Concentration Polarization and Forward Osmosis Membranes in Microgravity

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Forward Osmosis Membranes – What are they and Why are they Important

- Semi-permeable polymer sheets – they come in two forms: flat sheets, and hollow fibers (tubes)

- Utilize osmotic pressure to facilitate selective mass transport

- They are passive – don’t require pressure to “filter”

- On the ground, they are important for reducing the need for additional mechanical systems to drive filtration, energy = $$$

- In space, they are equally important in reducing equivalent system mass… mass = $$$

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Forward Osmosis and Challenges

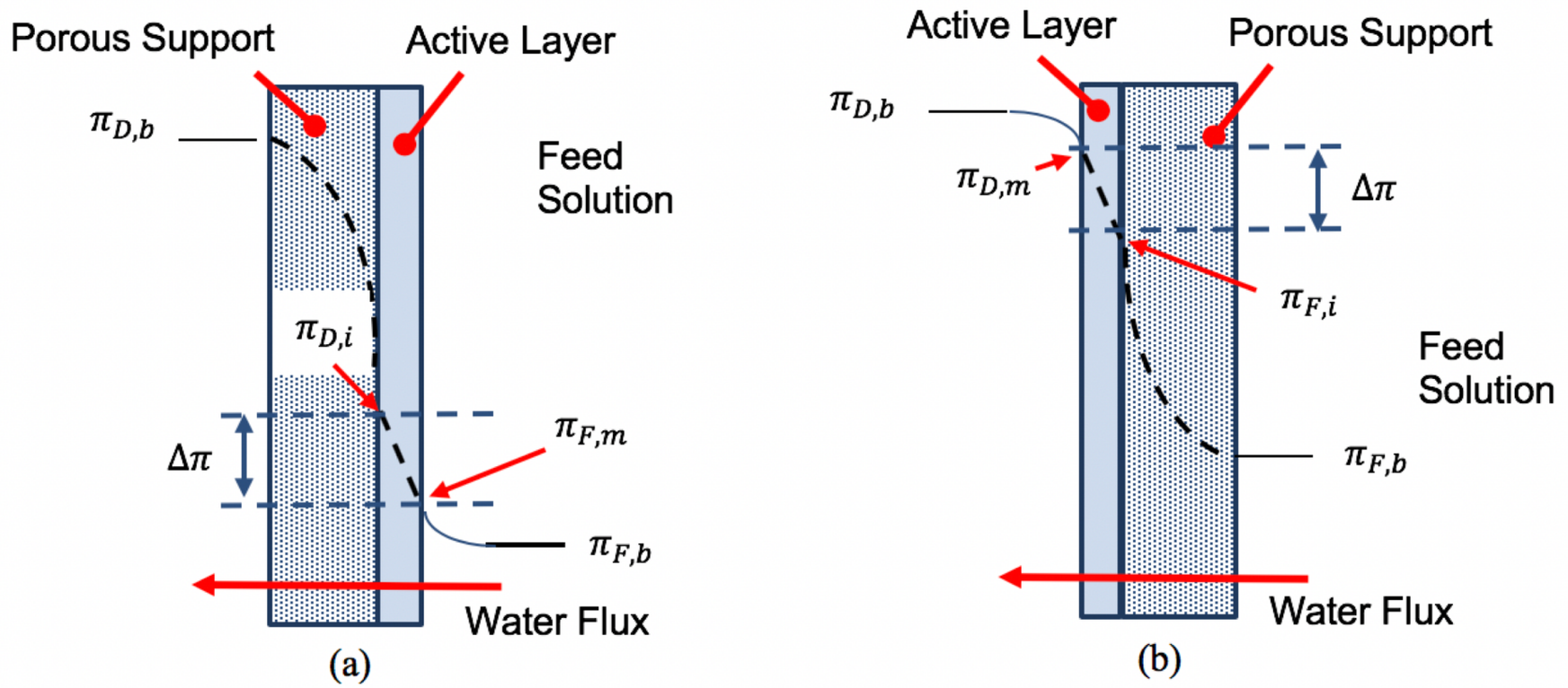

Figure 3: Two illustrations of osmotic driving force profiles with external and internal concentration polarization gradients shown: (a) dilutive internal concentration polarization (ICP), and concentrative external concentration polarization (ECP), and (b) concentrative ICP, and