

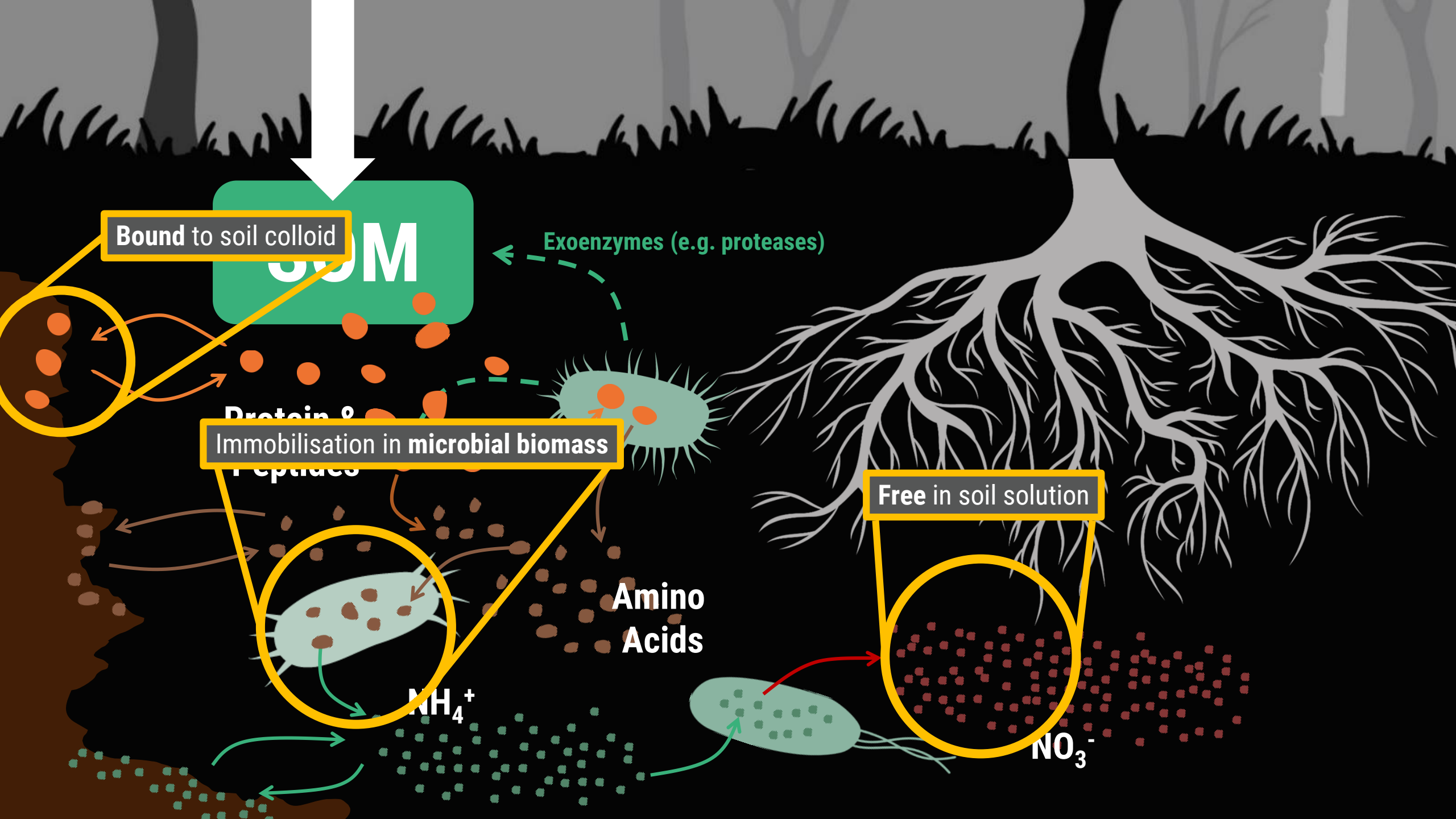
The influence of root exudates on N availability *an investigation using microdialysis*

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N availability is dynamic!

