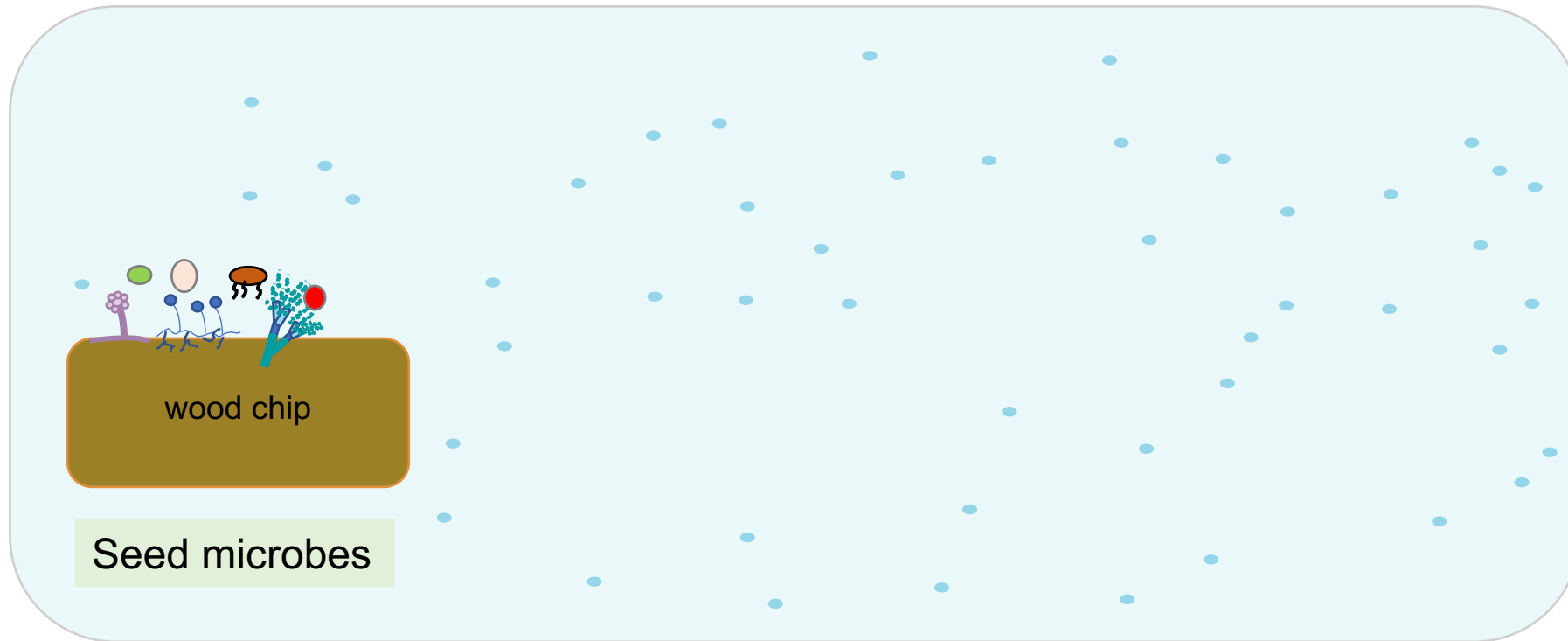


Are microbes remediating agrochemicals?

