



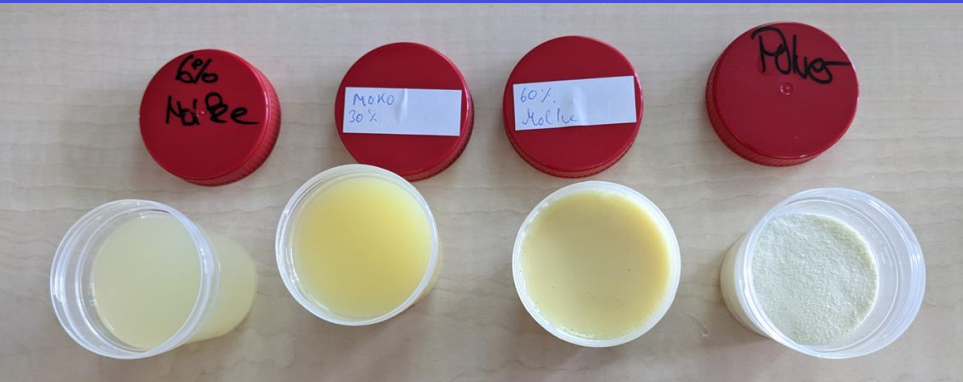
# **Control strategies and process optimization**

**26.09.2023**

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**[b-watersmart.eu](http://b-watersmart.eu)**



## Whey:

Residual liquid from cheese and curd production approx. 94% water, 4-5 % lactose, 0.6-1 % proteins, plus vitamins and minerals.