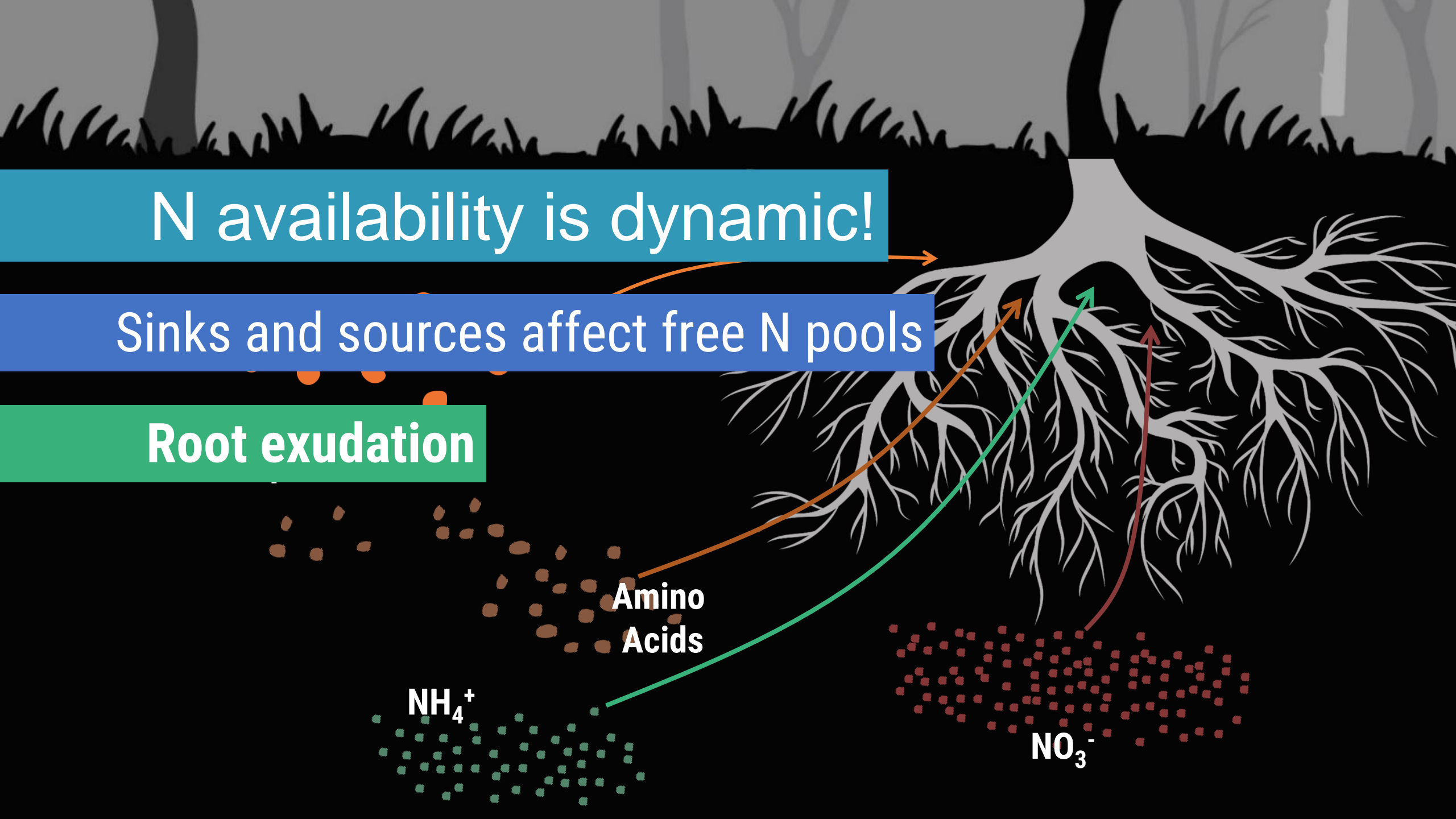
Sinks and sources affect free N pools

Root exudation

**Amino
Acids**

NH_4^+

NO_3^-



Exudate Processes



Physicochemical

Soil Aggregation
Soil Water Flow
Mineral Weathering
Nutrient Mobilisation
Detoxification

Biochemical

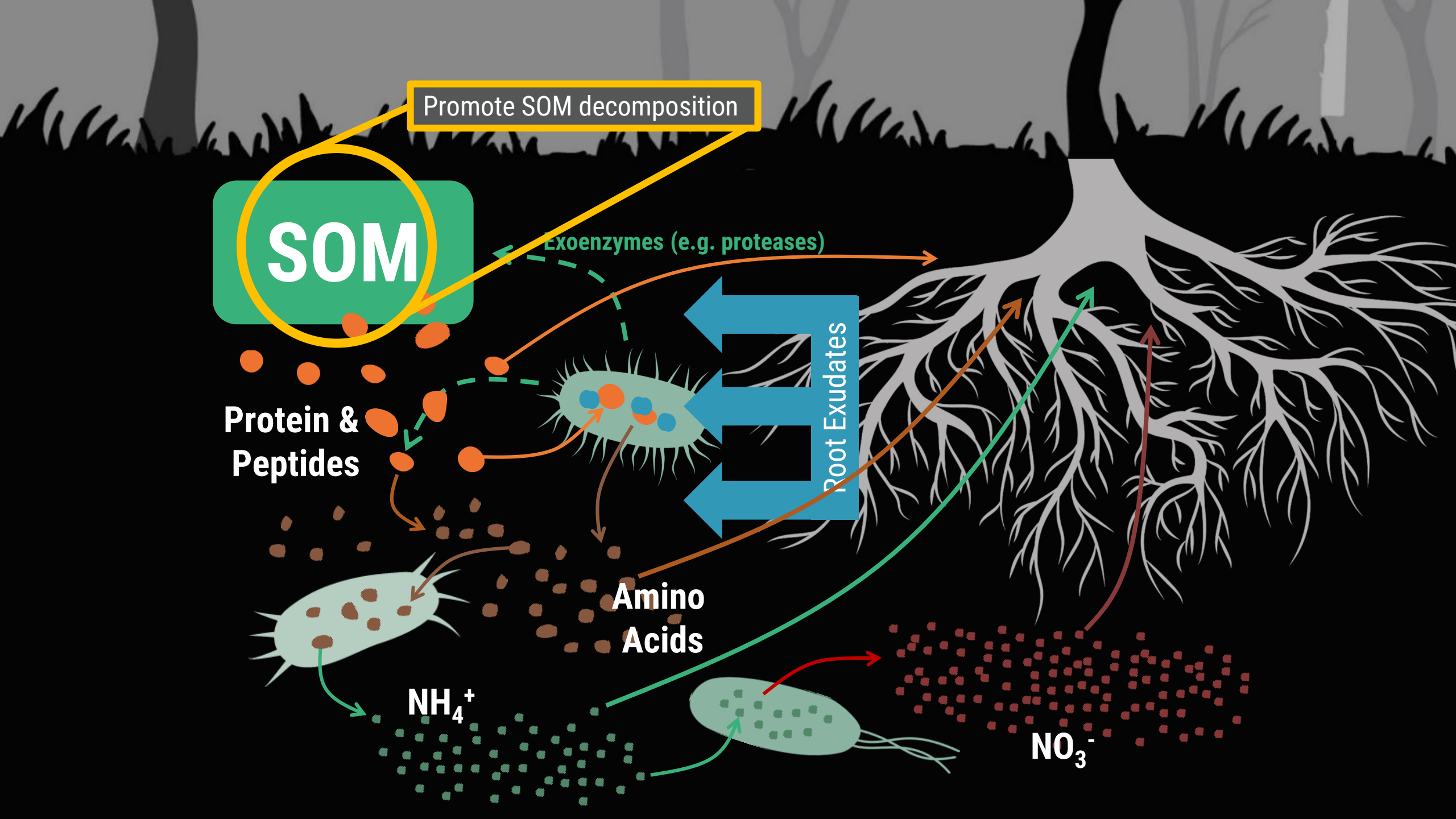
Soil Organic Matter Turnover
Nutrient Cycling
Respiration
Greenhouse Gas Emissions
Carbon Sequestration