# Microbiome build on woodchip bioreactors

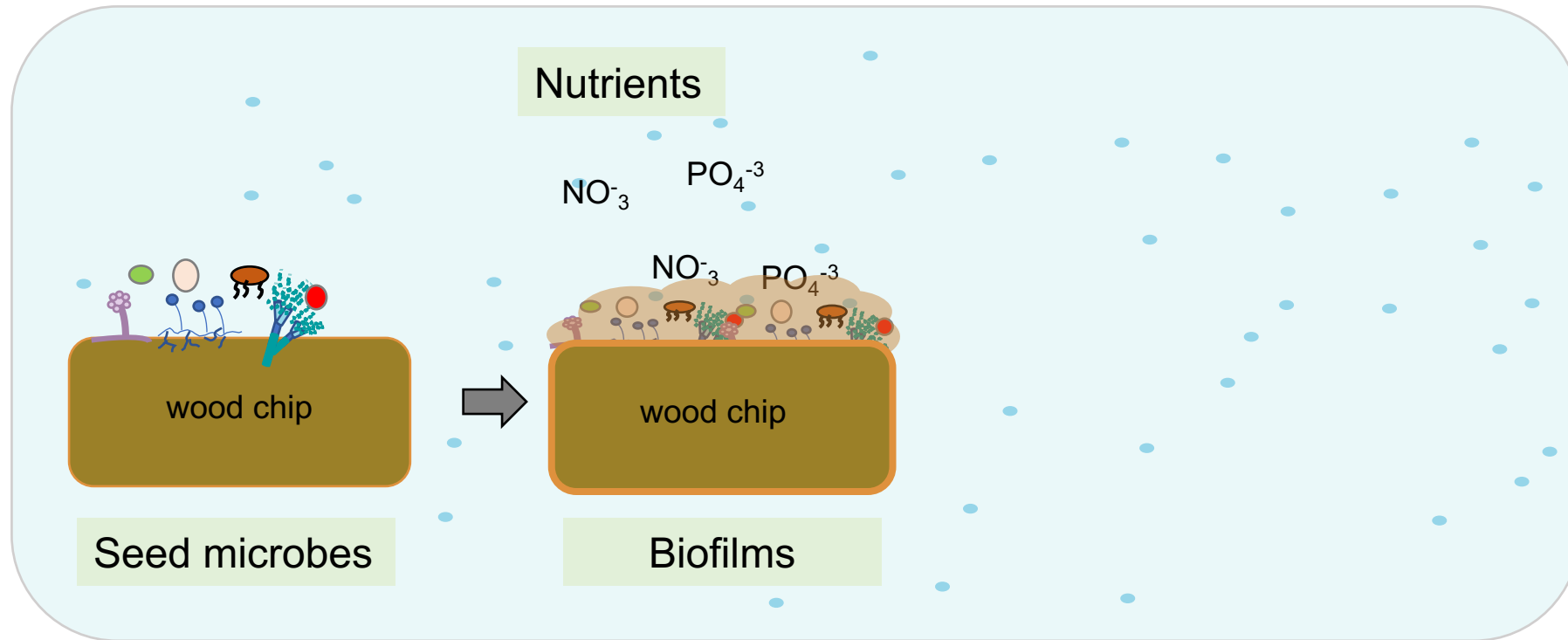


# Microbiome build on woodchip bioreactors

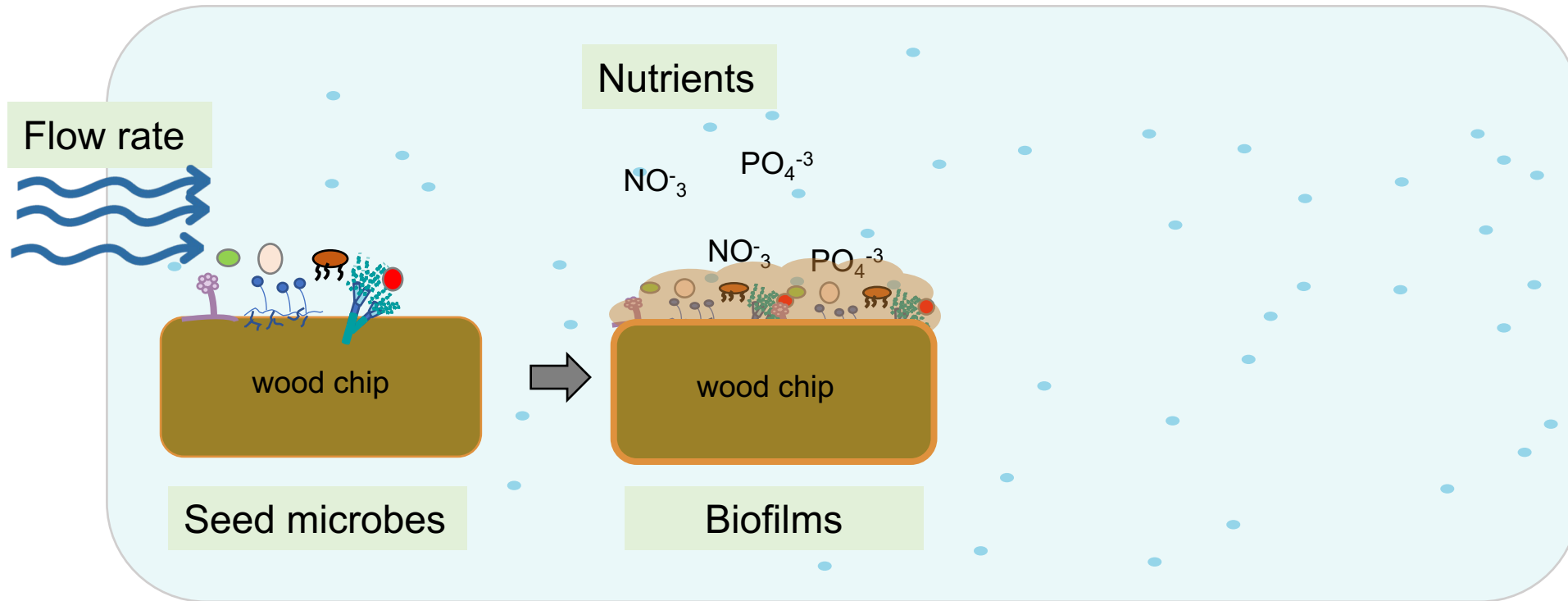




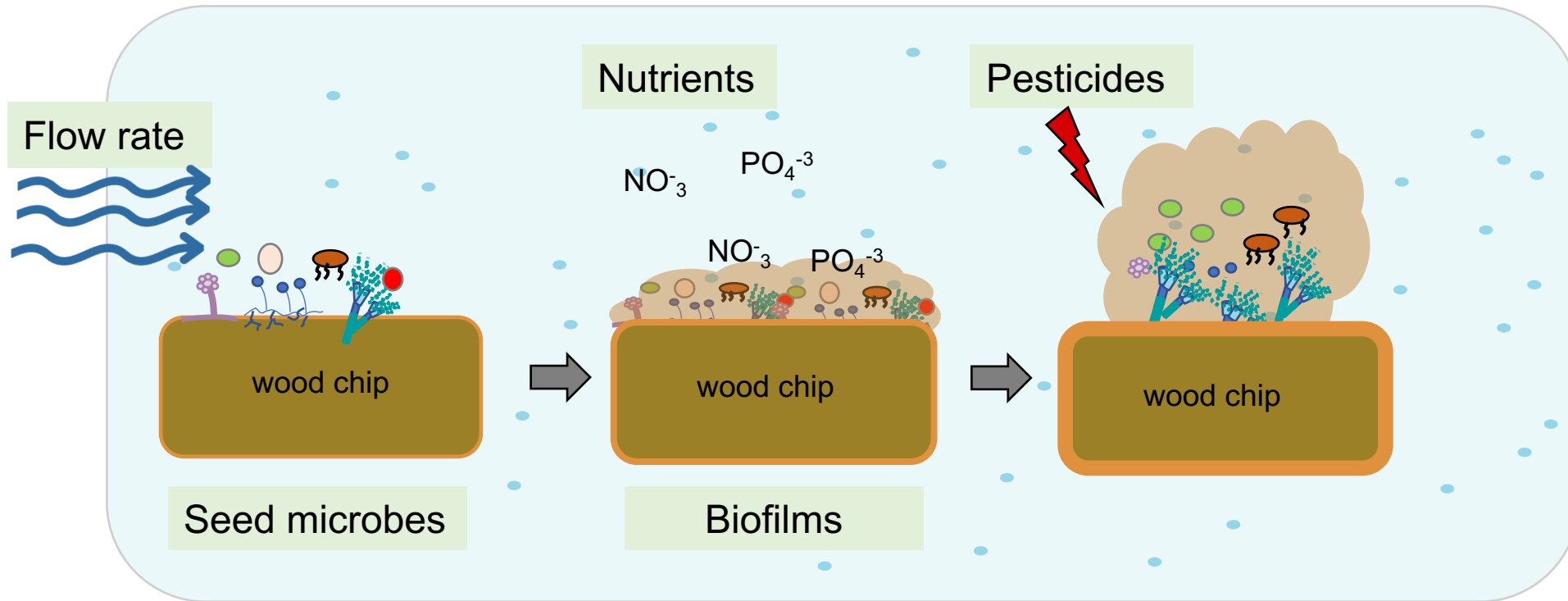
# Microbiome build on woodchip bioreactors



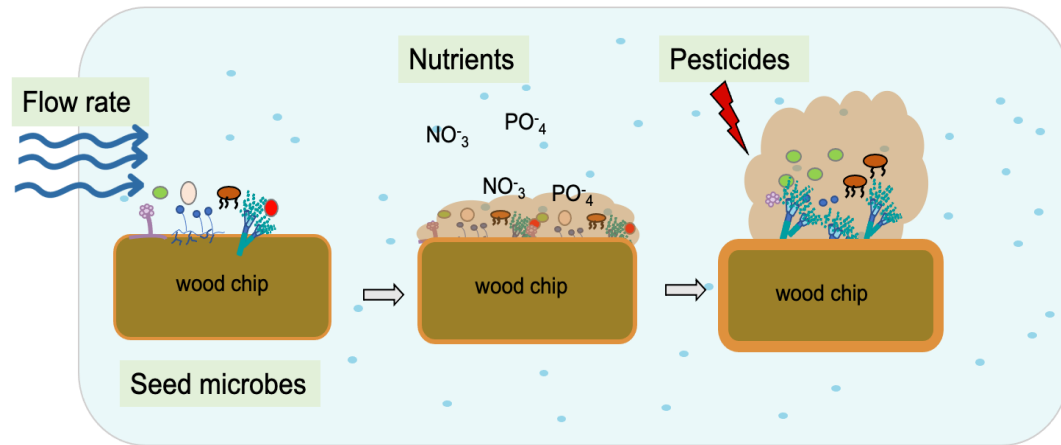
# Microbiome build on woodchip bioreactors



# Microbiome build on woodchip bioreactors

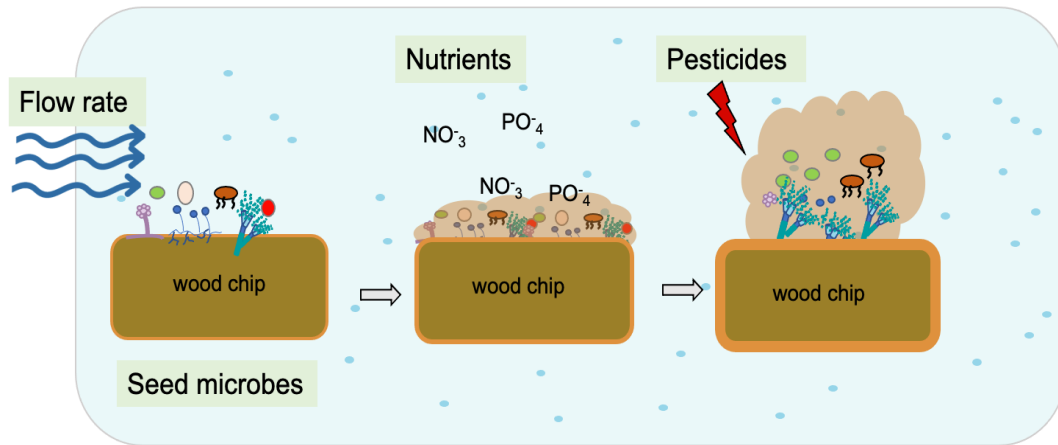


# Microbiome build on woodchip bioreactors



1. What microbes are remediating nutrients?
2. What is the effect of pesticides on woodchip microbiome?
3. How do they respond to retention time?

# Microbiome build on woodchip bioreactors

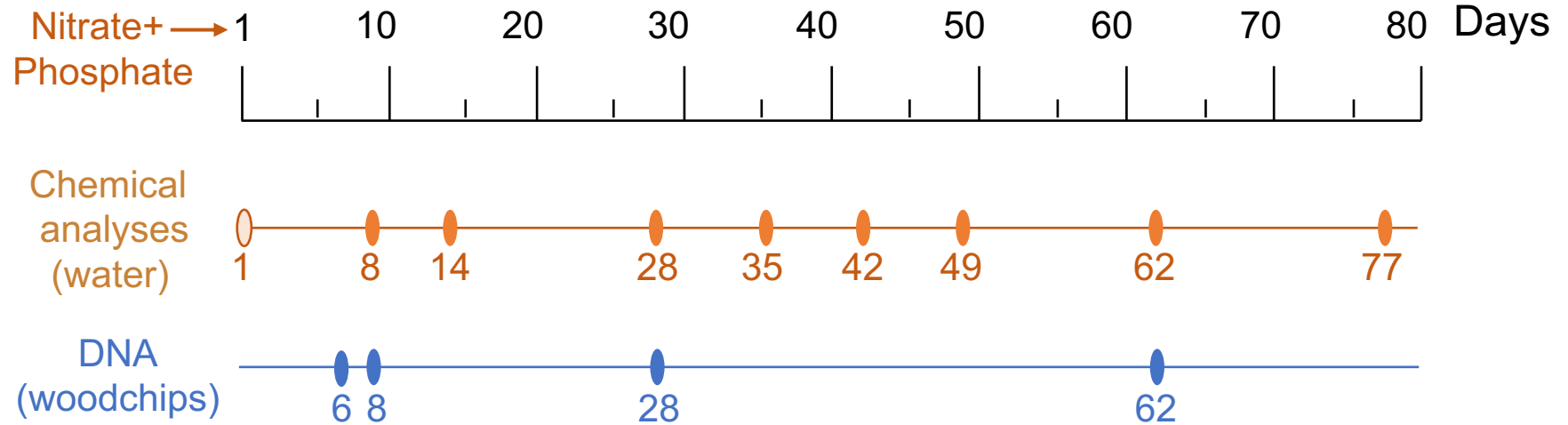


1. What microbes are remediating nutrients?
2. What is the effect of pesticides on woodchip microbiome?
3. How do they respond to retention time?