## Vapour condensate:

arises from the evaporation of milk or whey



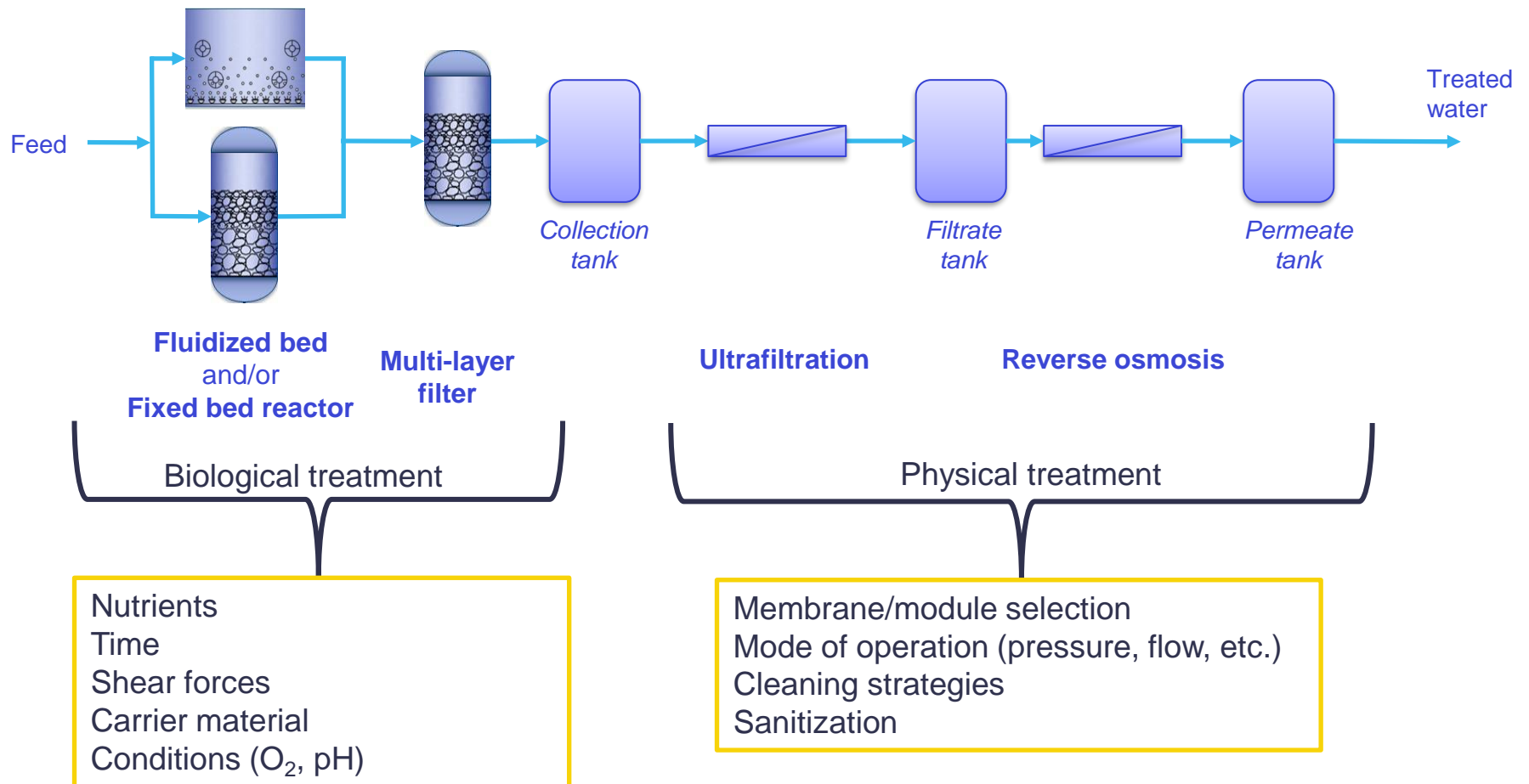
## Treatment process



## What are the relevant parameters?

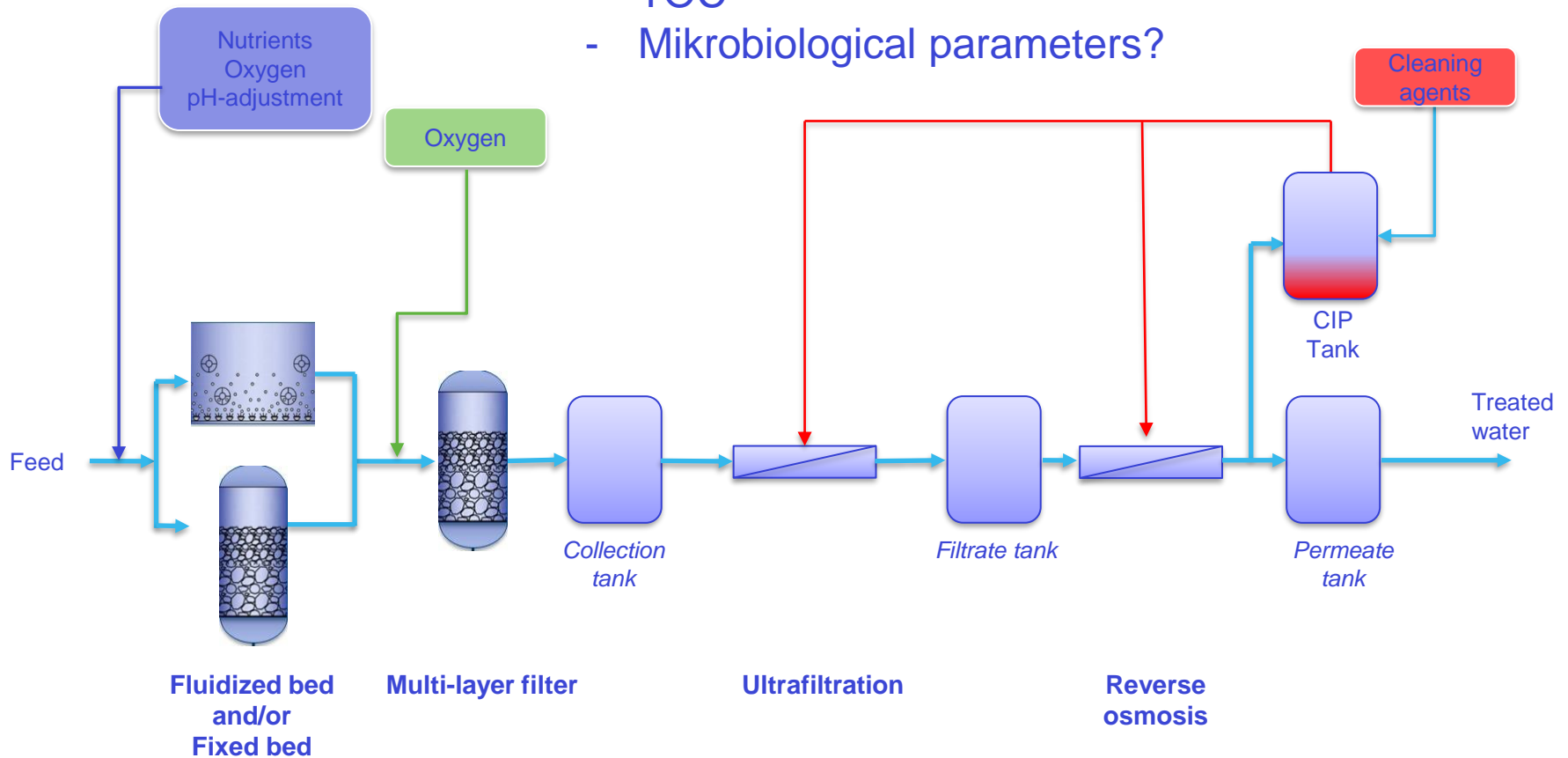
Parameter	Unit	TrinkwV	Drinking water	Vapour condensate
pH-value	-	$\geq 6,5$ und $\leq 9,5$	7,9	6,3
Conductivity	$\mu\text{S/cm}$	2790	324	15
Turbidity	NTU	1	0,3	1,8
Sodium	mg/l	200	13	< 0,5
Iron (total)	mg/l	0,2	0,008	< 0,02
Ammonium	mg/l	0,5	0,02	2,4
Chloride	mg/l	250	22	< 5
Nitrate	mg/l	50	< 2,5	< 5
COD	mg/l O <sub>2</sub>		0,4	26

# Which parameters are relevant for monitoring and controlling the treatment process?



# Sampling interval: online vs. offline

- Pressure, flow rate
- Temperature, pH, oxygen, conductivity, turbidity
- TOC
- Mikrobiological parameters?