Biological Interactions

Allelopathic Signalling
Symbiotic Signalling

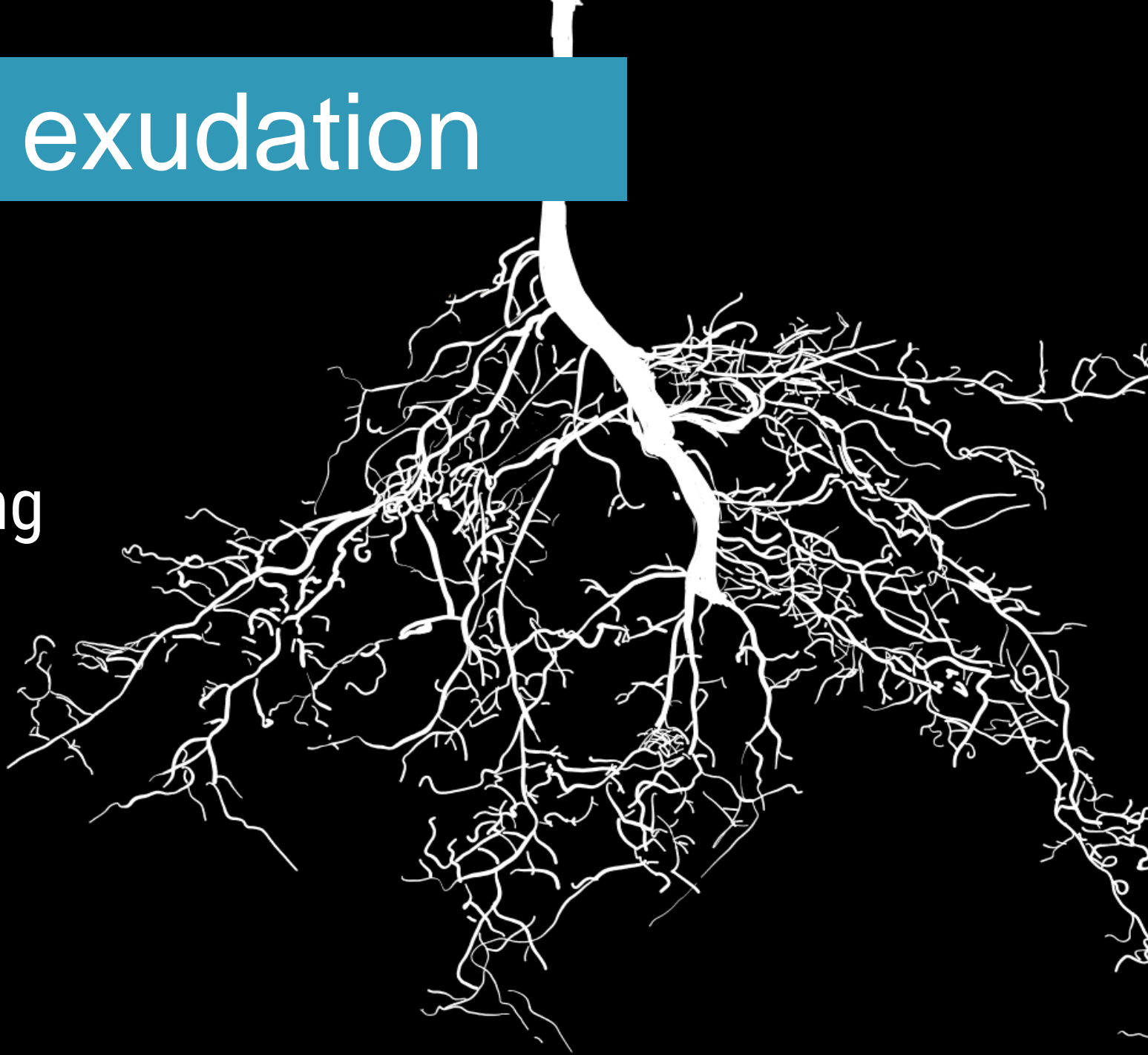
Microbial Community

- Size
- Composition
- Activity



Simulating exudation

- › Direct Injection
- › Stem Girdling
- › CO₂ isotope labelling
- › *In situ* methods
 - › Microlysimeters
 - › **Microdialysis**



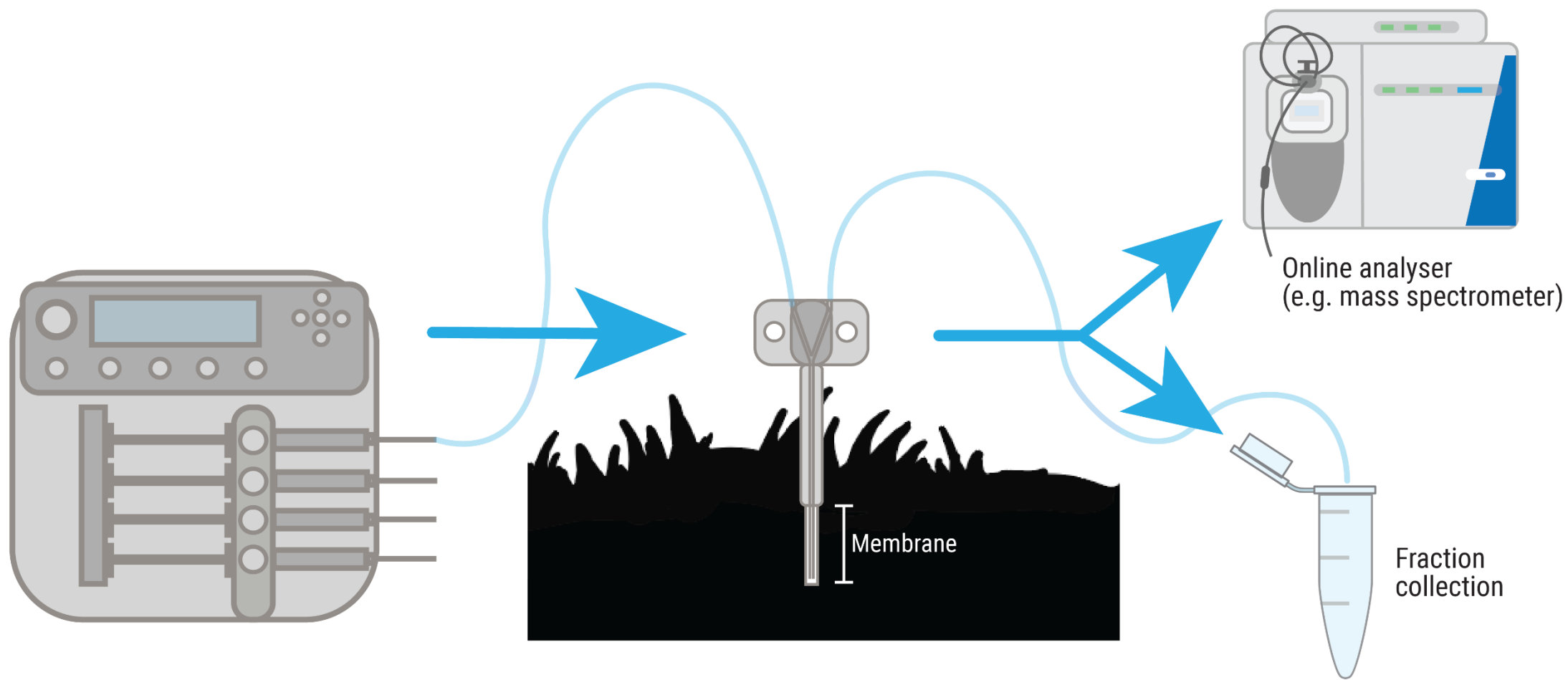
Microdialysis



Microdialysis

A person wearing safety glasses and a lab coat is working with microdialysis equipment. Several small containers, likely microcosms, are arranged on a tray. Each container contains soil and a small plant or seedling. Thin tubes are connected to the containers, likely for microdialysis. The background is a blurred laboratory setting.