# Experiment design

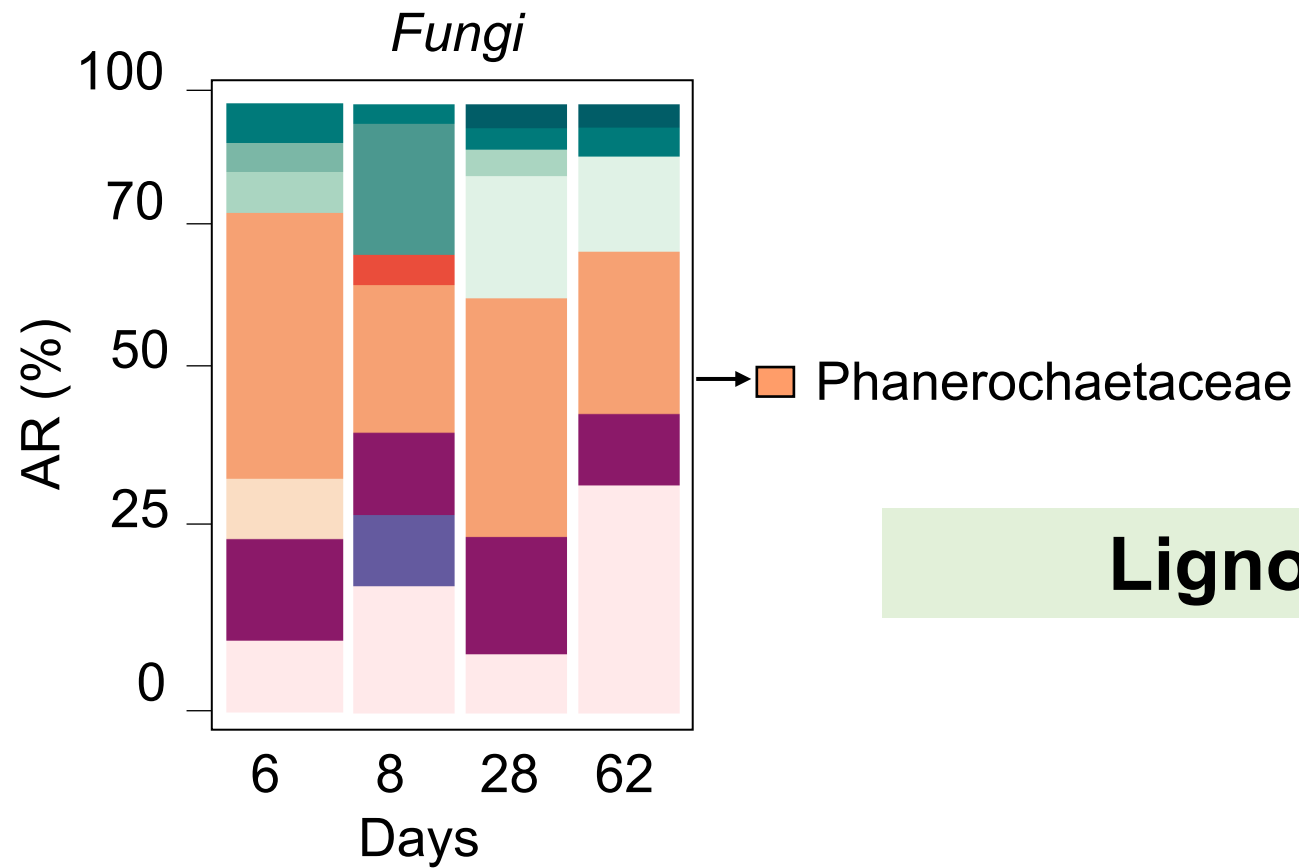


Retention time (RT):  
24 h



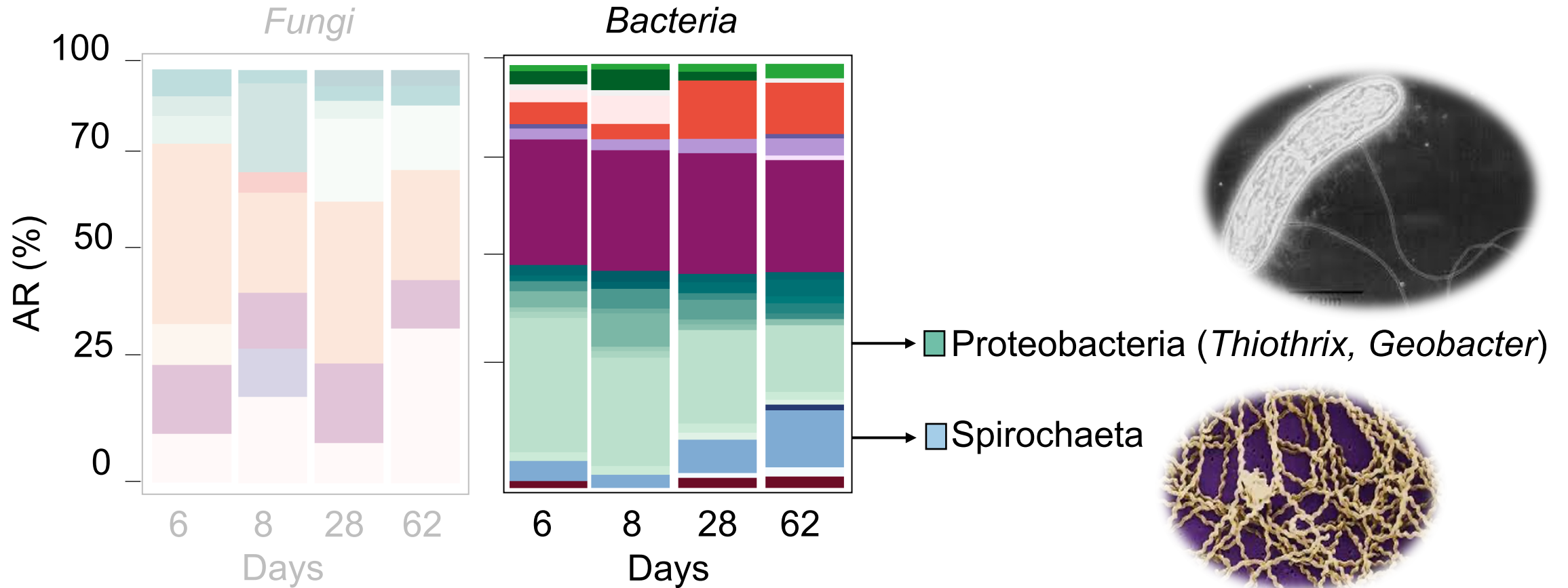
Amplicon sequencing: Illumina  
Bacteria: V3-V4  
Fungi: ITS1-ITS2

