Gravity Driven Membrane Disinfection for household drinking water treatment

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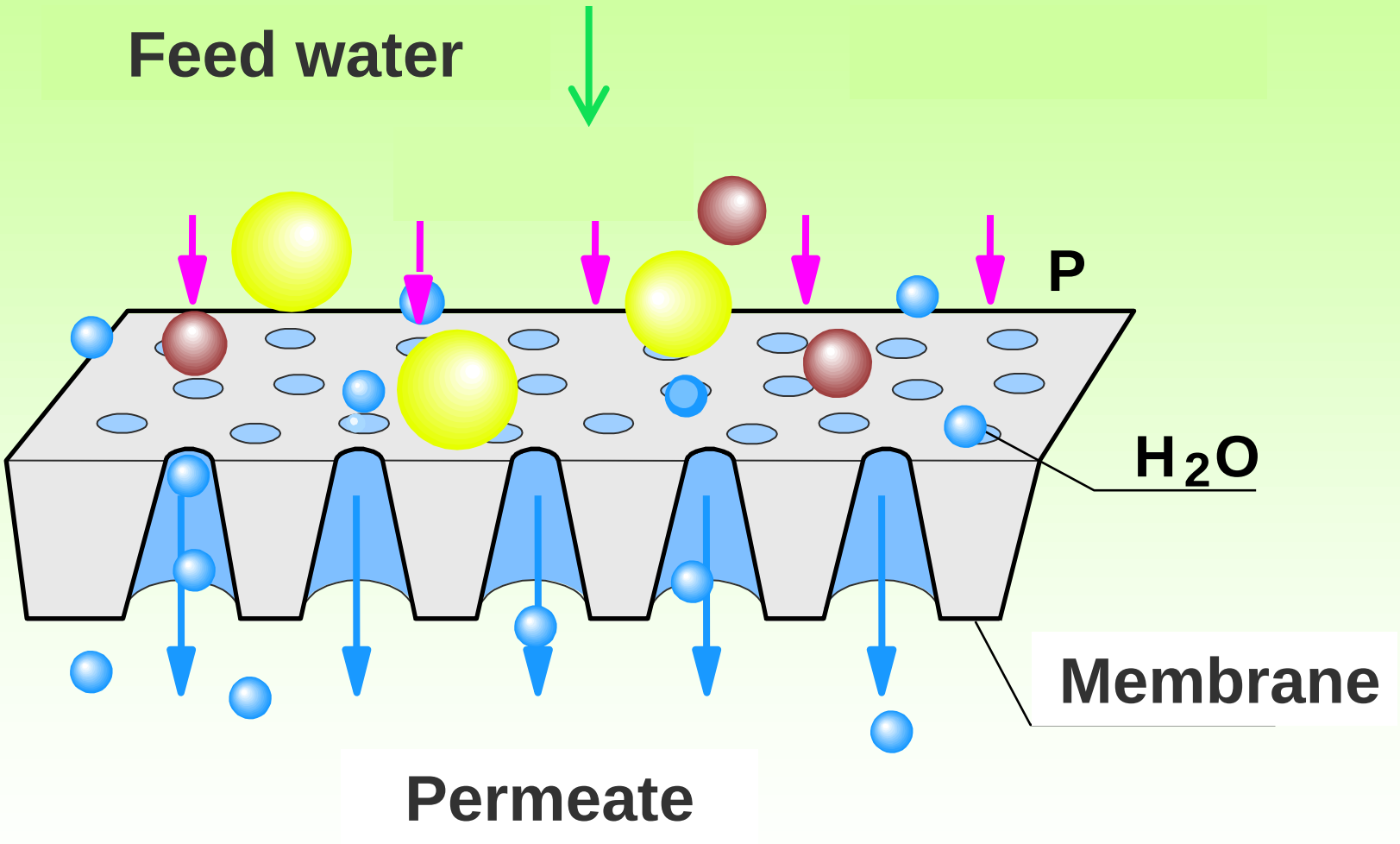
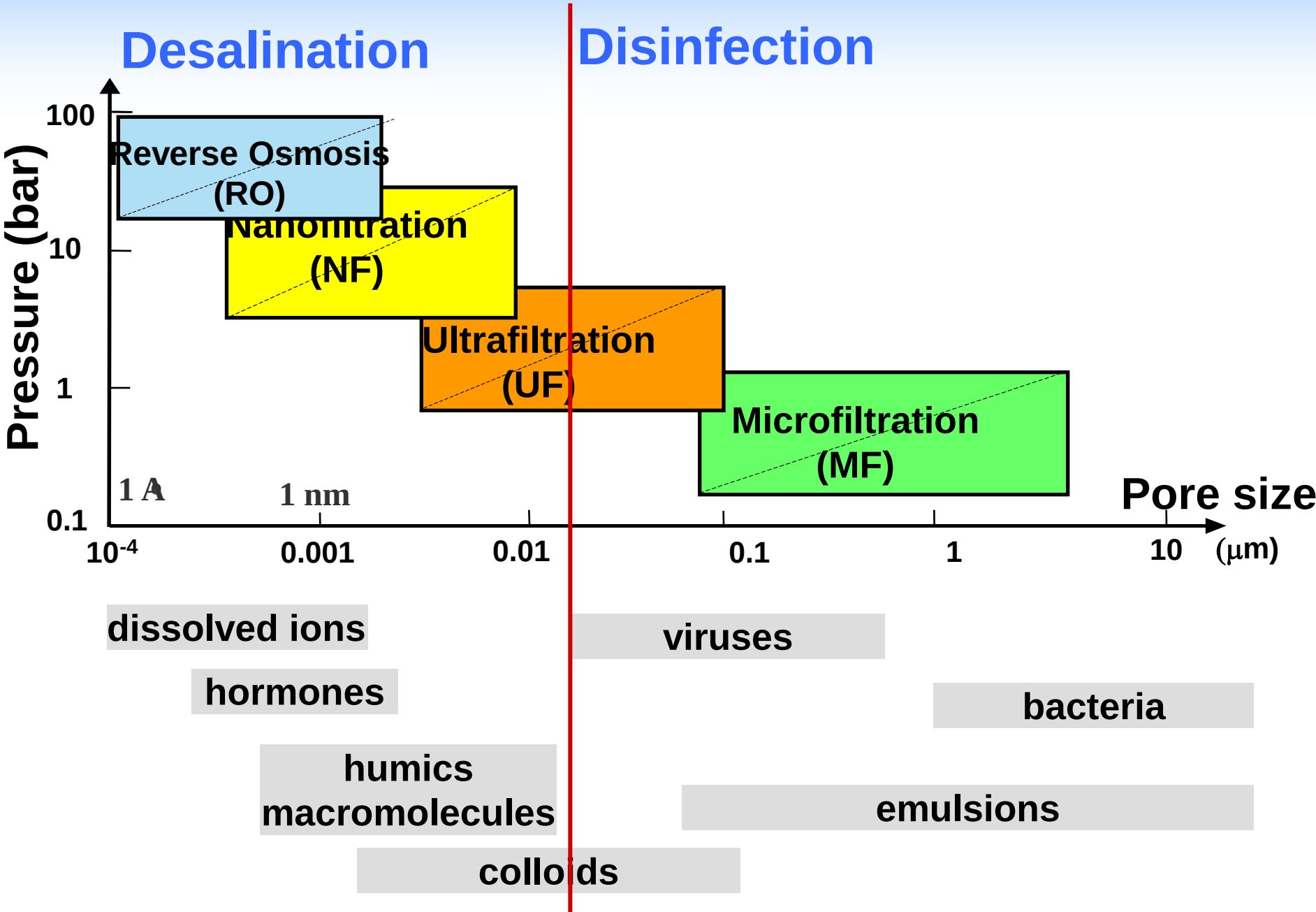
Principle of membrane filtration