# Biological treatment steps



1. Fixed bed reactor
2. Fluidized bed reactor
3. Multi-layer filter





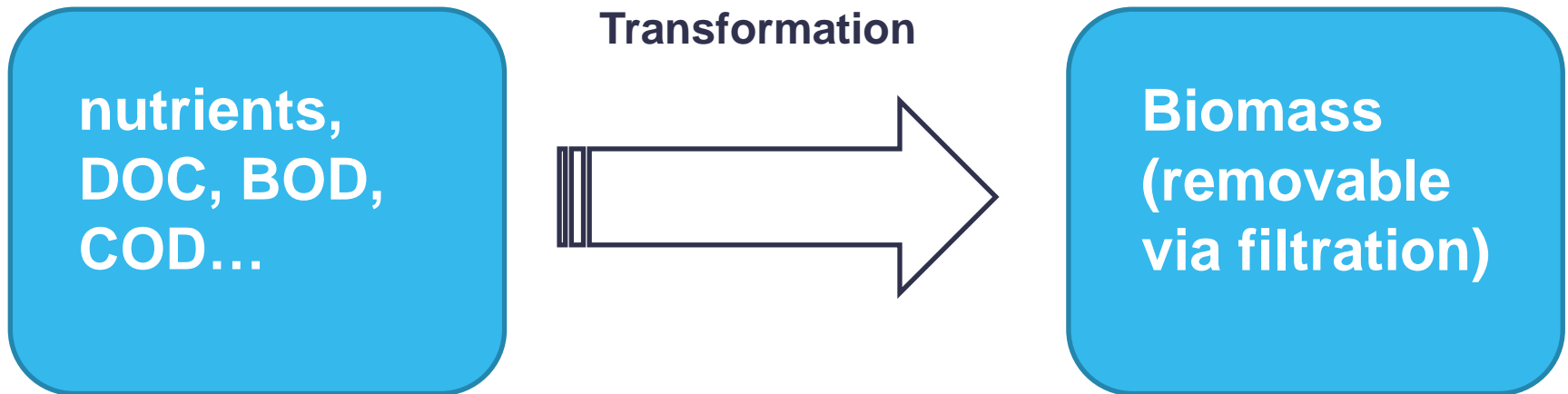
# Growth bodies

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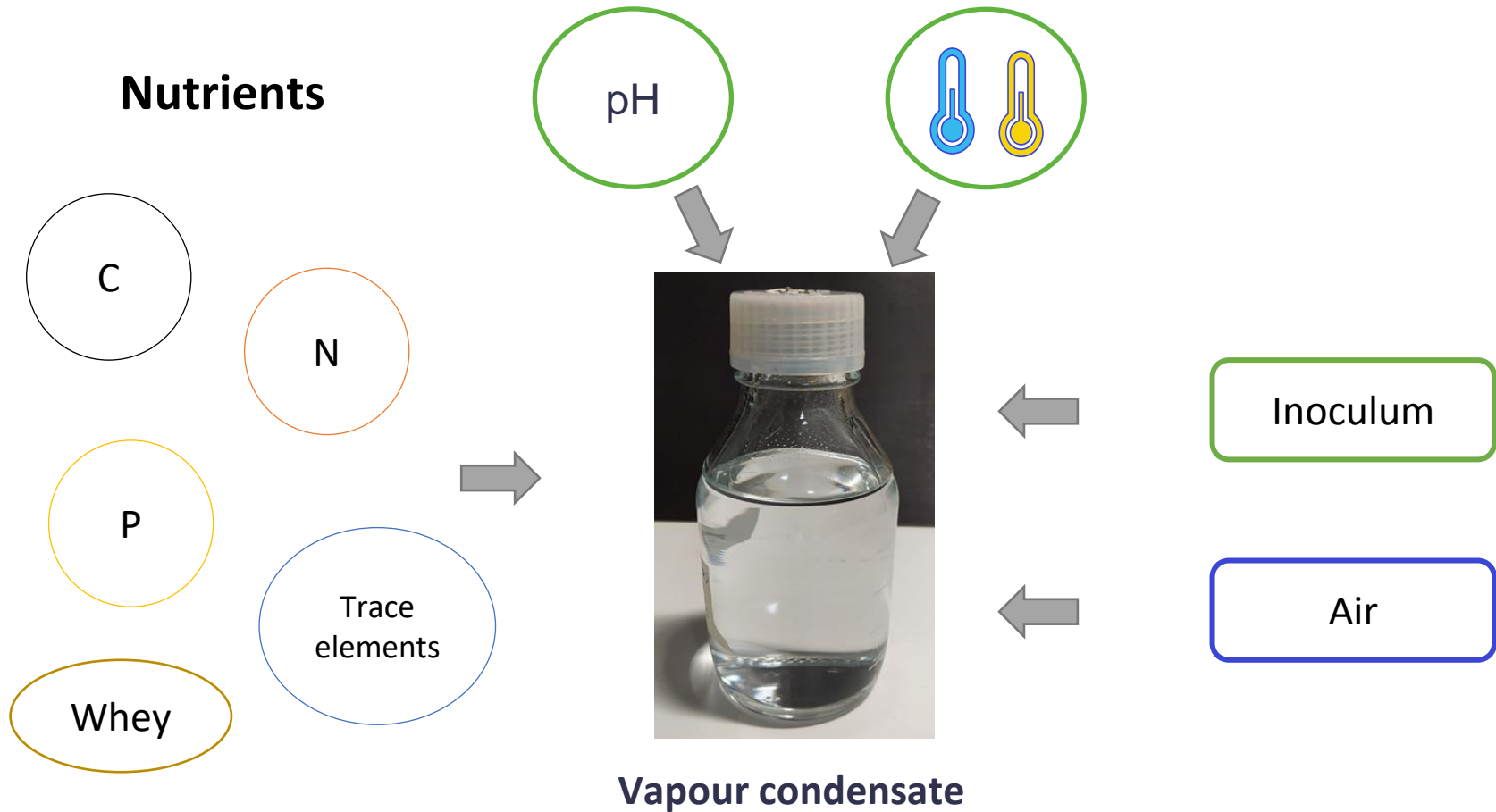


# Nutrient removal through biological transformation

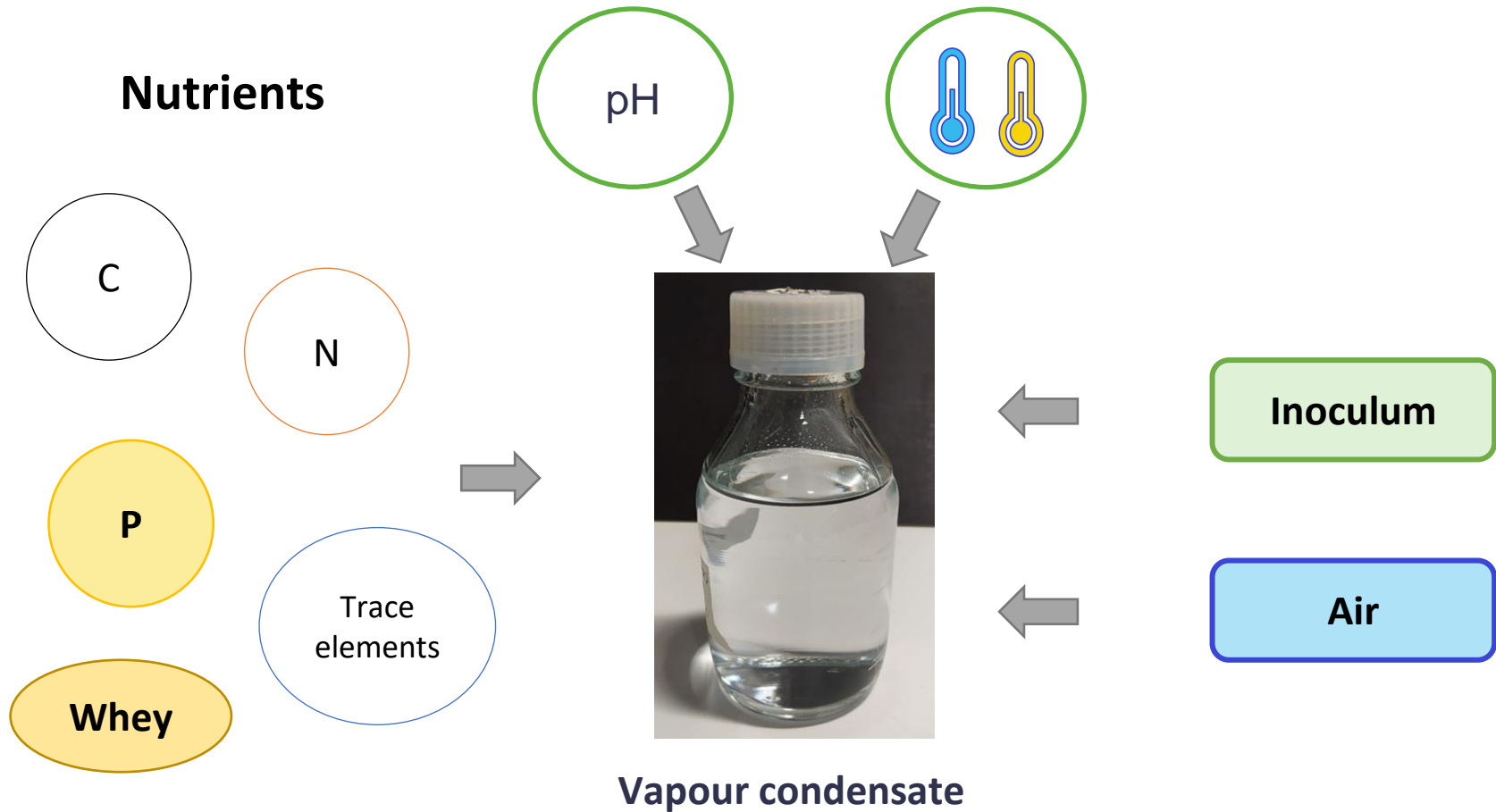


The challenge of the biological stages is to efficiently transform nutrients into biomass that is subsequently removed.