# What microbes are remediating nutrients?



**Lignocellulose degraders**

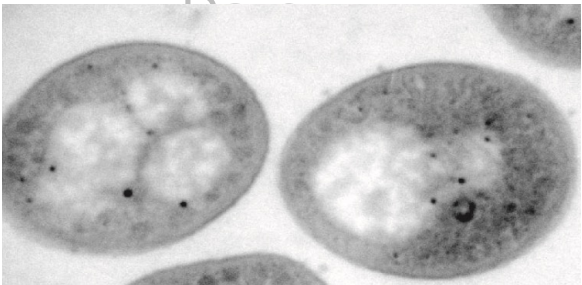
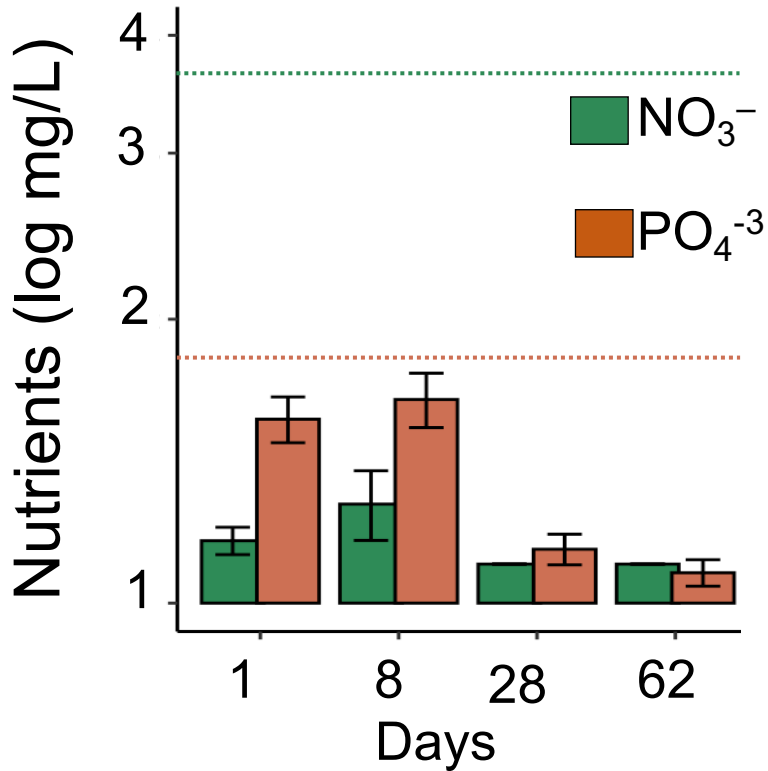
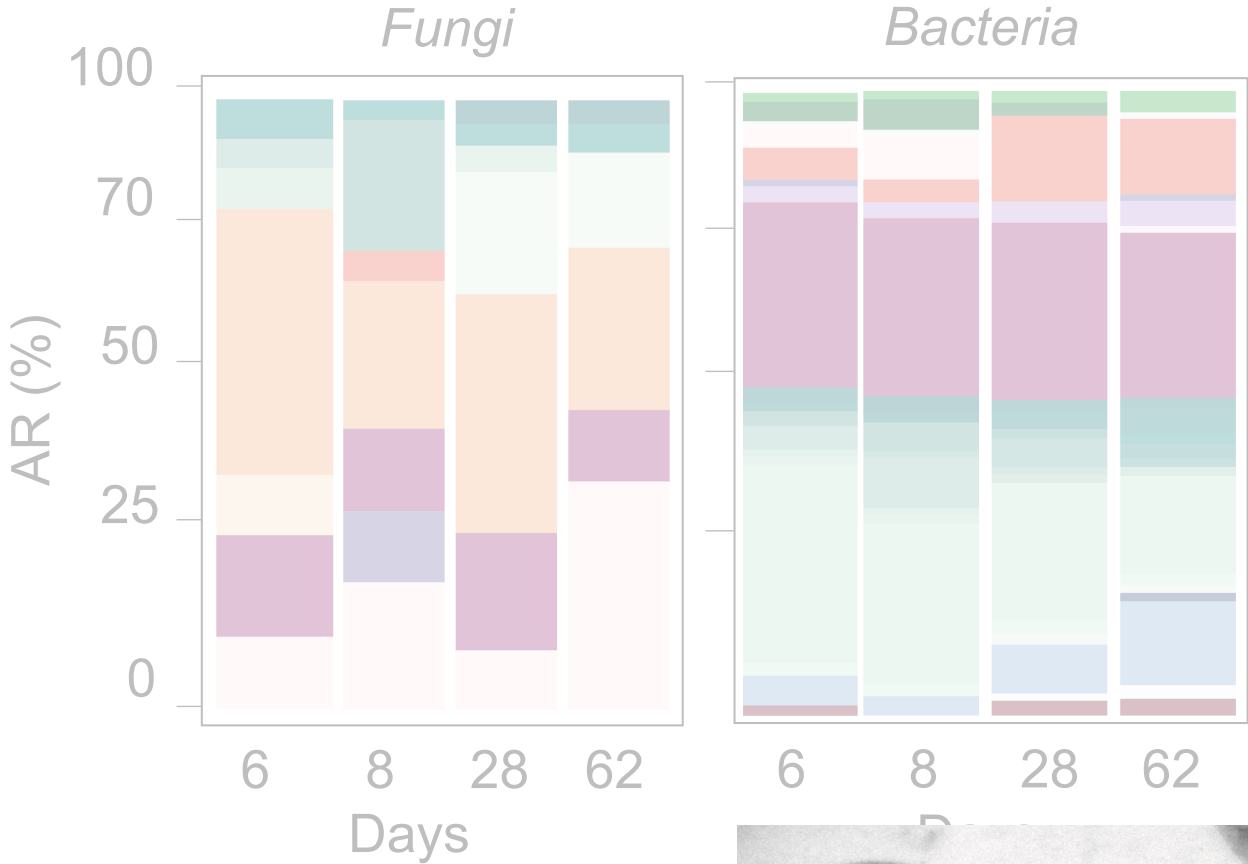
# What microbes are remediating nutrients?



- **DNRA bacteria** (*Geobacter*)
- **Denitrifiers** dominate

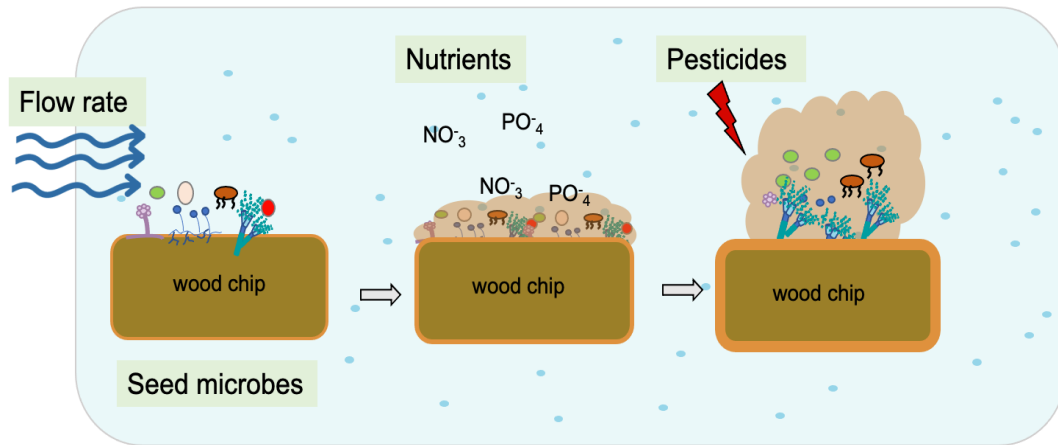


# Microbial community removes nitrate and phosphate



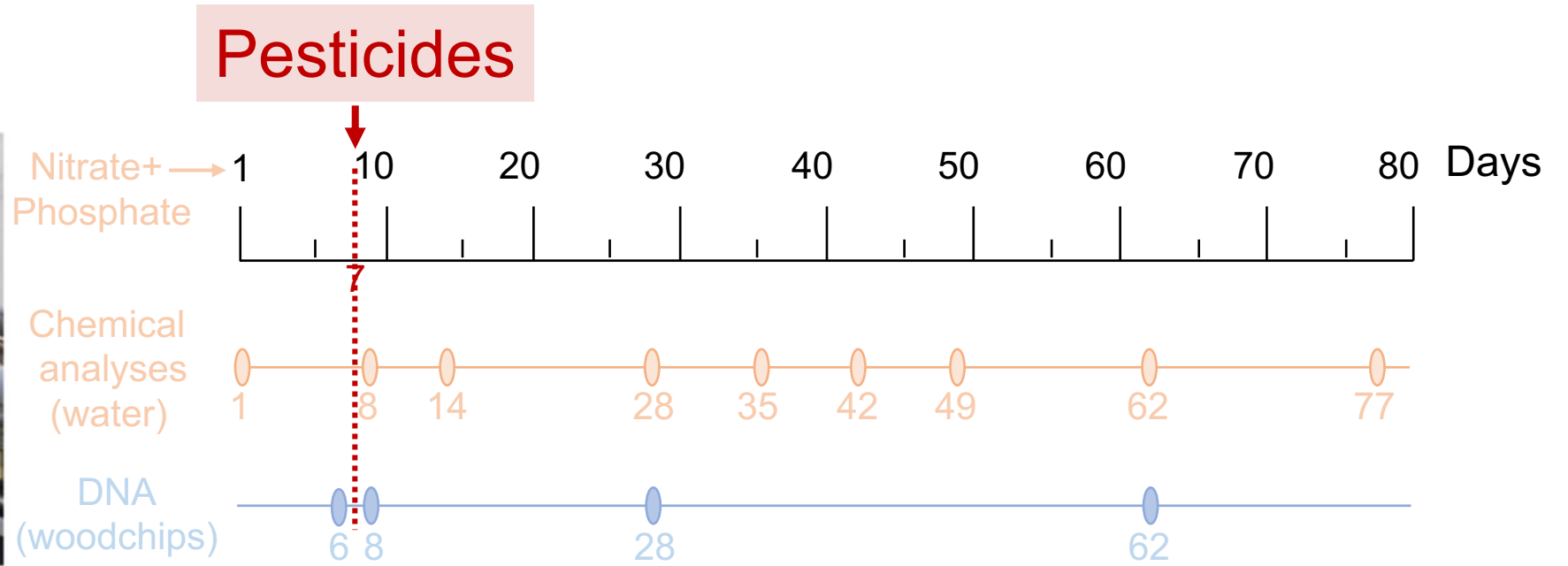
Storage (cells)  
Mineralization (biofilm matrix)

# Biofilms build on woodchip bioreactors



1. What microbes are remediating nutrients?
2. What is the effect of pesticides on woodchip microbiome?
3. How do they respond to flow rates?