Membrane filtration processes

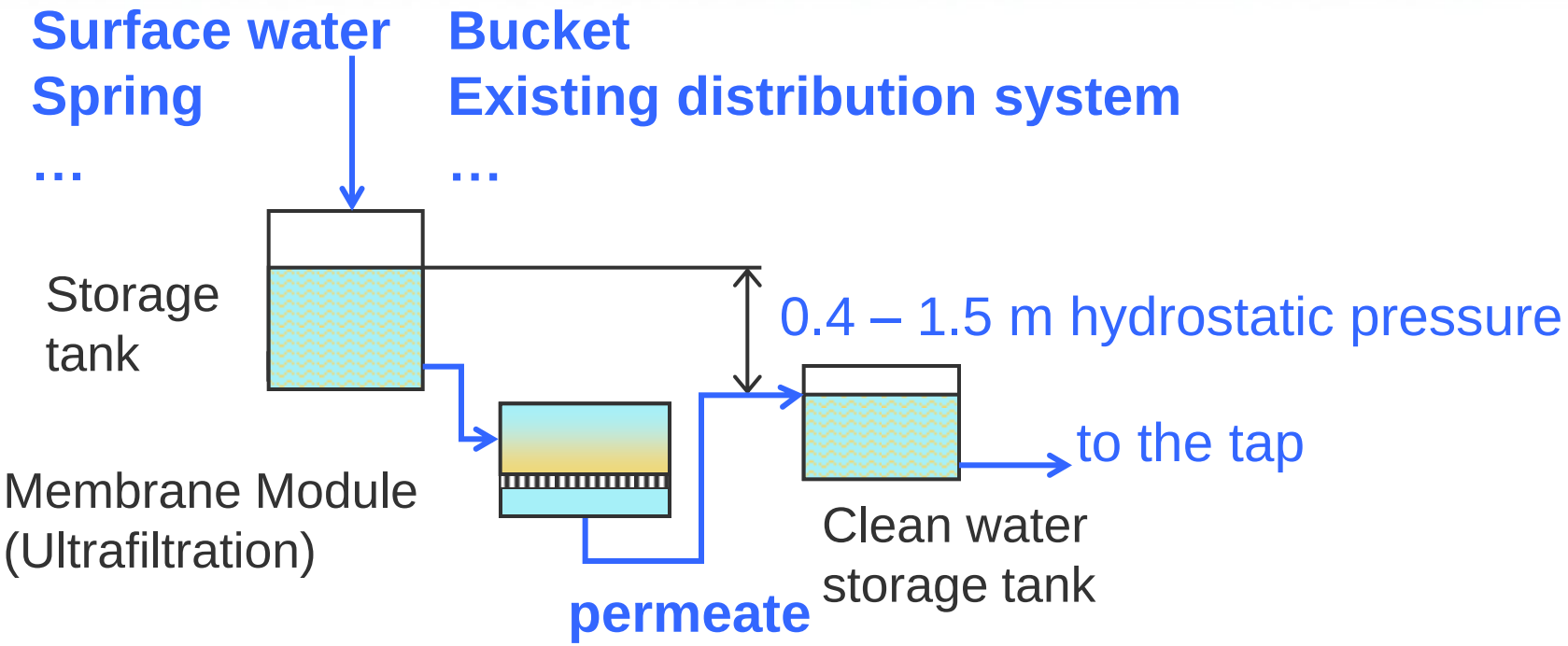


Disinfection → Ultrafiltration

Operation of Ultrafiltration on any scale requires:

- ✓ **Regular backflushing**
- ✓ **Disinfection**
- ✓ **Chemical cleaning**
- ✓ **Pre-treatment**
- ✓ **Pressure of 1-10 m water column**

Concept of Gravity-Driven Membrane (GDM) filtration

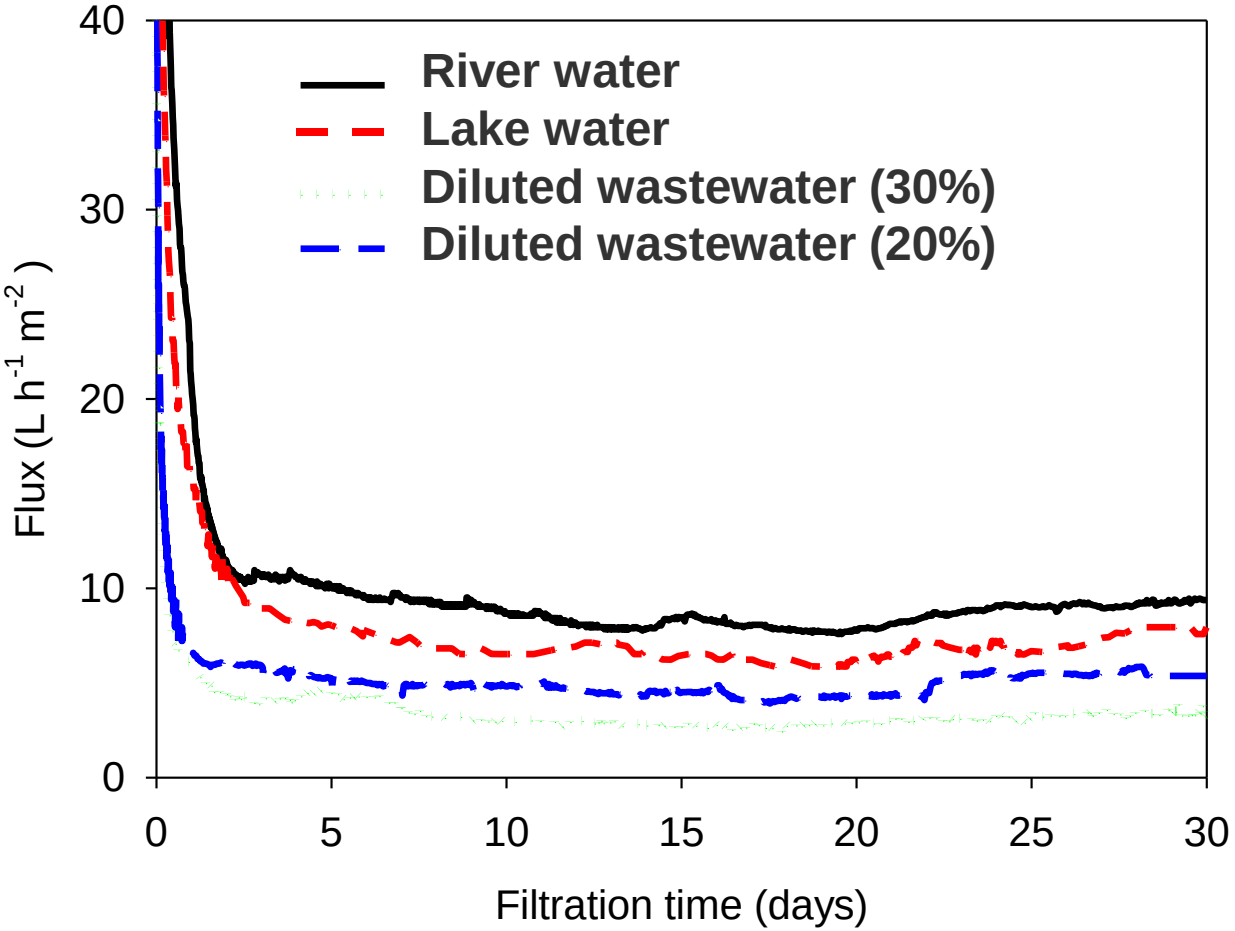


Membrane fouling and clogging is expected but does not occur

Due to the phenomenon of flux stabilization

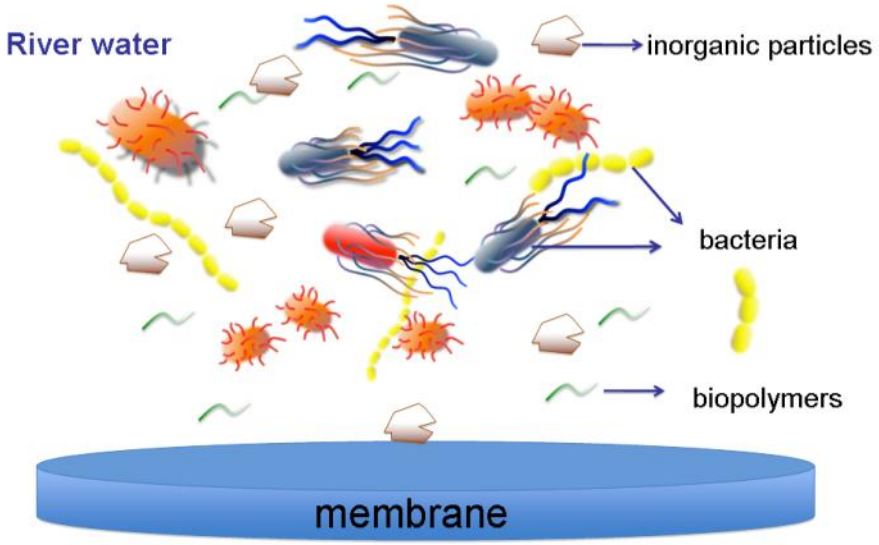
The phenomenon of flux stabilization

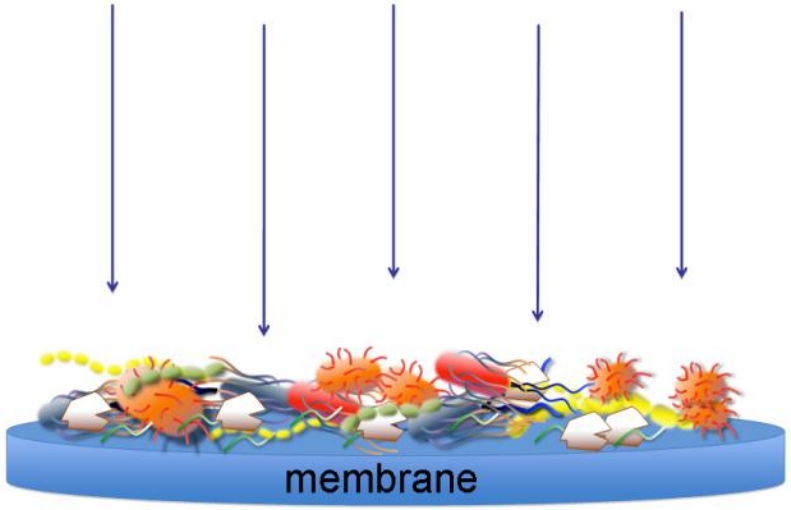
No cross-flow **No backflush** **No cleaning**