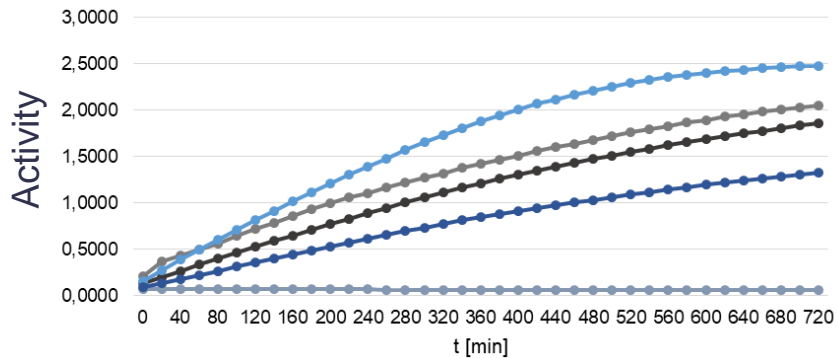
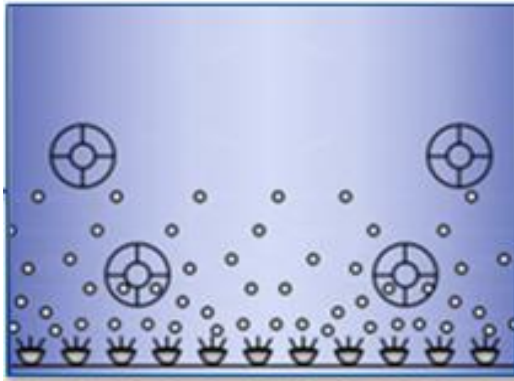
# What promotes growth in vapour condensates?



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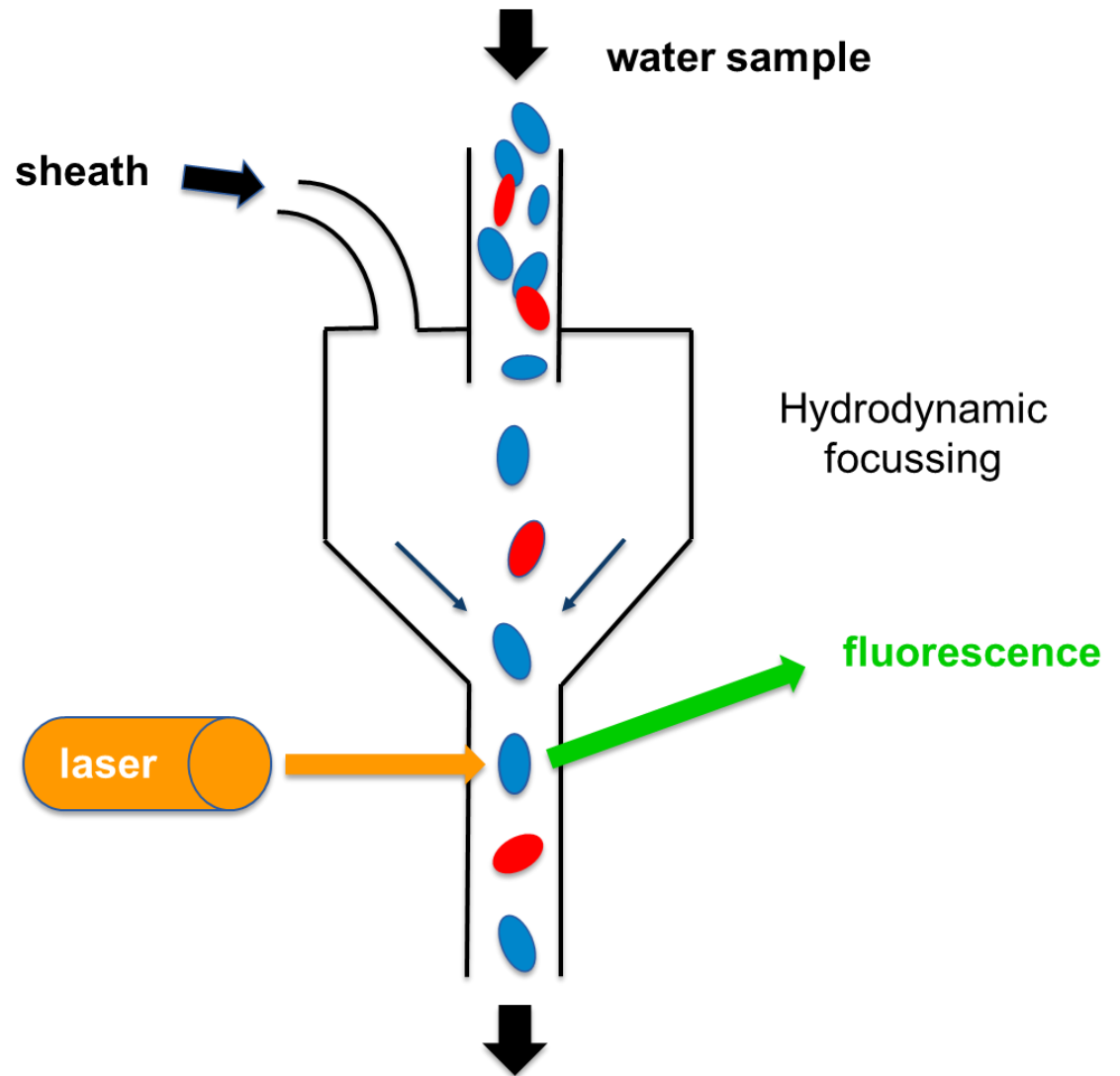
# Growth bodies



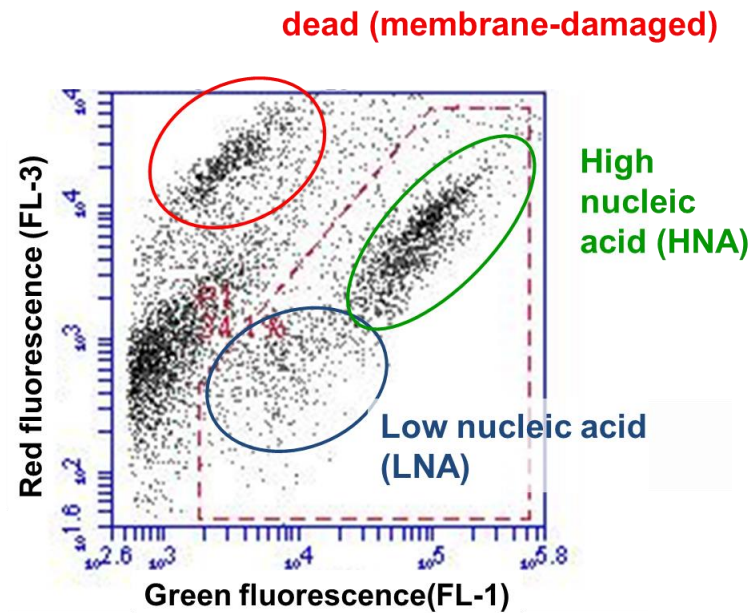
The growth and metabolic activity of the bacteria varies between different growth bodies.