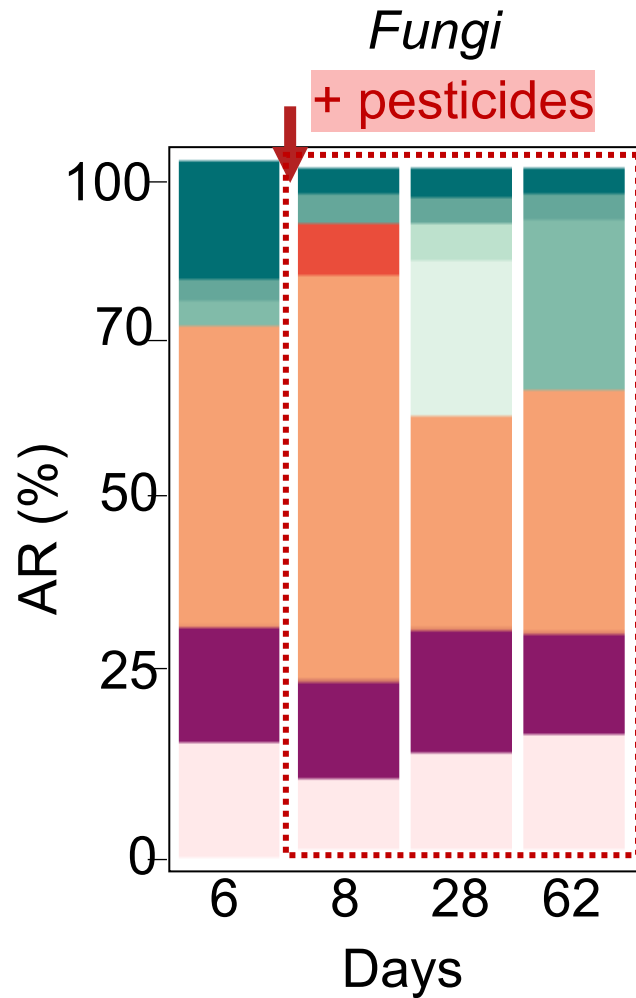
# What is the effect of pesticides on woodchip microbiome?



Retention time (RT):  
24 h

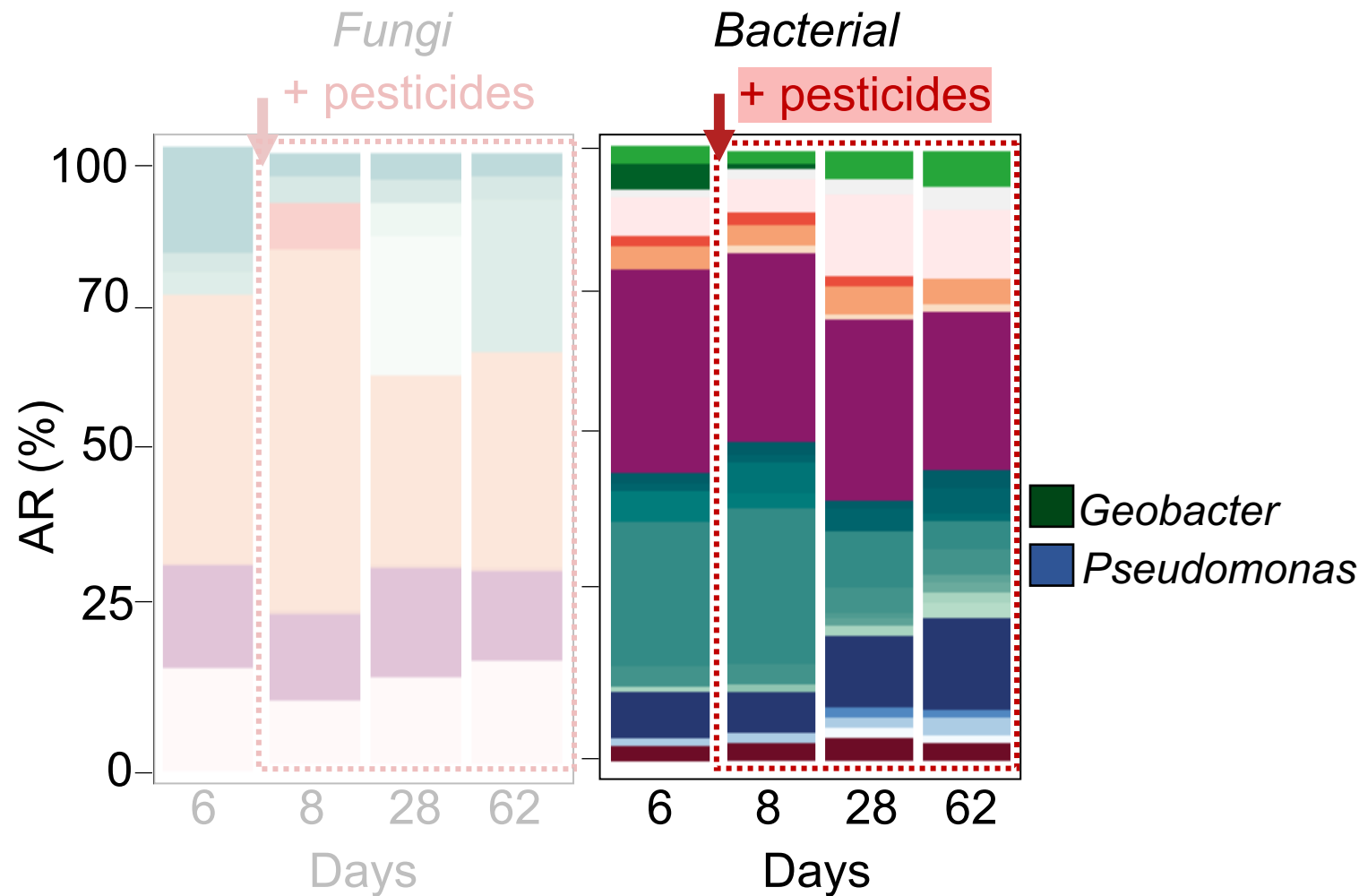
Amplicon sequencing: Illumina  
Bacteria: V3-V4  
Fungi: ITS1-ITS2