Flux stabilizes on a level of 4-10 (L $h^{-1}m^{-2}$) for at least 2 years

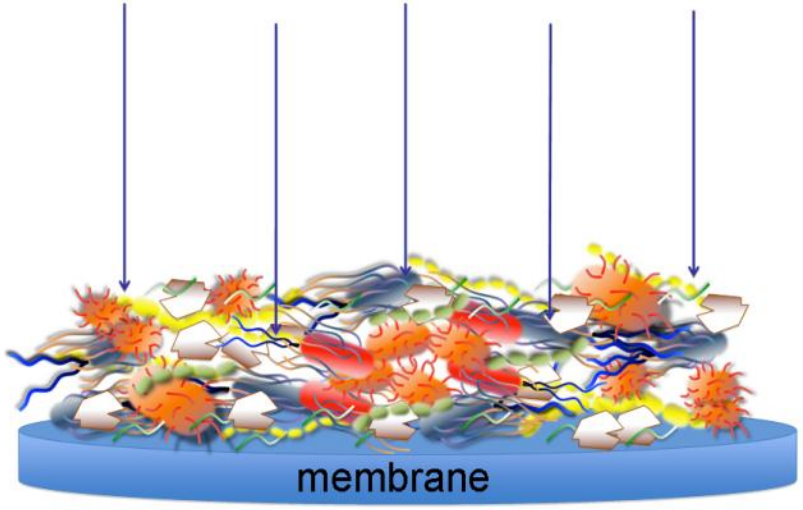
48 - 120 L/day with 0.5 m^2 membrane