## Principle of flow cytometry



## Example of microbiological water profile

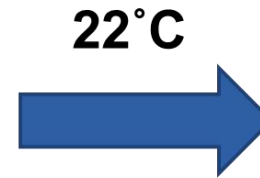
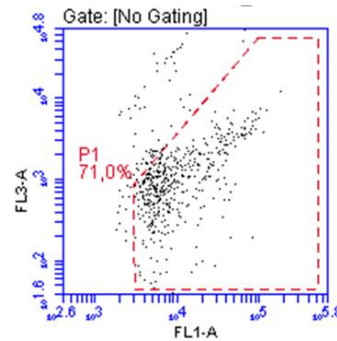


- Detection based on fluorescent staining
- Every signal in gated area represents one bacterium
- Detection of either total or intact bacteria
- Time demand: 15 min

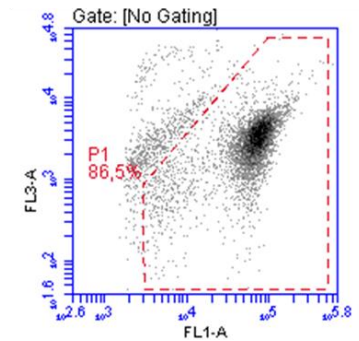
# Bacterial regrowth potential



**Day 0**



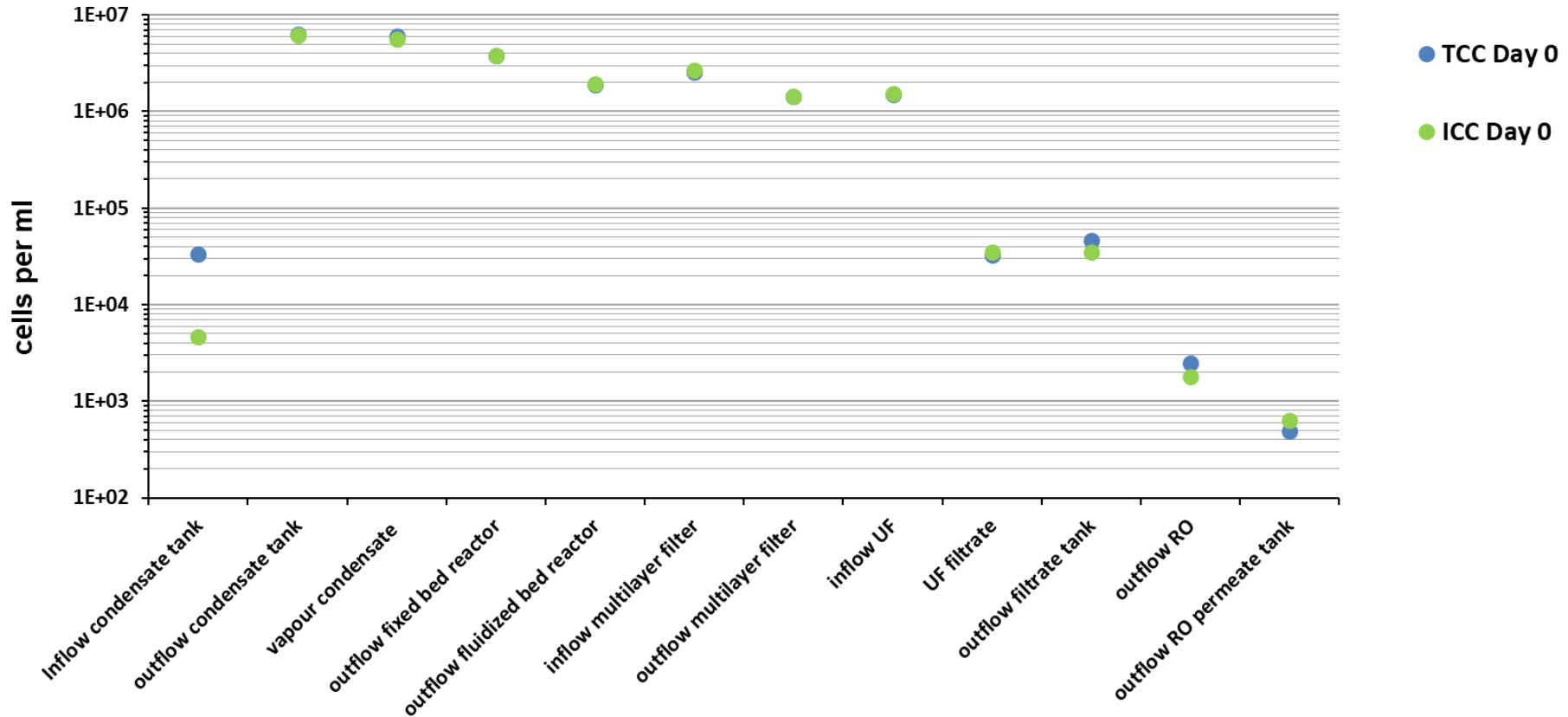
**Day 7**



# Changes of cell concentrations along the treatment train

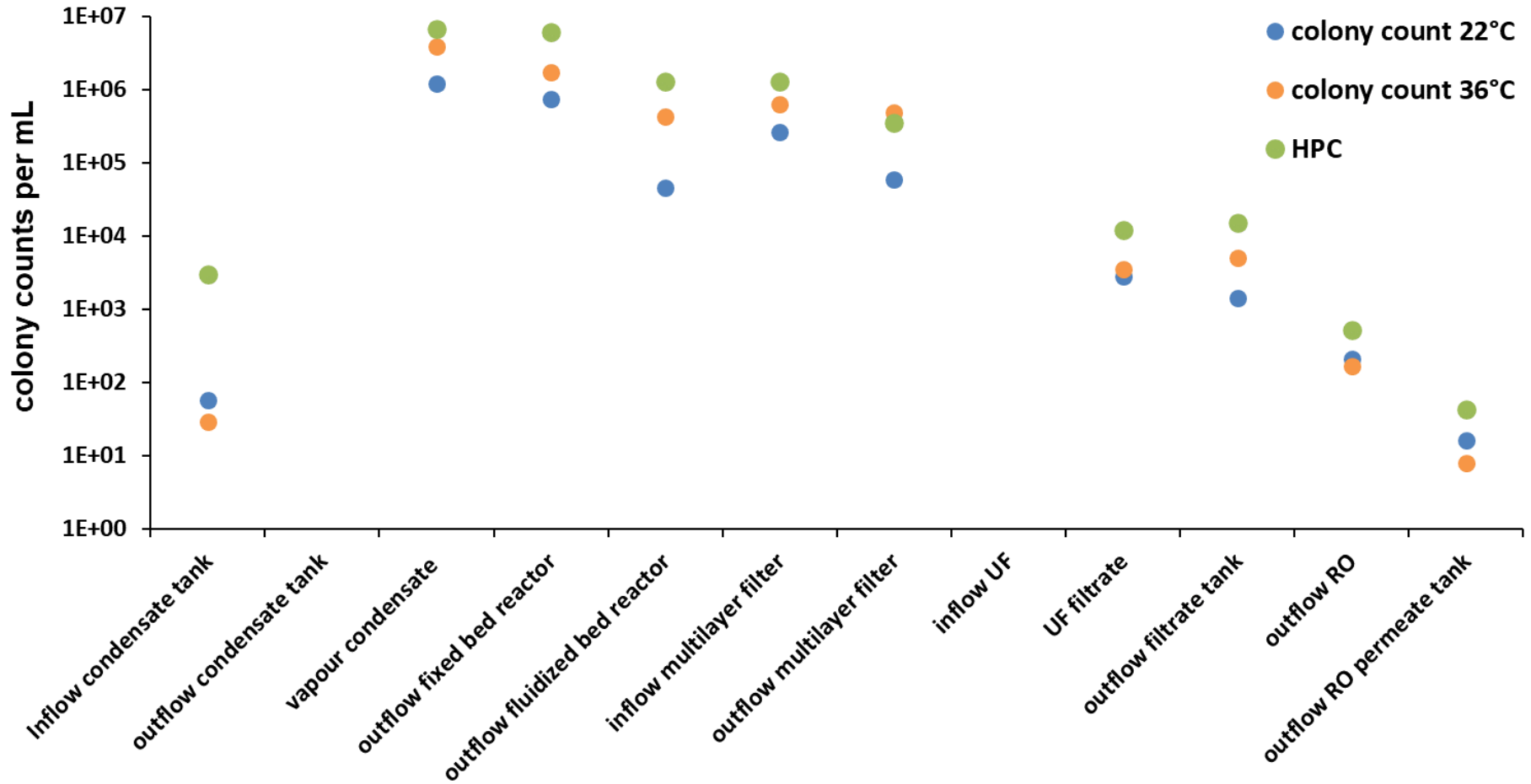