# What is the effect of pesticides on woodchip microbiome?



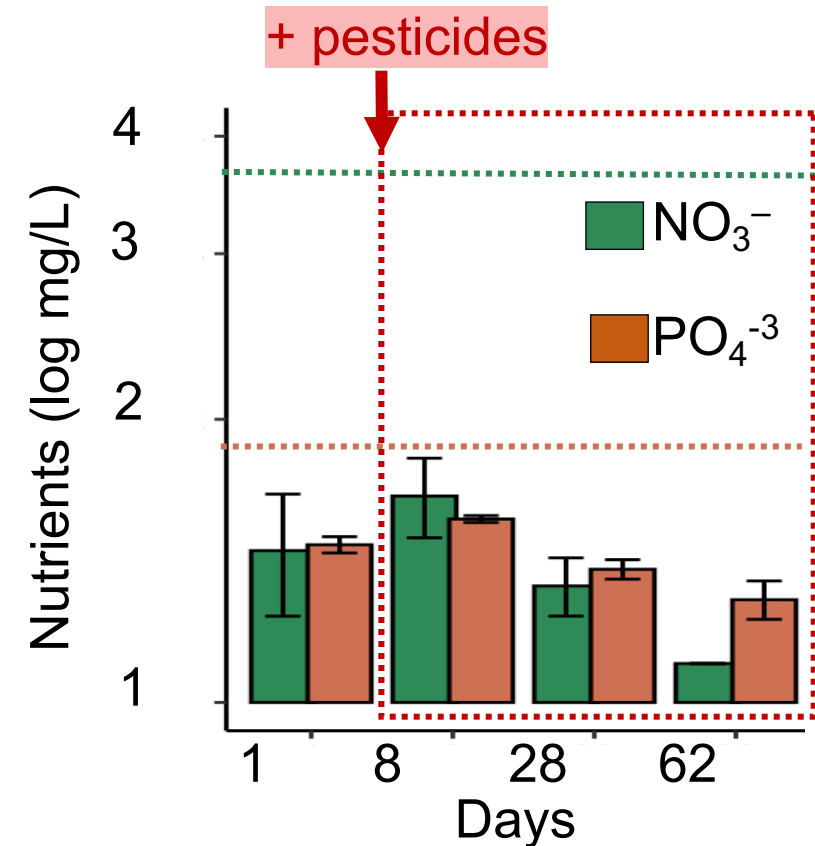
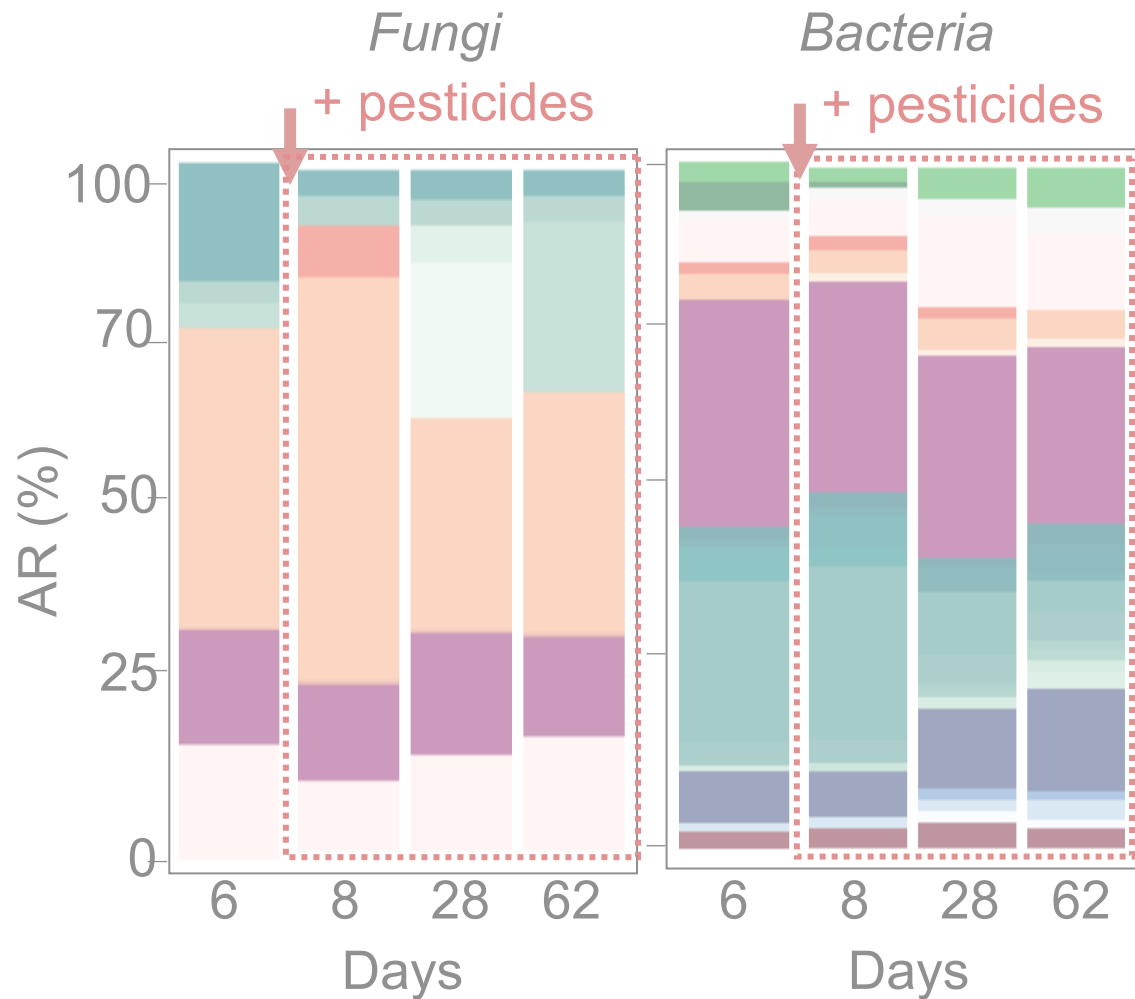
Similar fungal population

## Aim 2: DNRA during nitrate removal from agricultural runoff



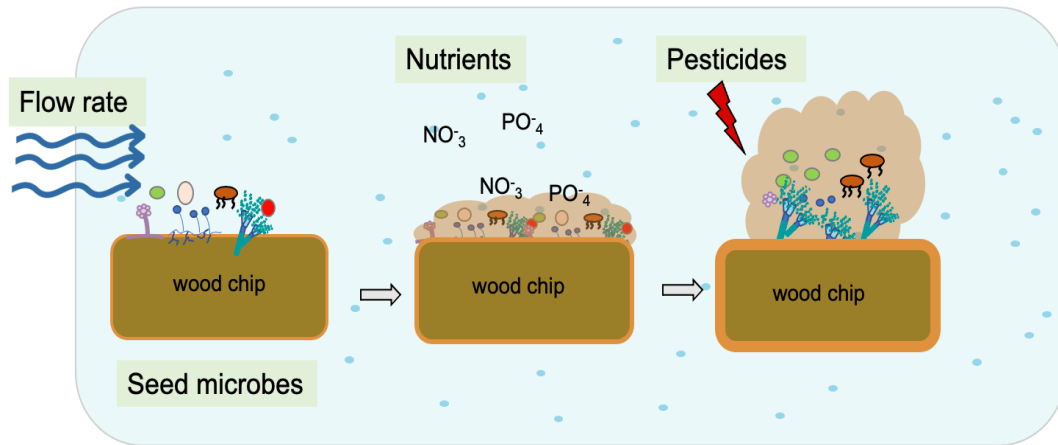
- Denitrifiers dominated
- Pesticides enrich for DNRA bacteria (*Geobacter*, *Pseudomonas*)

# What is the effect of pesticides on woodchip microbiome?



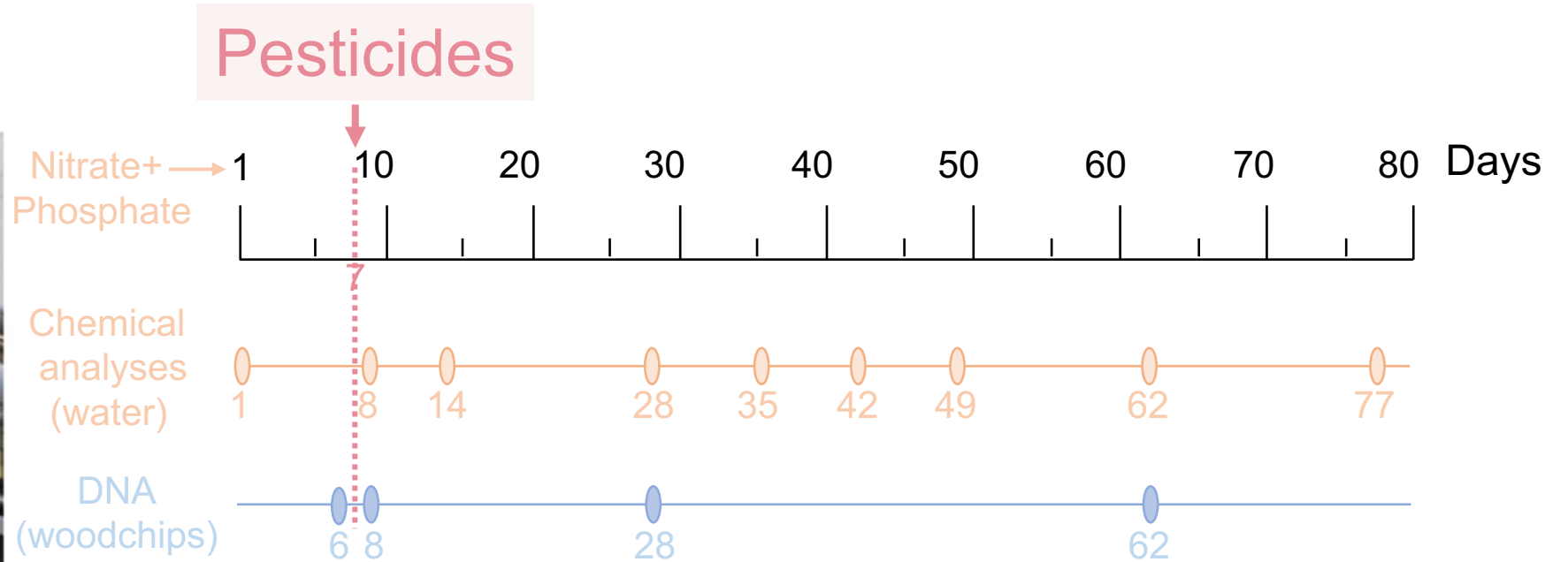
**Slightly** reduced performance,  
overall great removal

# Microbiome build on woodchip bioreactors



1. What microbes are remediating nutrients?
2. What is the effect of pesticides on woodchip microbiome?
3. How do they respond to retention time?