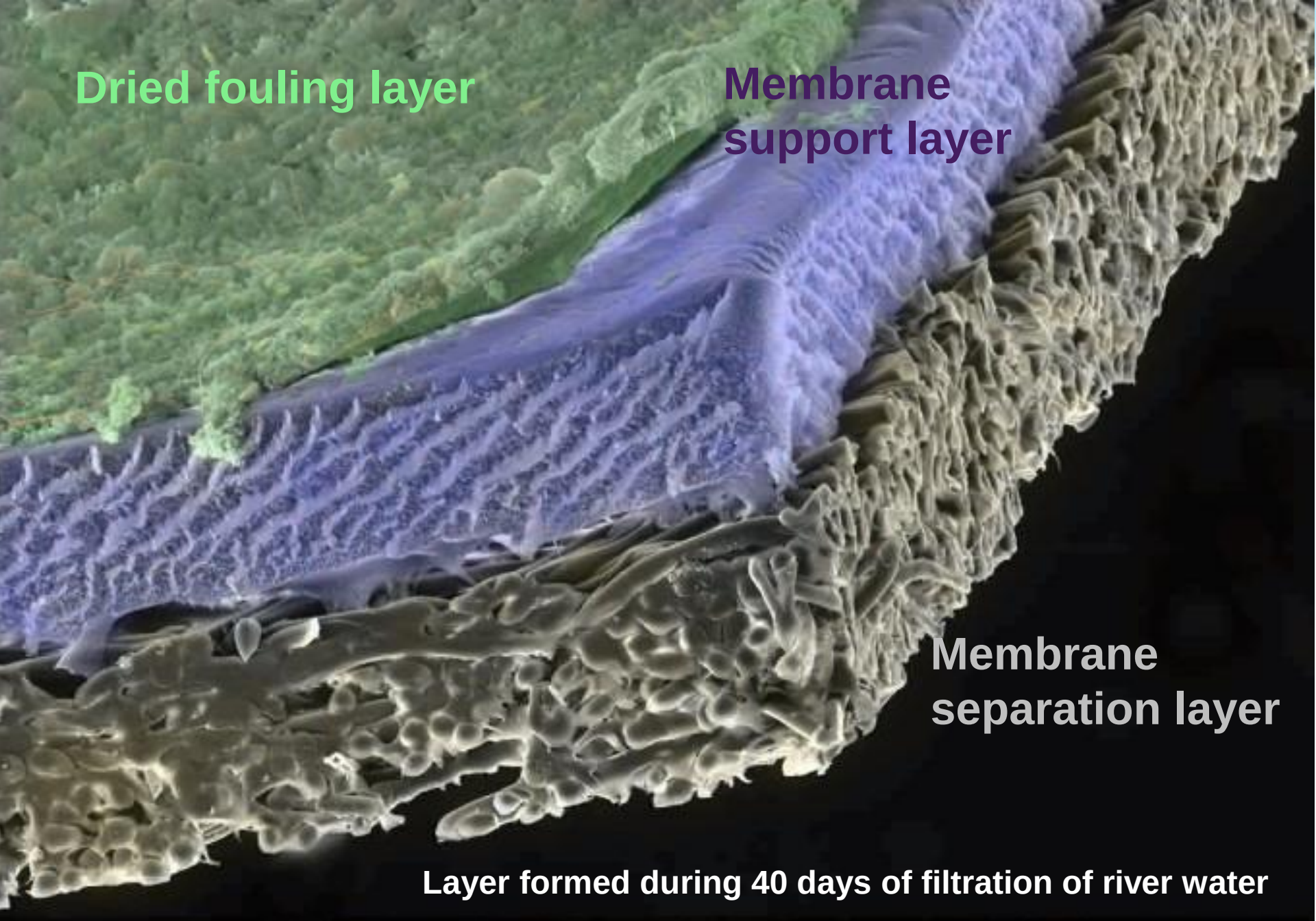




- Particulate and dissolved material deposits on membrane

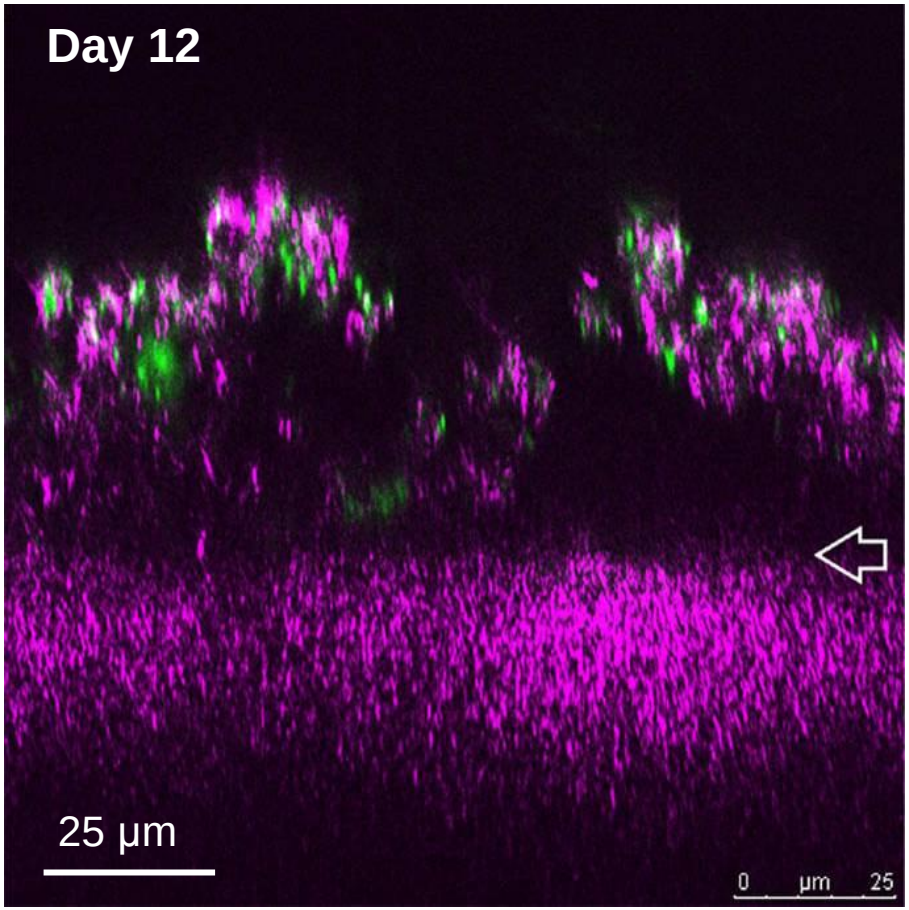
- Thickness of the layer increases in time