Day 0: reflects time point of sampling

TCC = total cell count  
IZZ = intact cell count



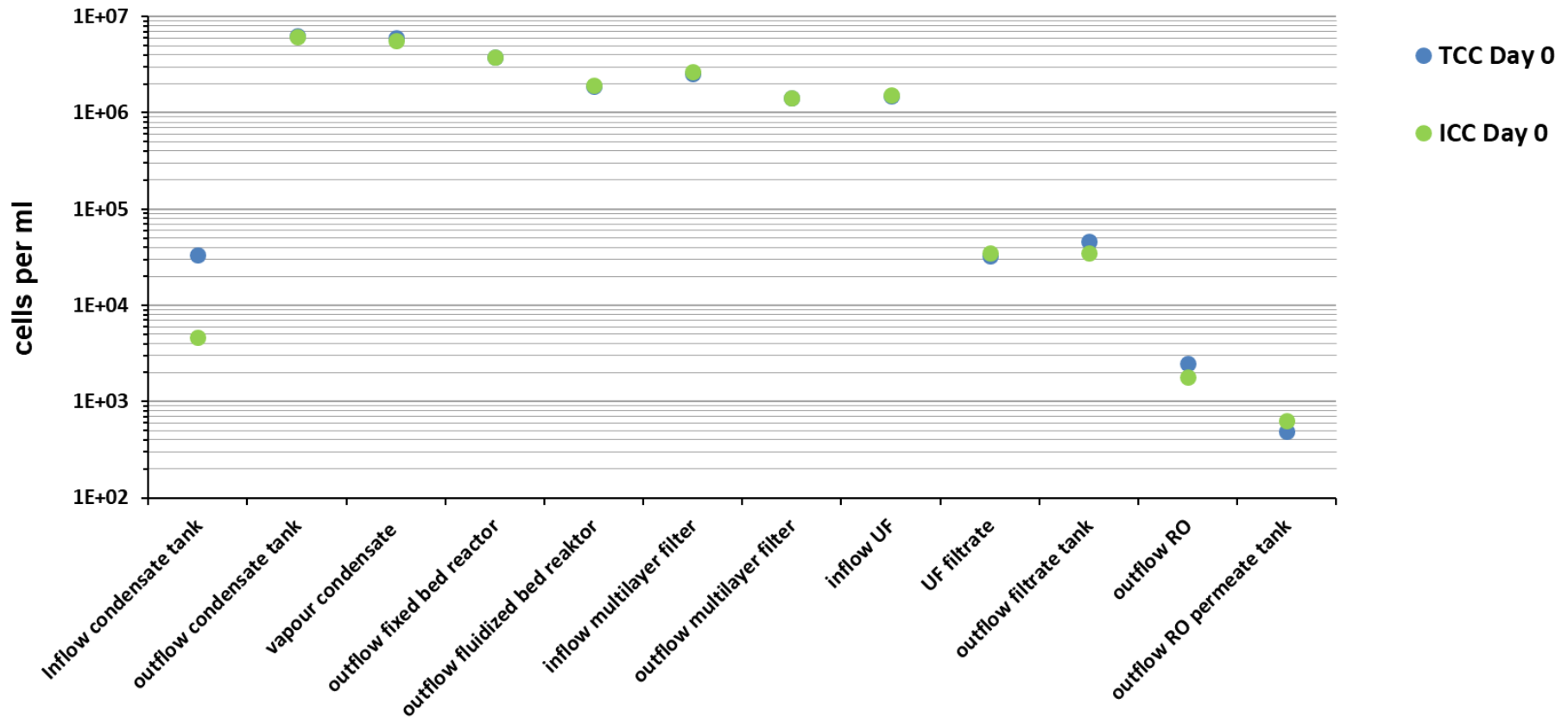


# Changes in culturable bacteria



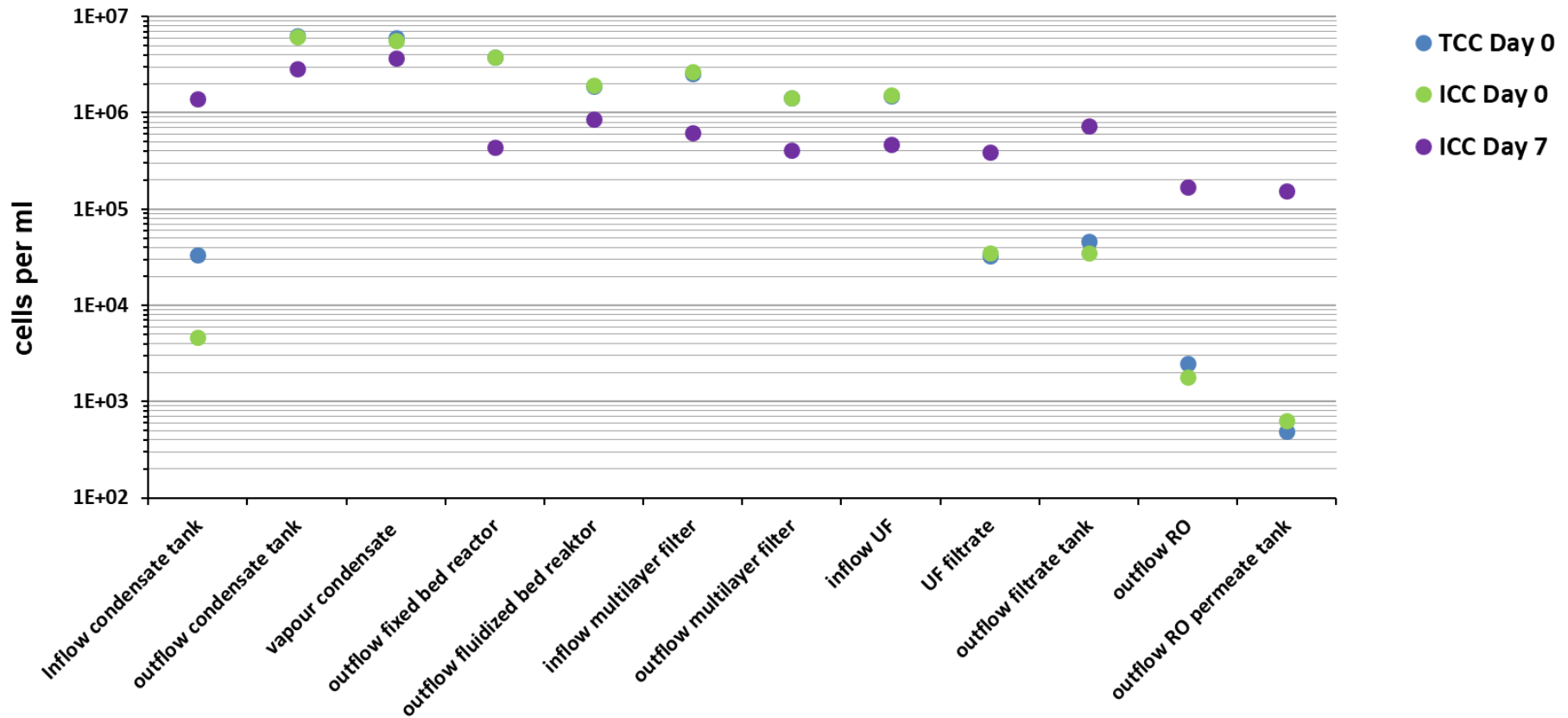
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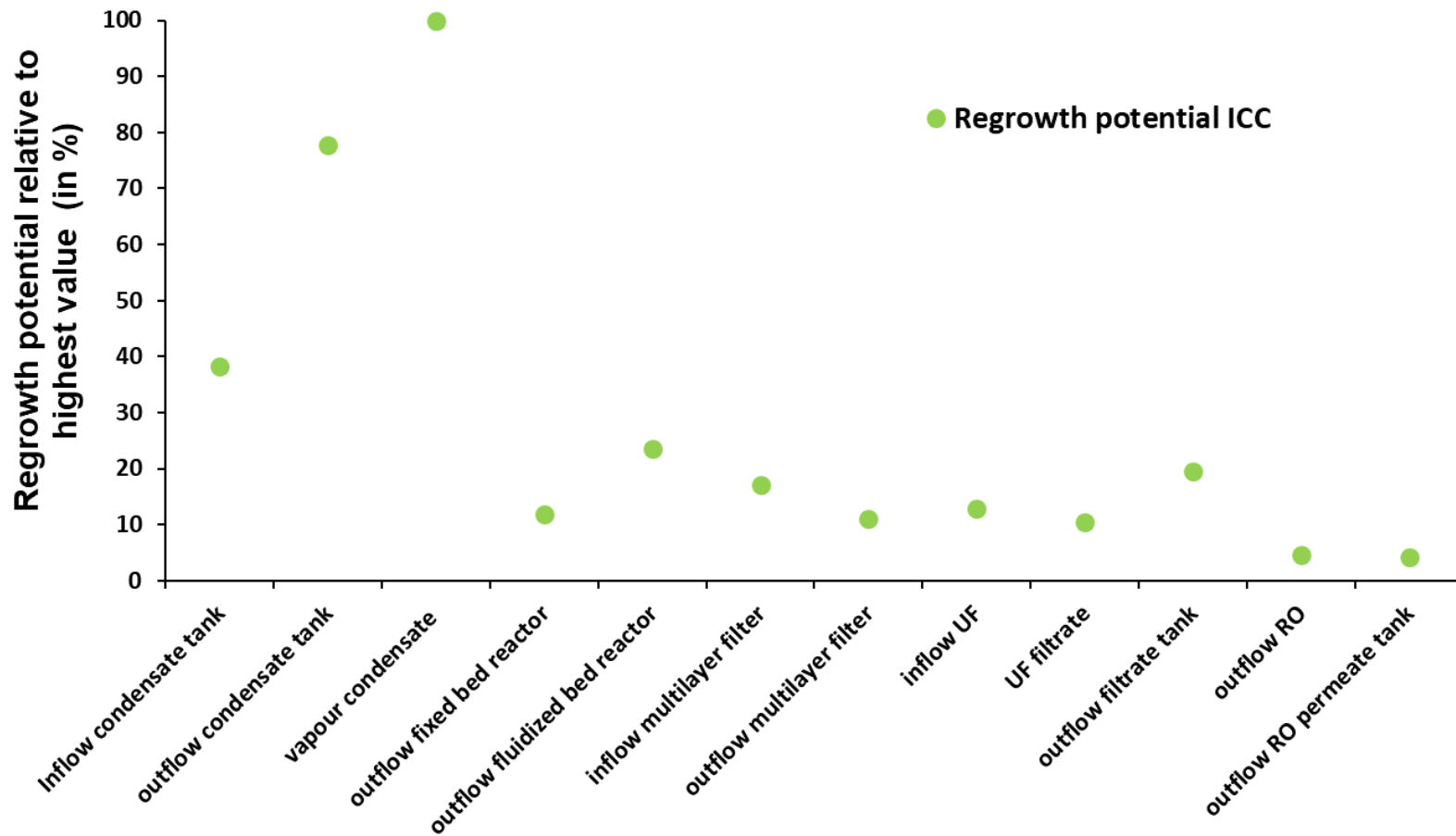