Soil microcosms



Syringe pump pushes
perfusate through to the probe
at a specified flow rate

Probe is positioned *in situ*. Soil
solute passively diffuse across
probe membrane.

Dialysates are collected for
offline analysis, or flow is
redirected to online analysers

Perfusate (inflow)

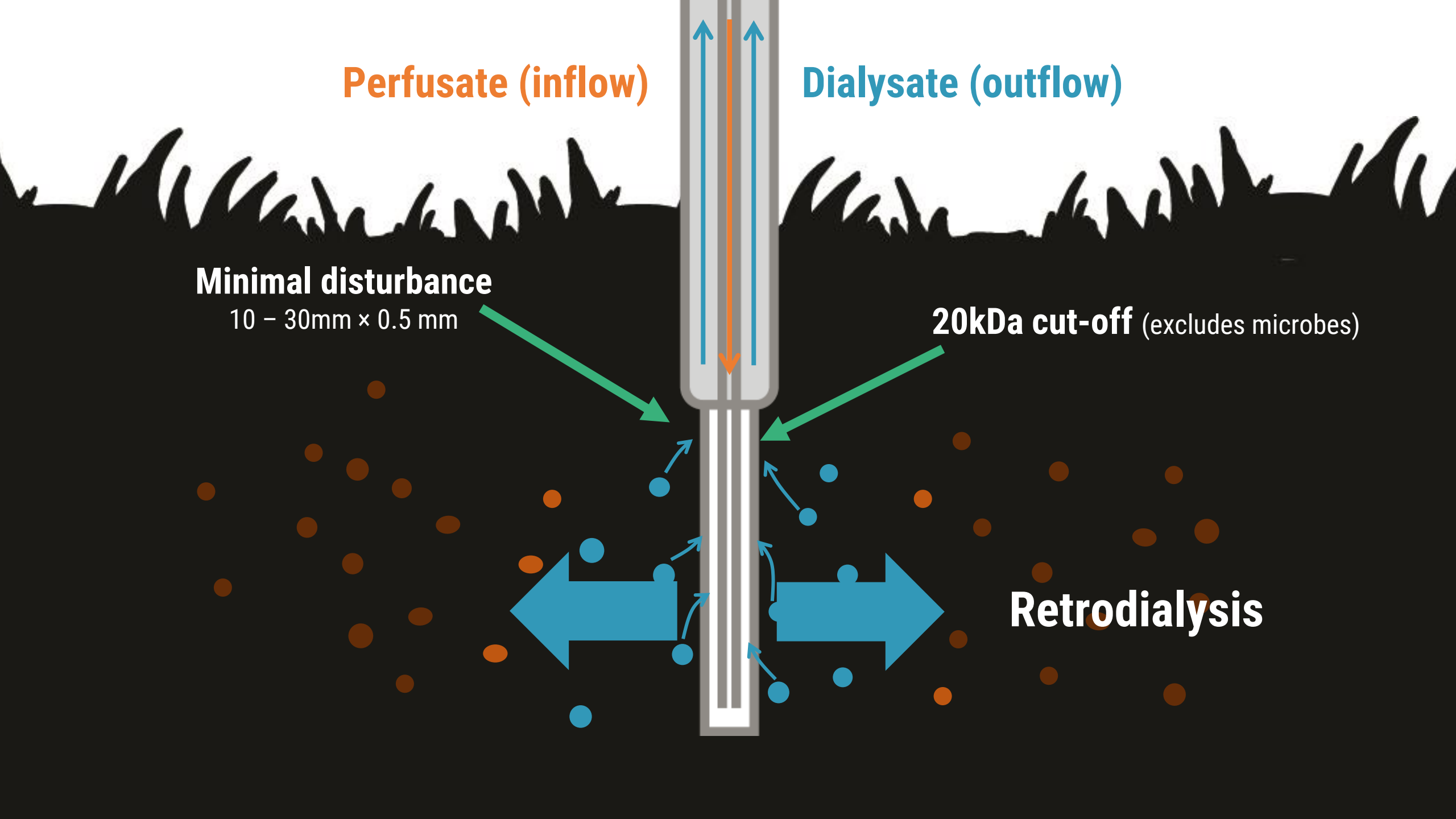
Dialysate (outflow)

Minimal disturbance

10 – 30mm × 0.5 mm

20kDa cut-off (excludes microbes)