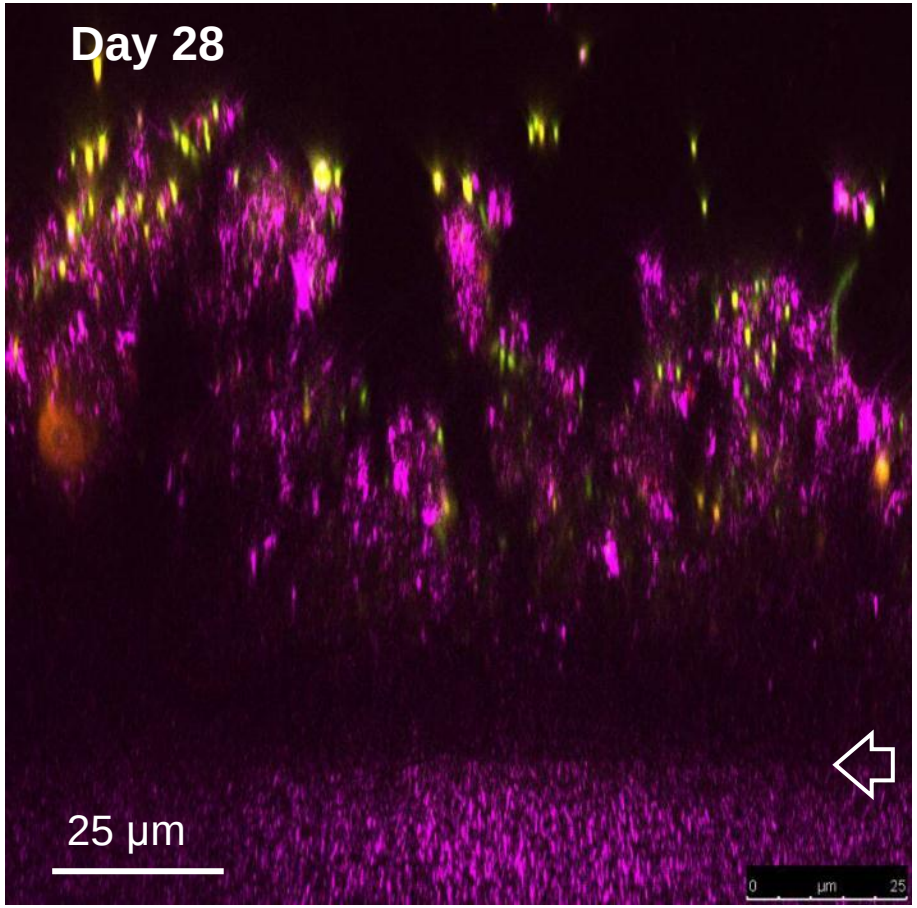




Layer formed during 40 days of filtration of river water

Fouling layer visualized by laser microscopy



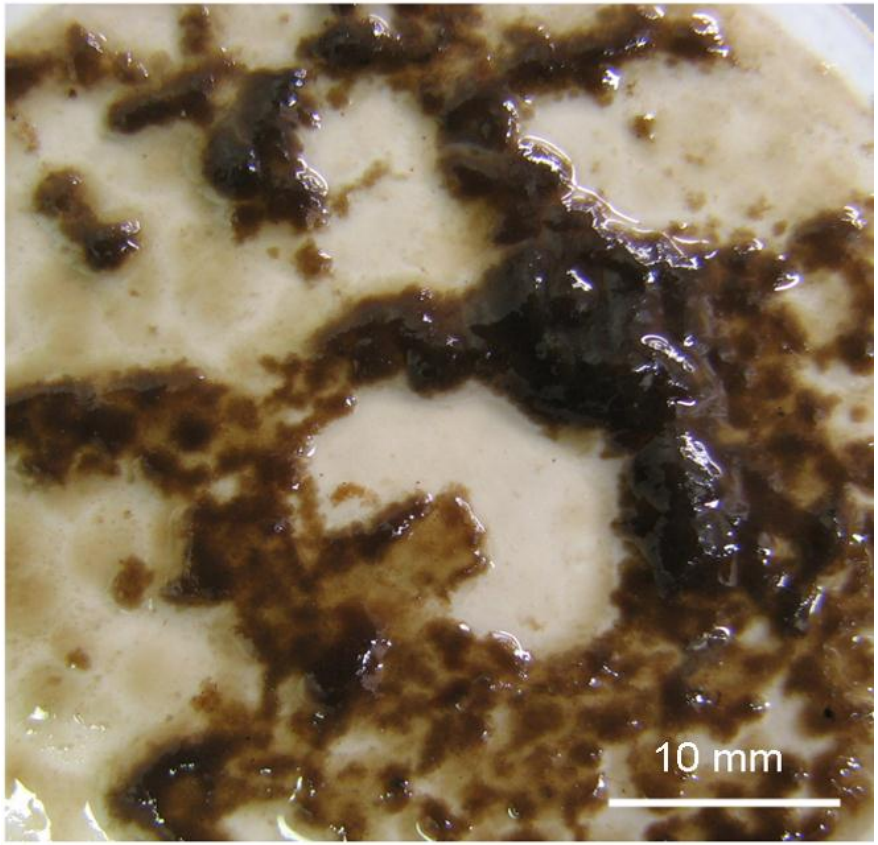


- All bacterial cells (SYBR® Gold)
-Particles and the membrane (Reflection)