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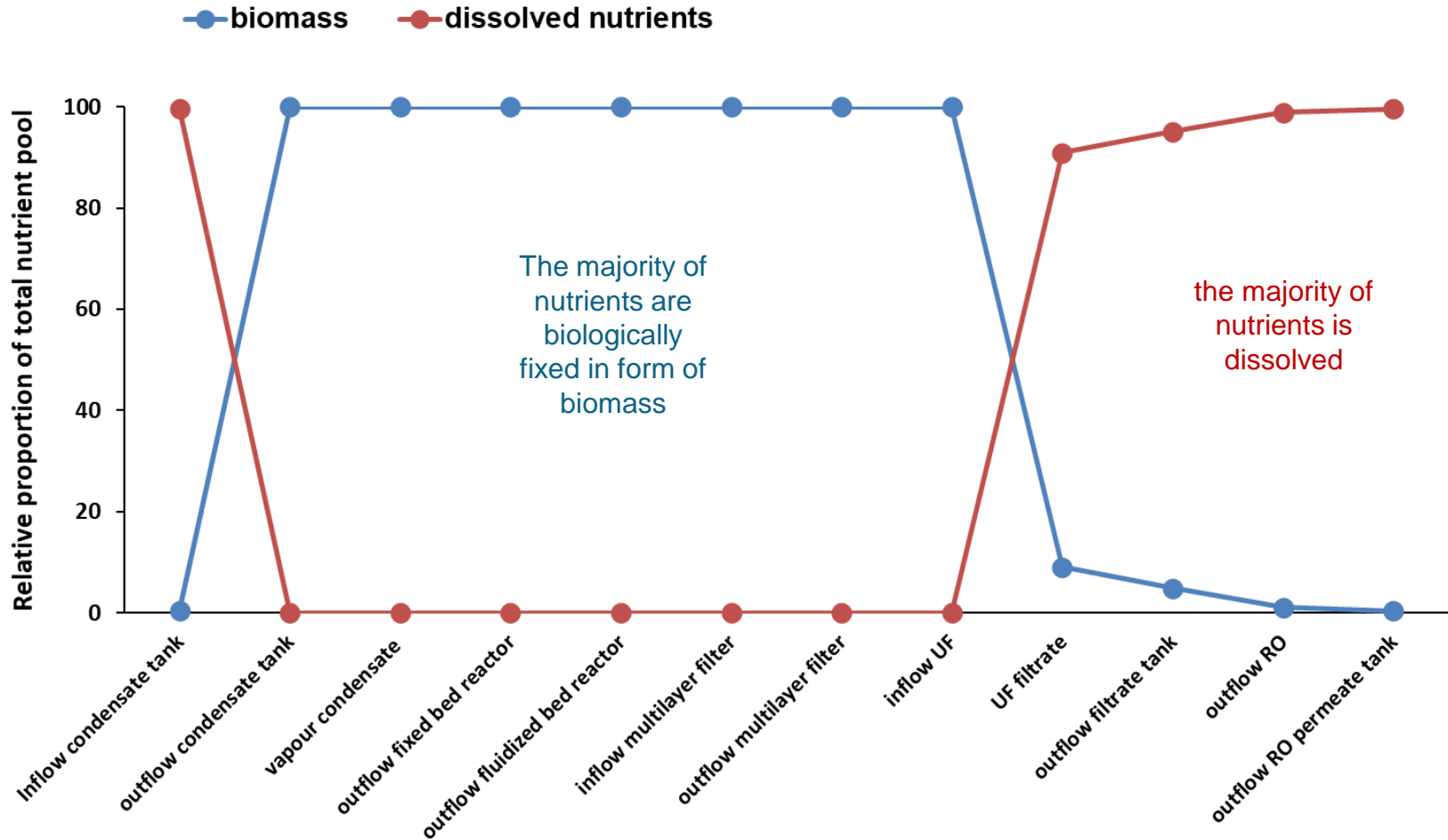


# Changes of regrowth potential along treatment train: linear scale

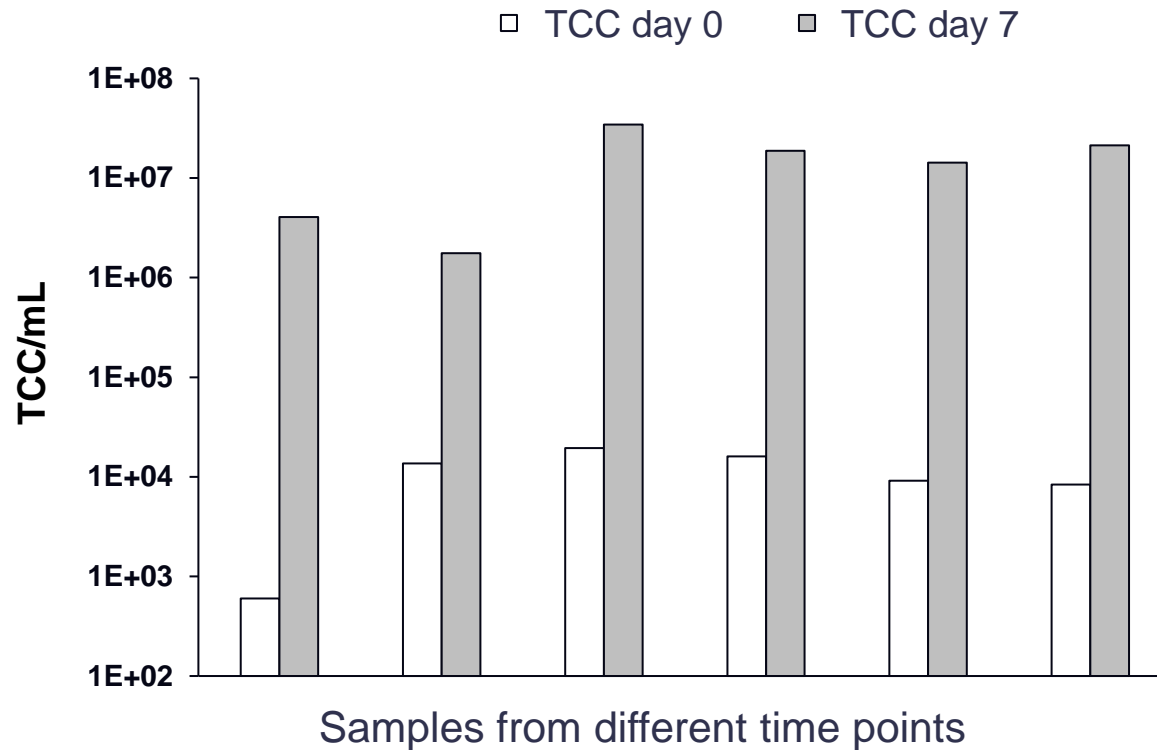




# Biomass vs. dissolved nutrients



## Challenge: temporal fluctuations in vapour composition



Same type of vapour from the same sampling site, but sampling at different times: strong differences in cell concentrations and regrowth potentials

# Questions?

Who?

How?

Where?



What?

Why?



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 869171. The publication reflects only the authors' views and the European Union is not liable for any use that may be made of the information contained therein.