# How do they respond to retention time?



## Retention time (RT):

**4 h**

24 h

**48 h**

Amplicon sequencing: Illumina  
Bacteria: V3-V4  
Fungi: ITS1-ITS2



# How do they respond to retention time?



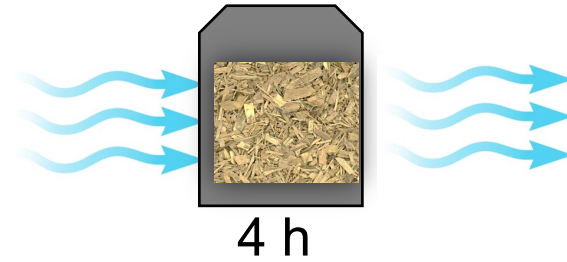
Retention time (RT):

**4 h**

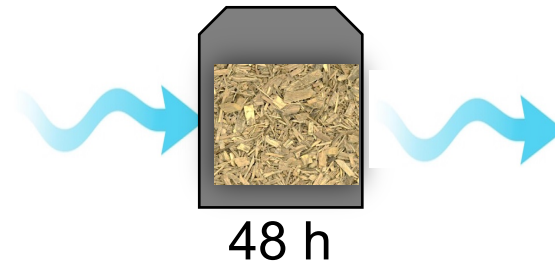
24 h

**48 h**

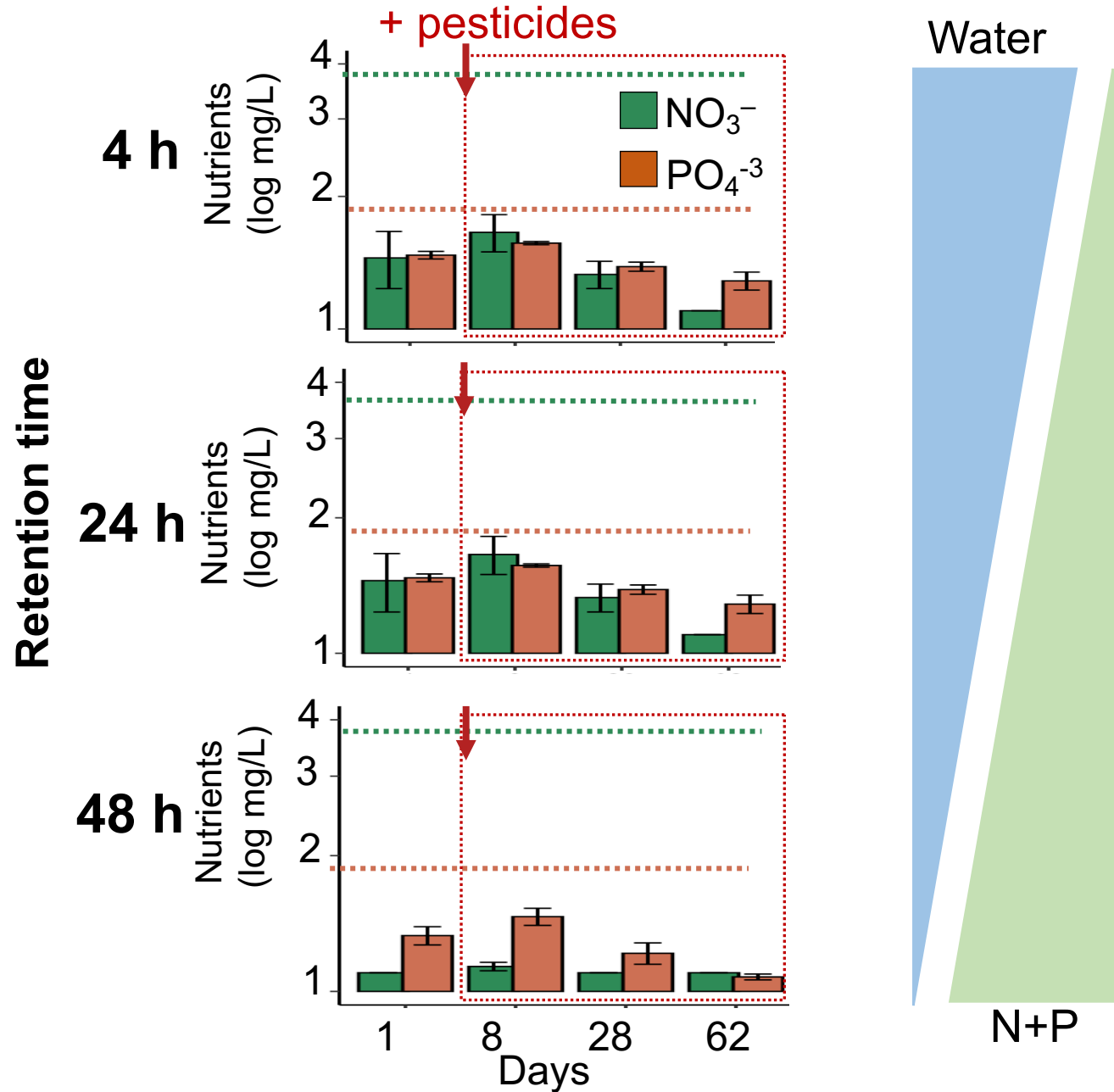
Fast flow rate = short retention time



Slow flow rate = long retention time

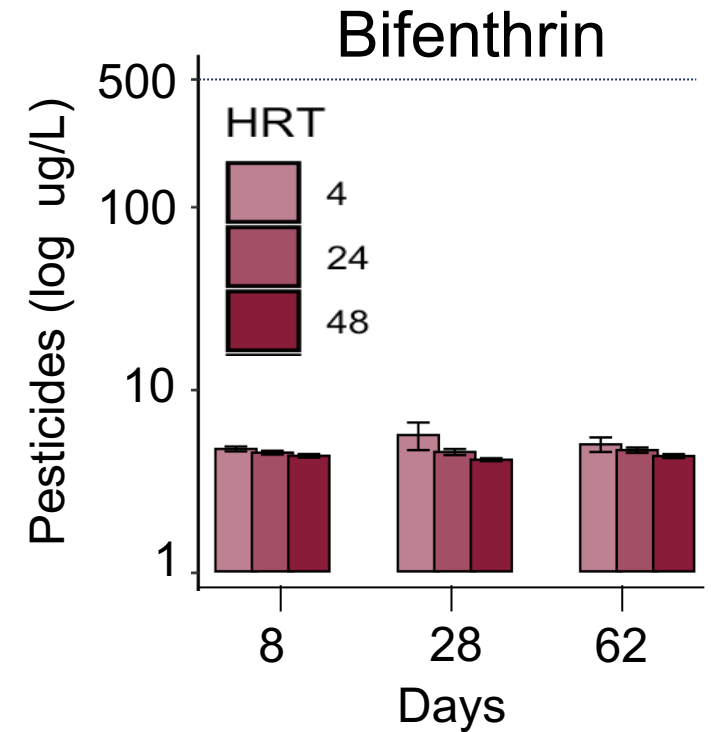
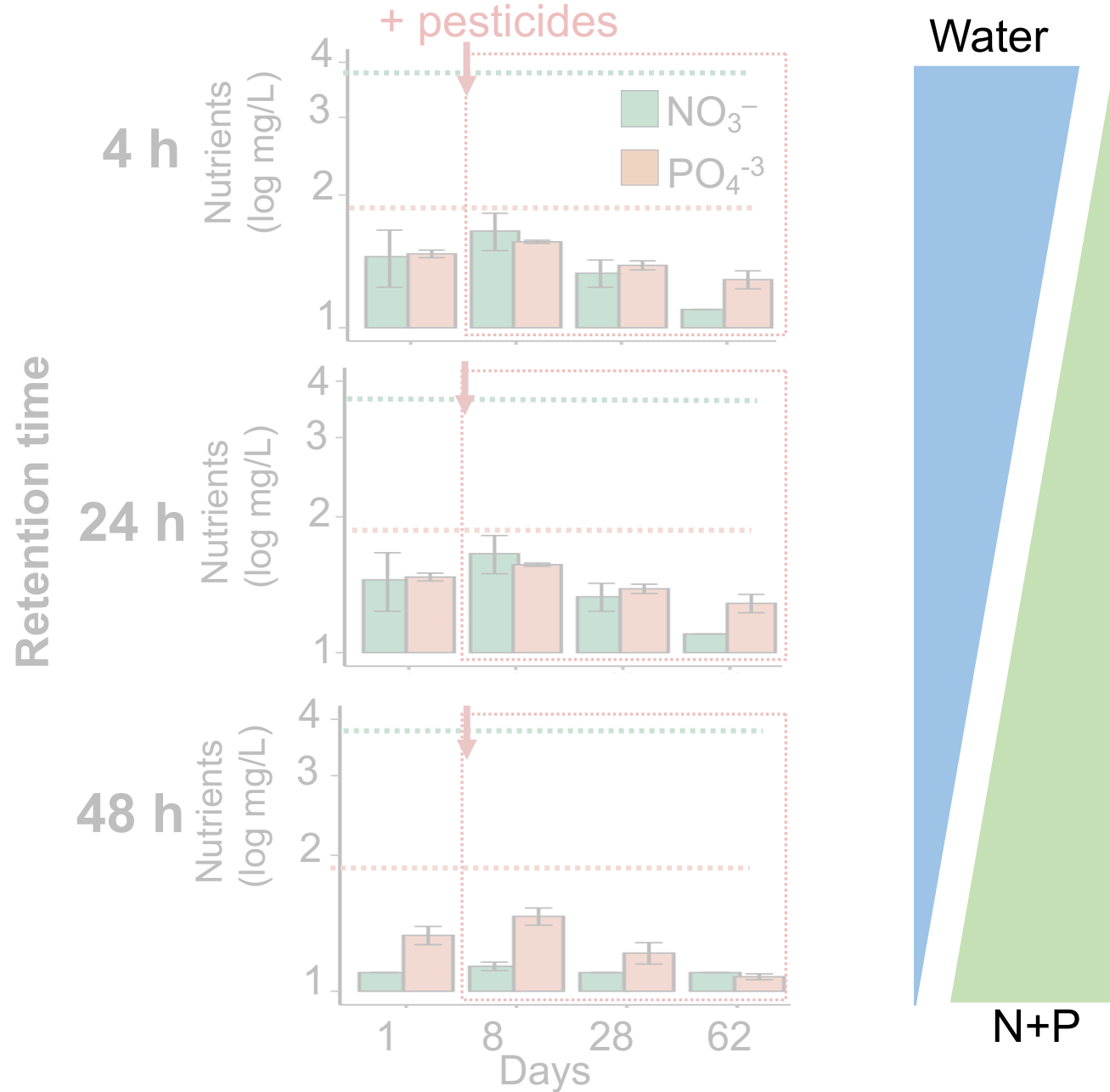