Retrodialysis



SOM

Enzymes

**Protein &
Peptides**

Stimulate SOM decomp by supplying C compounds

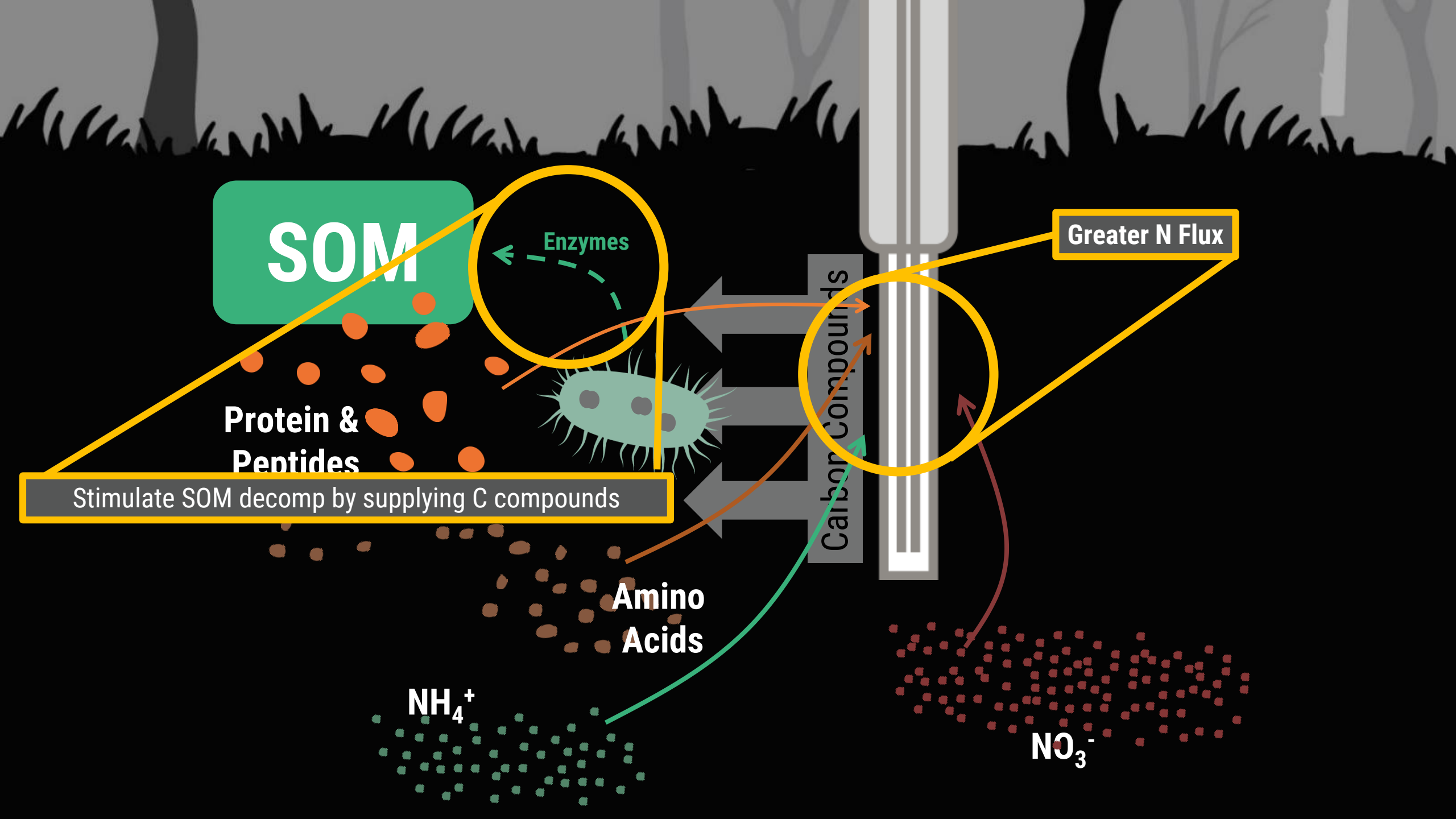
Greater N Flux

Carbon Compounds

**Amino
Acids**

NH_4^+

NO_3^-



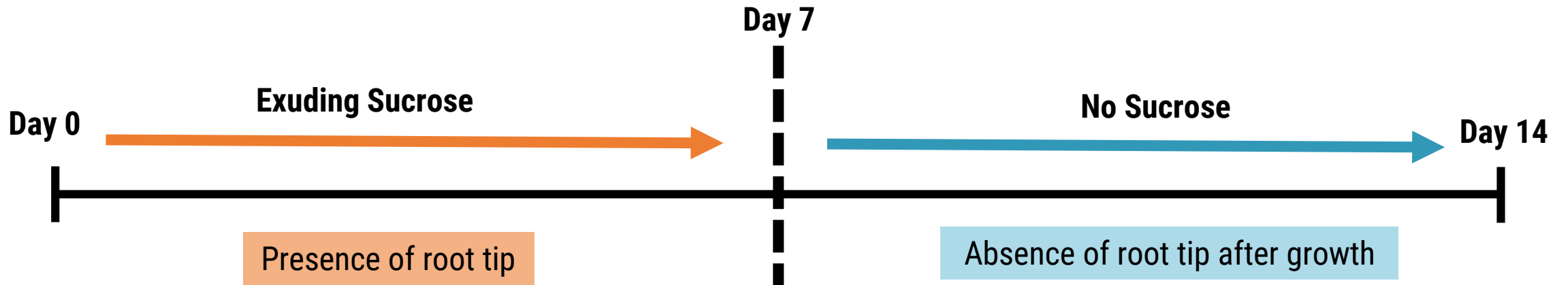
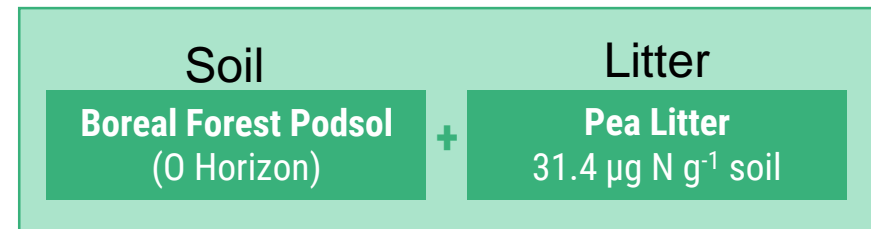
Experimental Setup

- › **5 mM & 0.5mM sucrose** (and *nil* sucrose)
- › 0.1–10 mM concentrations in cytosol

Lohaus et al, 1994. Journal of experimental botany.