dilutive ECP. $\pi_{D,b}$ is the bulk draw osmotic pressure, $\pi_{D,m}$ is the membrane surface osmotic pressure on the permeate side, $\pi_{F.b}$ is the bulk feed osmotic pressure, $\pi_{F.m}$ is the membrane surface osmotic pressure on the feed side, $\pi_{F,i}$is the effective osmotic pressure of the feed, $\pi_{D,i}$ is the effective osmotic pressure of the draw solution, and $\Delta\pi$ is the effective osmotic driving force.[ii]

- A little studied phenomena called concentration polarization (cP) exists
- Observed in all osmotic processes – plant cell wall diffusion for example, not just manufactured materials!

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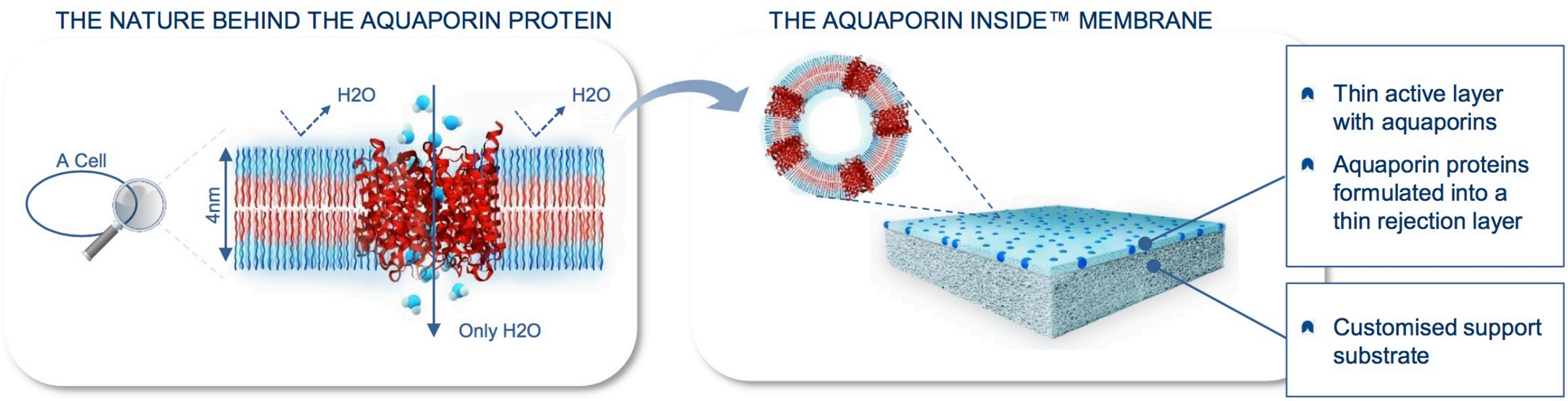
A new approach: Aquaporin membranes

- Aquaporin water channels are **nature's water filters** and can be found in all cells – from bacteria to plants and humans

- Aquaporin water channels **only allow water molecules** (H_2O) to pass, while **blocking all other impurities**, regardless of their molecular weight