# How do they respond to retention time?

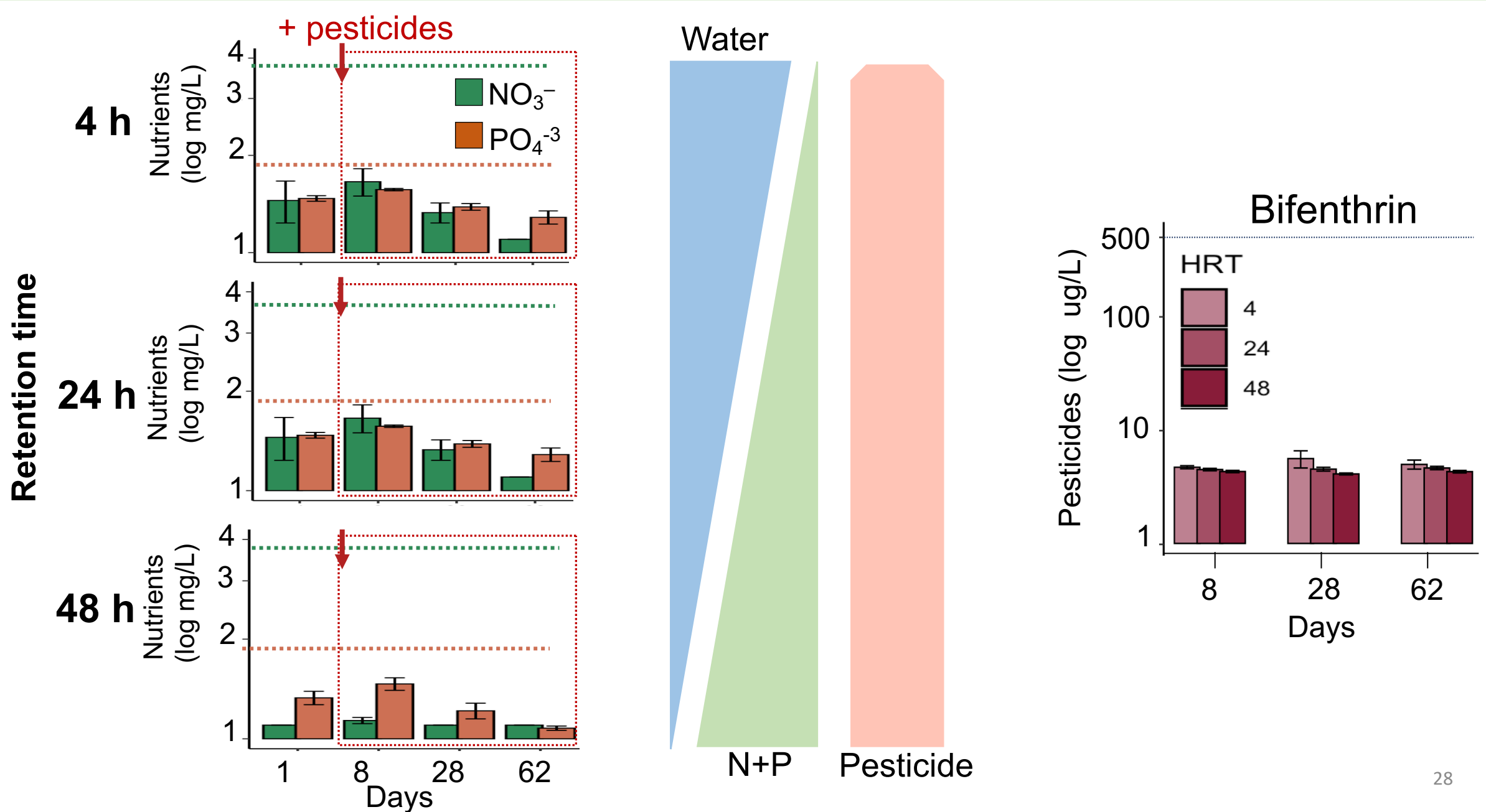


Flow rate controls retention time (4,24,48 h) and N+P removal

# How do they respond to retention time?



# How do they respond to retention time?



# DNRA during nitrate removal from agricultural runoff

## Conclusions

- Pesticides selected for resilient nitrate-reducers but denitrifiers prevailed
- Flow rate modulates nitrate removal without impacting pesticide removal substantially

# DNRA during nitrate removal from agricultural runoff

## Conclusions

- Pesticides selected for resilient nitrate-reducers but denitrifiers prevailed
- Flow rate modulates nitrate removal without impacting pesticide degradation substantially



Some growers need to remove pesticide and recycle nutrients (N+P)

# Future directions

## Large MI greenhouse operation



### 1. *Scale up bioreactor*

- Remove pesticide and recycle nutrients (N+P)

### 2. *Isolate candidate microbes (bioaugmentation)*

- *Geobacter* (nitrate and pesticide remediation)

# Acknowledgments

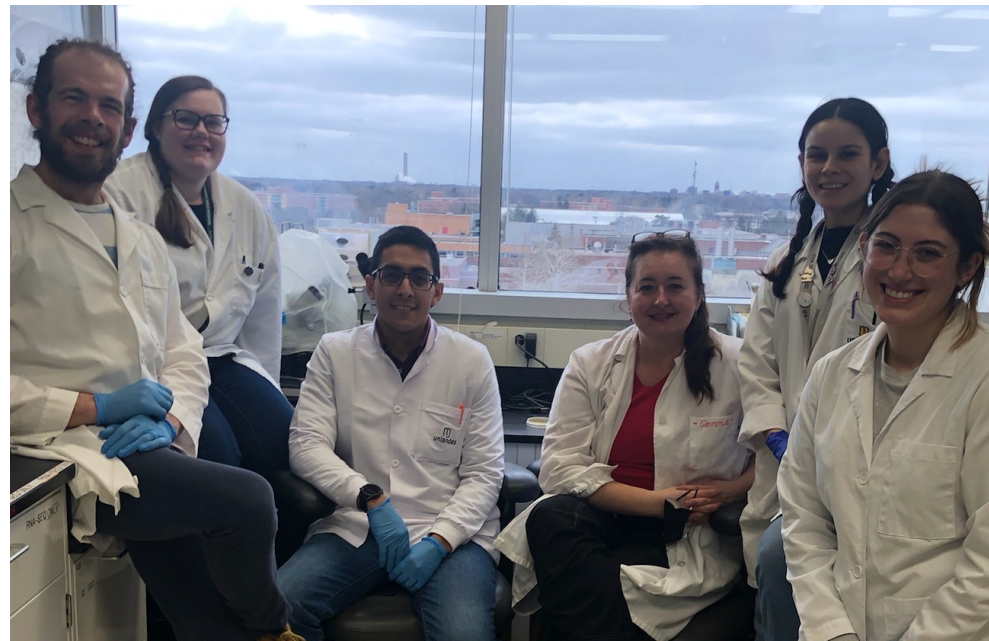
- **Main Collaborators**

Dr. Fernandez  
Dr. Abdi



- **Reguera Lab**

Dr. Gemma Reguera  
Dr. Kristin Jacob  
Hunter Dulay  
Morgen Clark

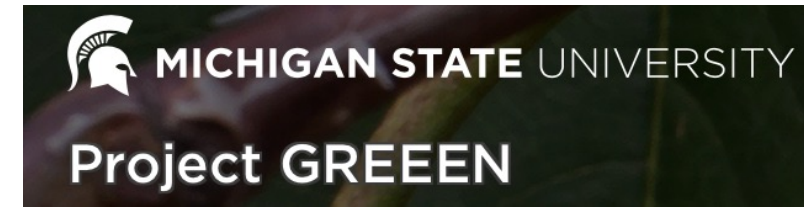


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Dr. Marco Lopez

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# Thank you!