- › **Soil treatments**

- › Soil only
- › Soil and Litter

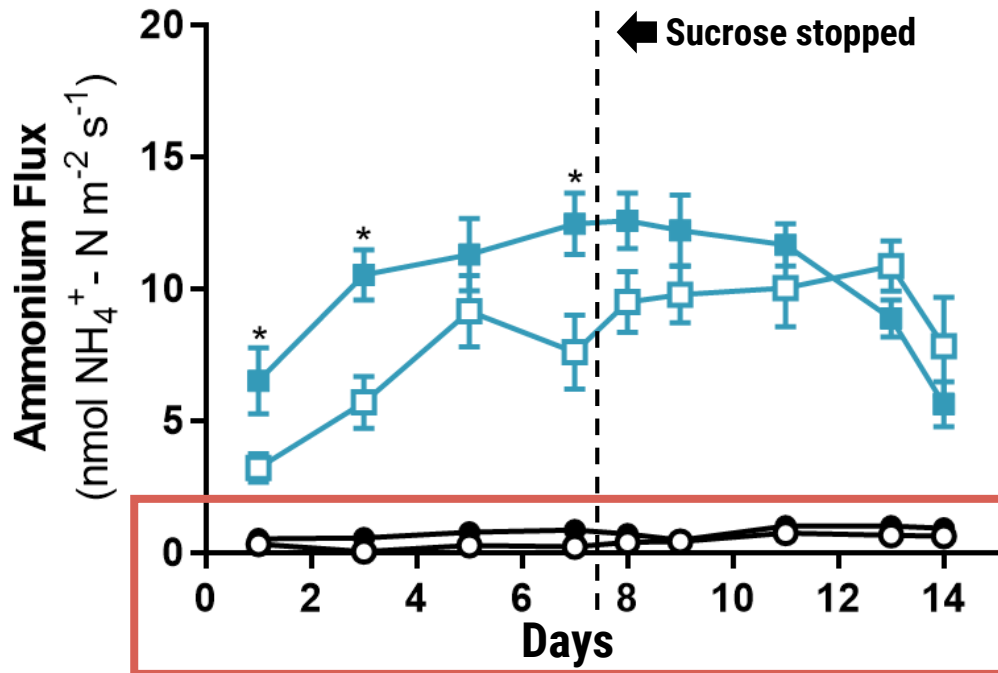


Nitrogen Fluxes

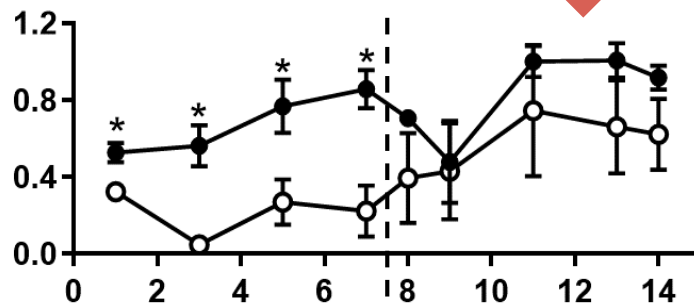
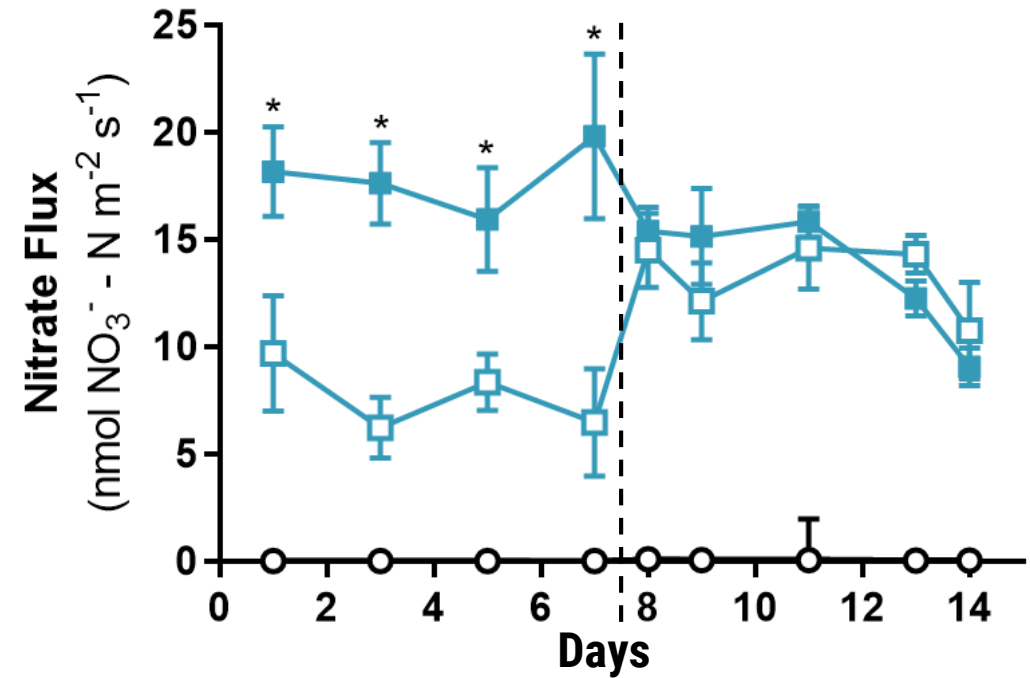
5 mM Sucrose

C exudation promoted N immobilisation

NH_4^+



NO_3^-



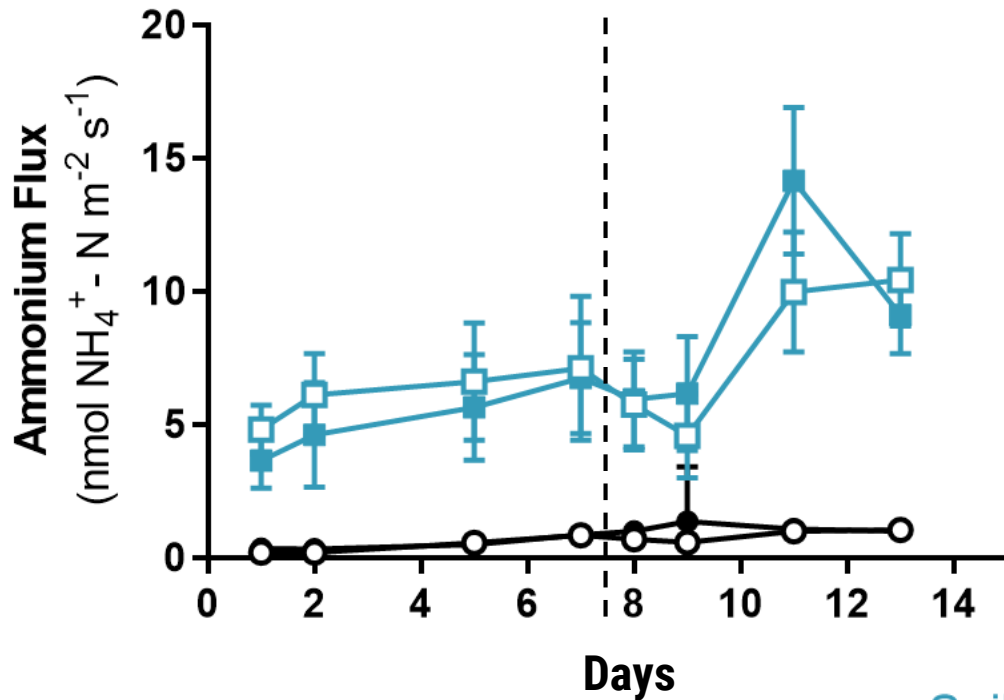
- Soil + Litter
- Soil + Litter + Sucrose
- Soil
- Soil + Sucrose