Fouling layer structure on macro-scale

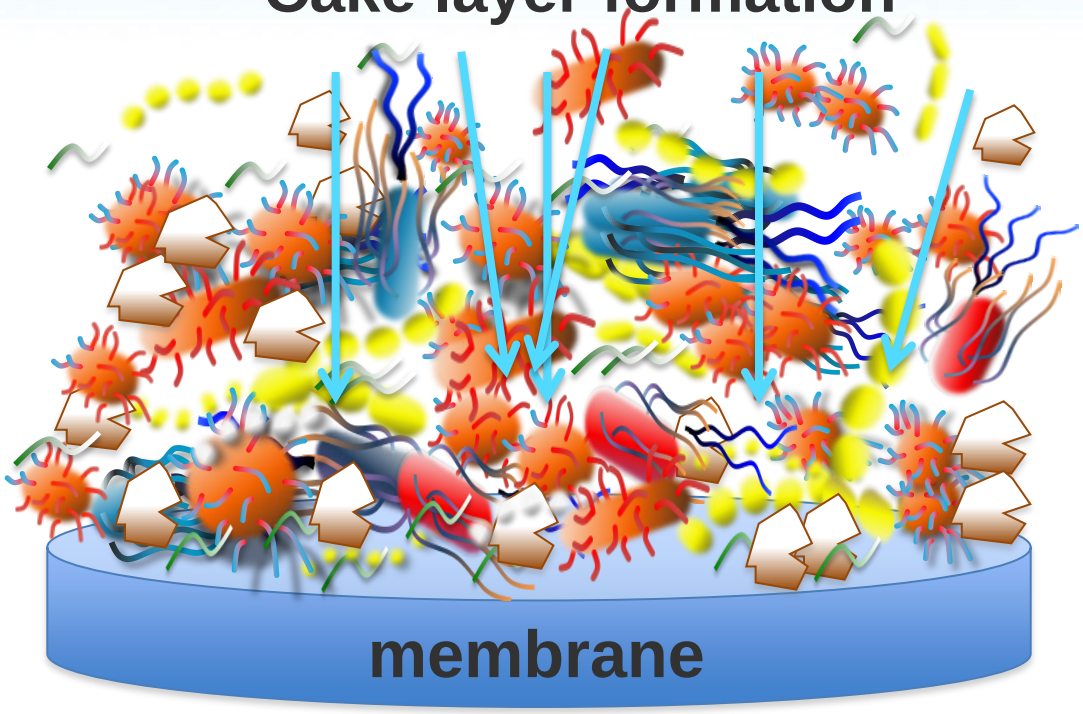
1 month, river water

3 month, diluted wastewater



The changes of the fouling layer structure lead to the stabilization of flux

Cake layer formation



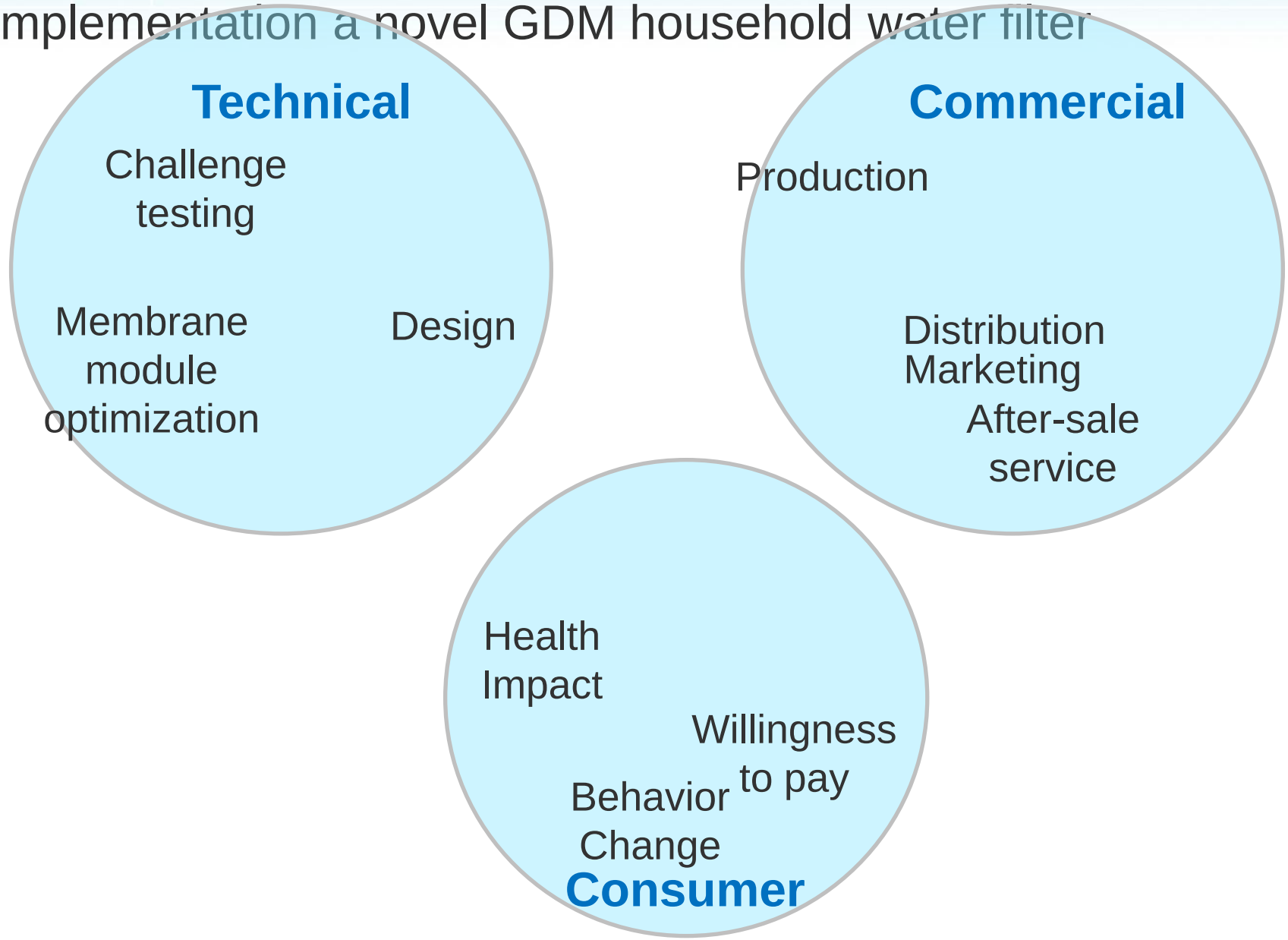
Structural changes within the fouling layer are caused by biological and physical processes in the layer