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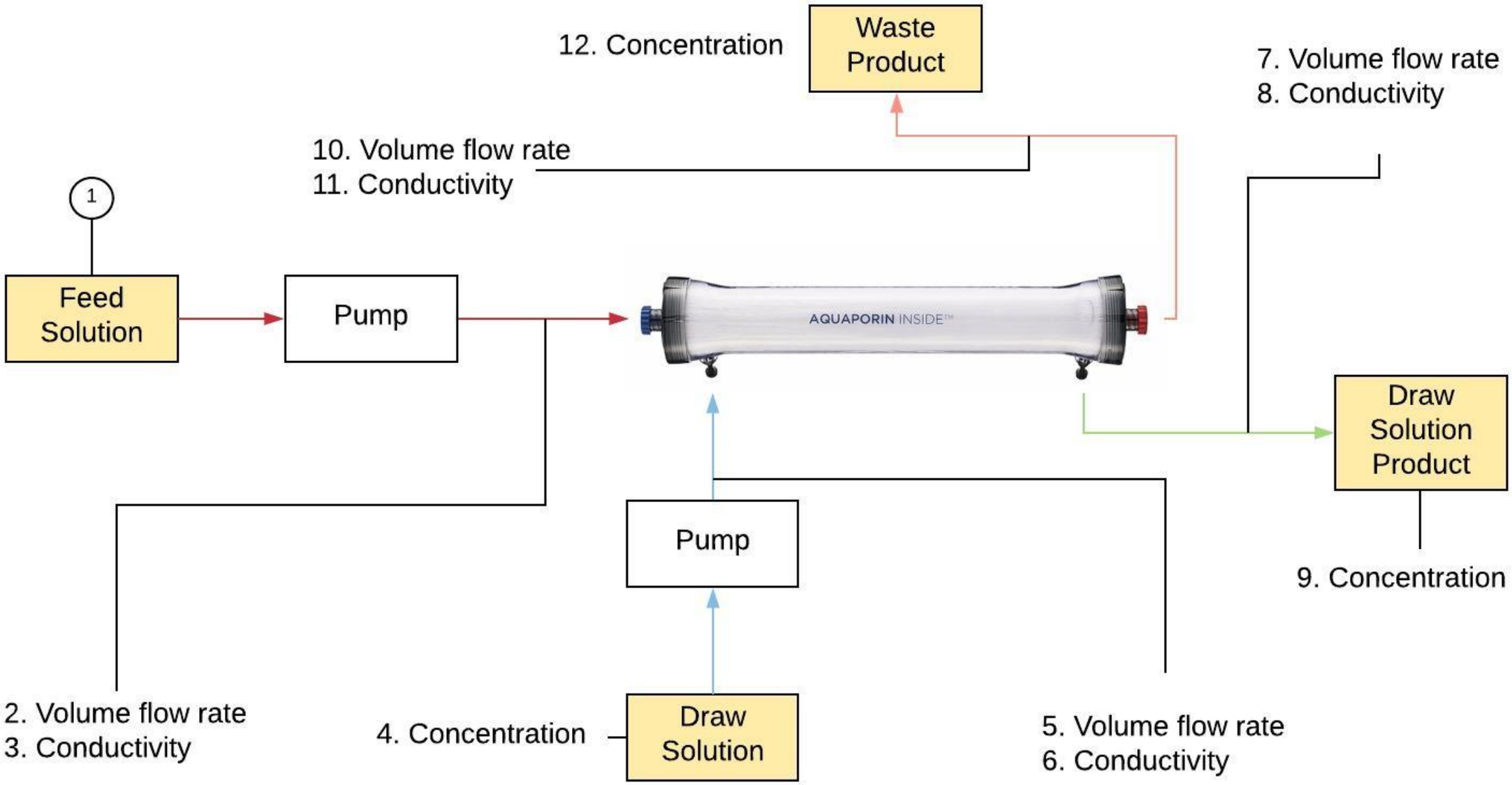
How we could study Aquaporin membranes in space



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Potential Insights

- Do we learn anything new about Concentration Polarization?

- If we do, can it dramatically change the way we think about designing systems that utilize osmotic concentration gradients

- Potential gains: significant reduction in energy usage for water processing systems

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Thank you!

The difficulty lies not so much in developing new ideas, but escaping old ones

- John Maynard Keynes

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