Nitrogen Fluxes

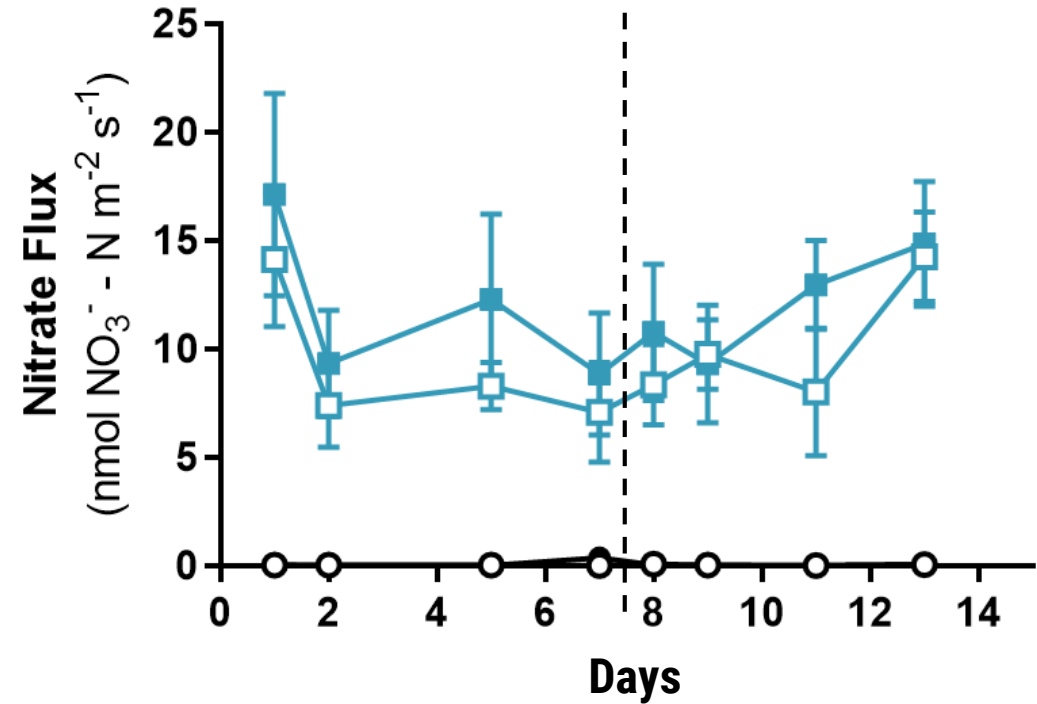
0.5 mM Sucrose

Lower C concentrations had **no effect**

NH_4^+



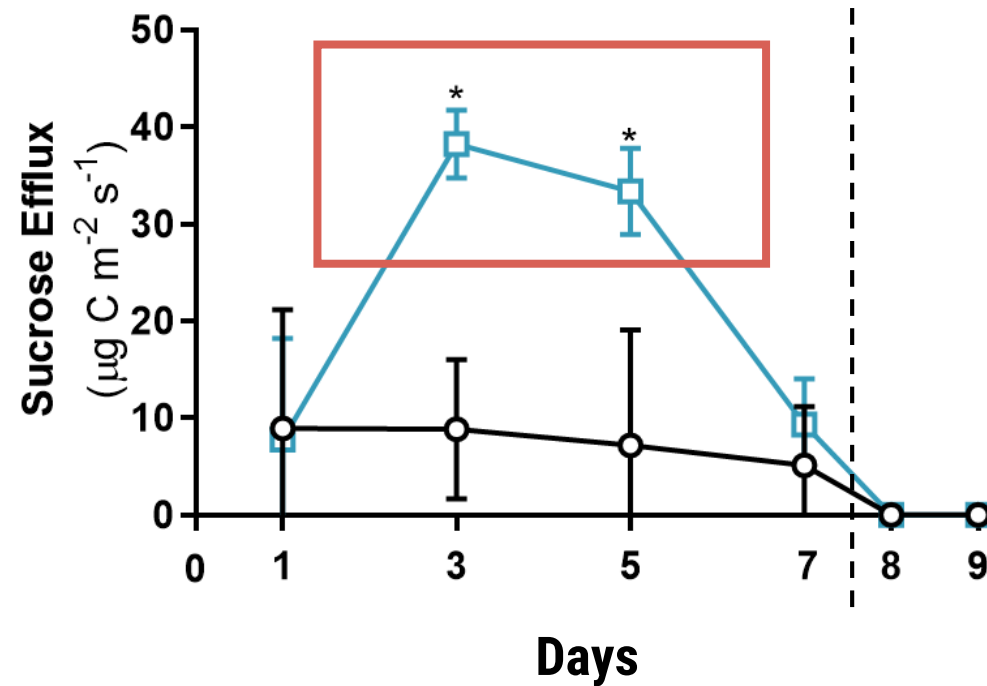
NO_3^-



Exudation Rates

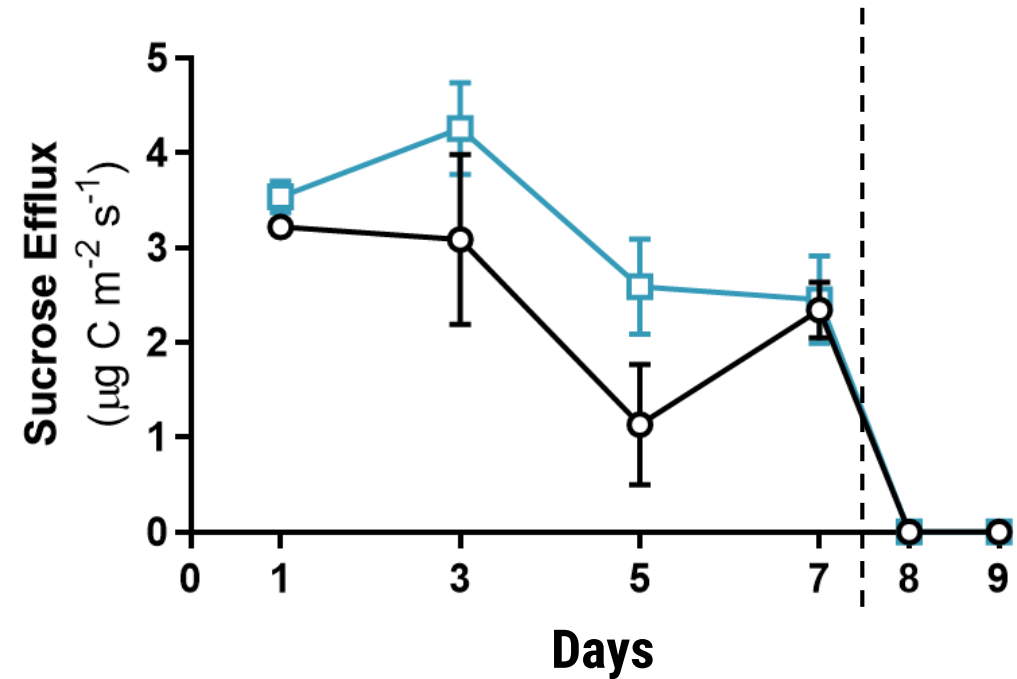
Microbial demand **drives exudation**

5 mM



—□— Soil + Litter + **Sucrose**
—○— Soil + **Sucrose**

0.5 mM



Rates similar to plant exudation rates
($0.1 - 35 \mu\text{g C m}^{-2} \text{s}^{-1}$)