Advantages of GDM-filtration

- ✓ **Effective**: Parasites, Viruses, Bacteria
- ✓ **Easy**: no energy, almost no maintenance
- ✓ **Robust**: even highly turbid water can be used, not fragile
- ✓ **Long life span**: expected life span 5-8 years → therefore, low costs for the expected life span
- ✓ **No recurring costs** (e.g. chemicals)

GDMD project in Kenya

Goal: development, design, production and sustainable implementation a novel GDM household water filter



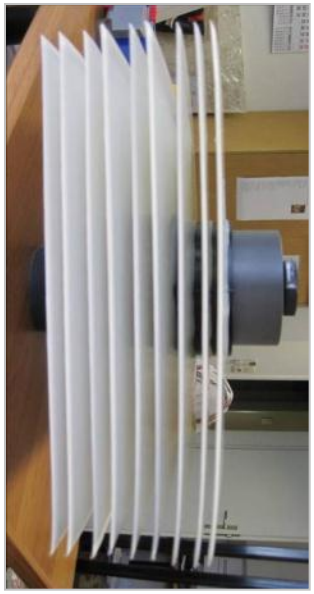
Technical evaluation in the field

First prototype of a GDM-filter

Pre-filter (cloth)

Membrane:

- Micodyn-Nadir, (Germany)
- 150 kDa cut-off (about 20nm pore size)
- 0.6 m^2 surface area



Clean water tank, 10L

Capacity: New: 10L in 2 h, Fouled: 10L in about 4 h

Challanging waters:

25 filters

Kajiado: 16 filters
Pond water , borehole,
open shallow wells
(organic matter, turbidity, Fe)

Thika: 5 filters
Thika river
(organic matter, turbidity)

Nairobi: 4 filters
Distribution network
(chlorine)

Monitoring

- Frequency of use and flow rate → Level sensors
- Water quality →

  E.coli and Coliforms: Nissui Compact Dry Plates

  Biological activity: ATP pens

  Conductivity, Oxygen, pH

  Relevan ions: Fe

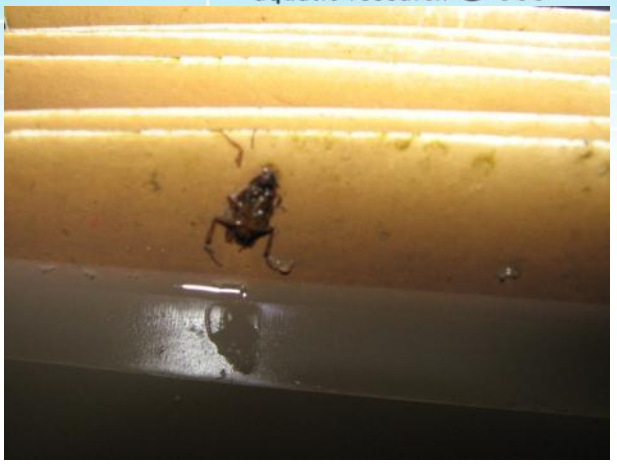
End-user perception

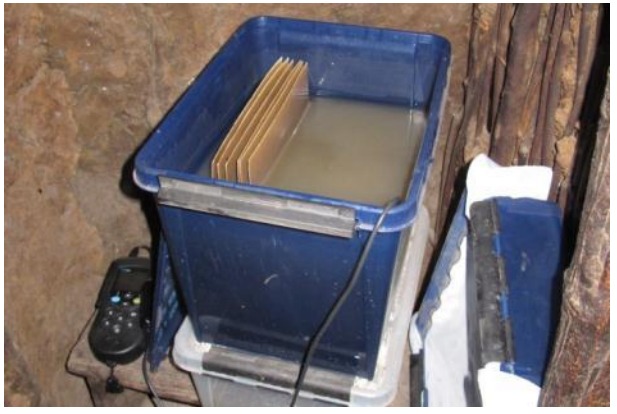
Survey: feedback from households

First results (after 1 month)

- ✓ Good pathogen removal
- ✓ Sufficient flow rate inspite of thick fouling layer
- ✓ High acceptance by households mostly due to removal of turbidity
- ✓ Filter used regulary, mostly once a day

- Re-contamination at the tap and in the clean water tank
- Interpretation of microbial tests





Next steps

Technology and design

- Design of the system by professional designers
- Optimization and design of the membrane module
- New microbiological methods adapted for the field studies

Business chain

Business planning and production

- Planning large scale production
- Business plan development

Reaching low-income market

- Assessment of distribution chains for low-income households, promotion
- Alternative financial mechanisms
- Willingness to pay, acceptance

Many thanks to

- Kenya Water for Health Organization
- Public Health Officer of Kajiado
- Workshop staff of Kenya Water Institute
- Thika Wintersea Orphan school and children project

Thank you for your attention!

Further information www.eawag.ch/membranefilter