Soluble Sugars

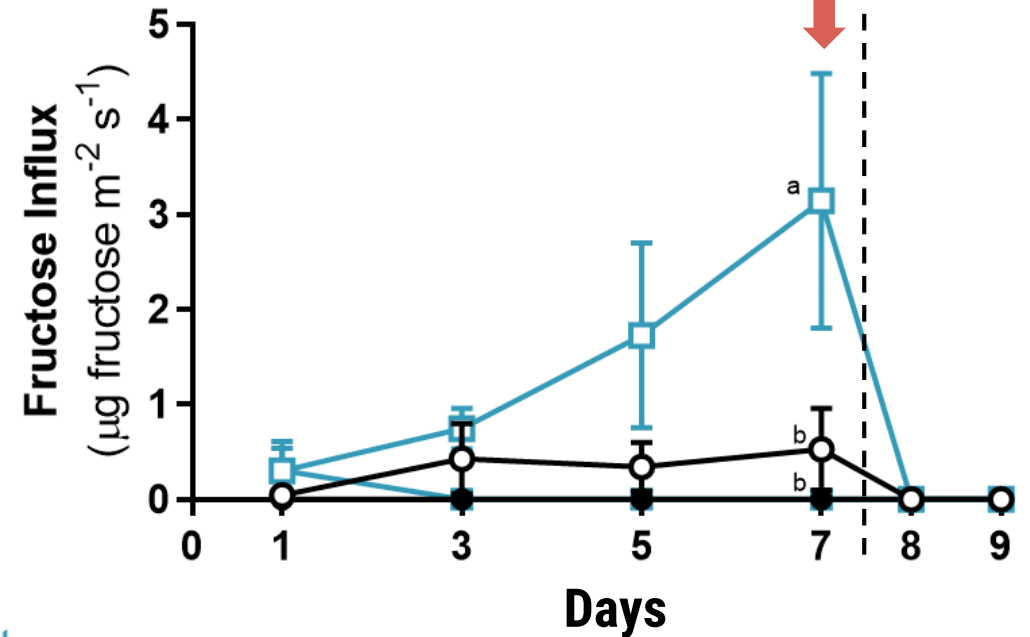
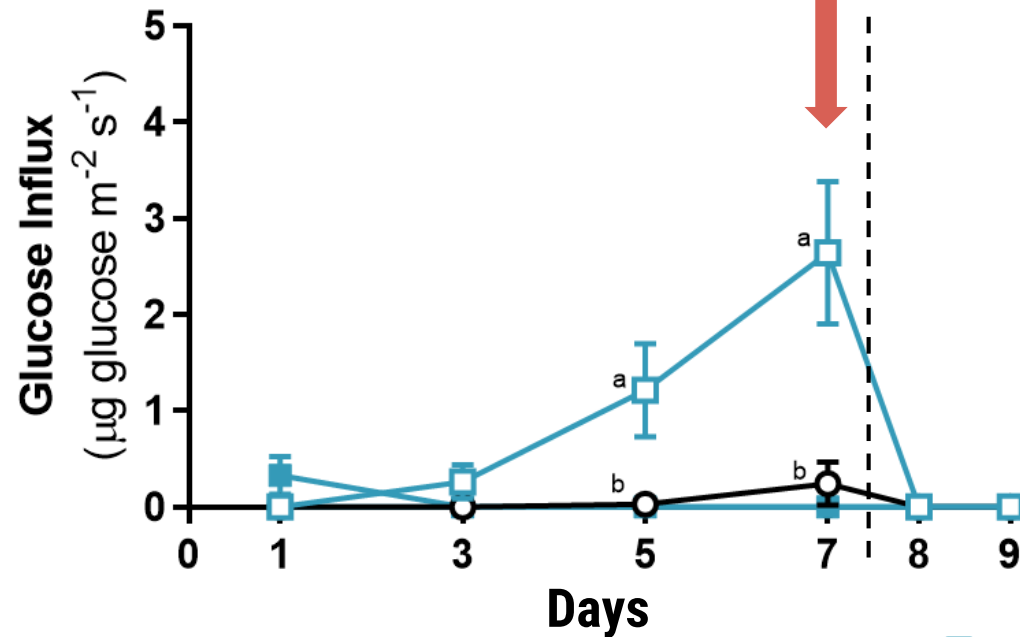
5 mM Sucrose

Microbial activity **increased over time**

Glucose

Fructose

Greater fluxes decreased sucrose depolymerisation?



- Soil + Litter
- Soil + Litter + Sucrose
- Soil
- Soil + Sucrose

Exudation in boreal soils

- › Carbon exudation showed **nil/negative influence on N availability**
 - › More **efficient N use by microbes**
Wild et al. 2017. Biogeochemistry
- › Are there **temporal and spatial benefits?**
 - › Longer time-frames?
 - › Gradients away from root surfaces?

Exudation in boreal soils

- › Boreal forest soils are very **N limited**

- › Stoichiometry of substrates matter

Drake et al. 2013. Biogeosciences.

- › Competition for organic N likely

Schimel & Bennett. 2004. Ecology.

Inselsbacher & Näsholm. 2012. New Phytologist.

- › The next steps...

- › Soil types

- › Organic N fluxes (protein, amino acids)

- › Enzyme activity

Buckley et al. 2019. Soil Biology & Biochemistry

Diffusive Exudation with Microdialysis

- › Exudation via diffusion **modified by microbial demand**
 - › Critical for primary metabolites such as **sugars** and **amino acids** Canarini et al. 2019. Frontiers in Plant Science
- › Plants may have physiological controls that limit effluxes
 - › **SWEET**-related transporters (sugars) Chen et al. 2015. The Plant Journal
 - › **UMAMITs** (amino acids) Tegeder & Hammes. 2018. Curr. Op. in Plant Biol.
- › **Realistic rates**

Thanks for listening!

Keep in touch

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