

# Development of Hemodialysis Membranes for Outside-in Filtration

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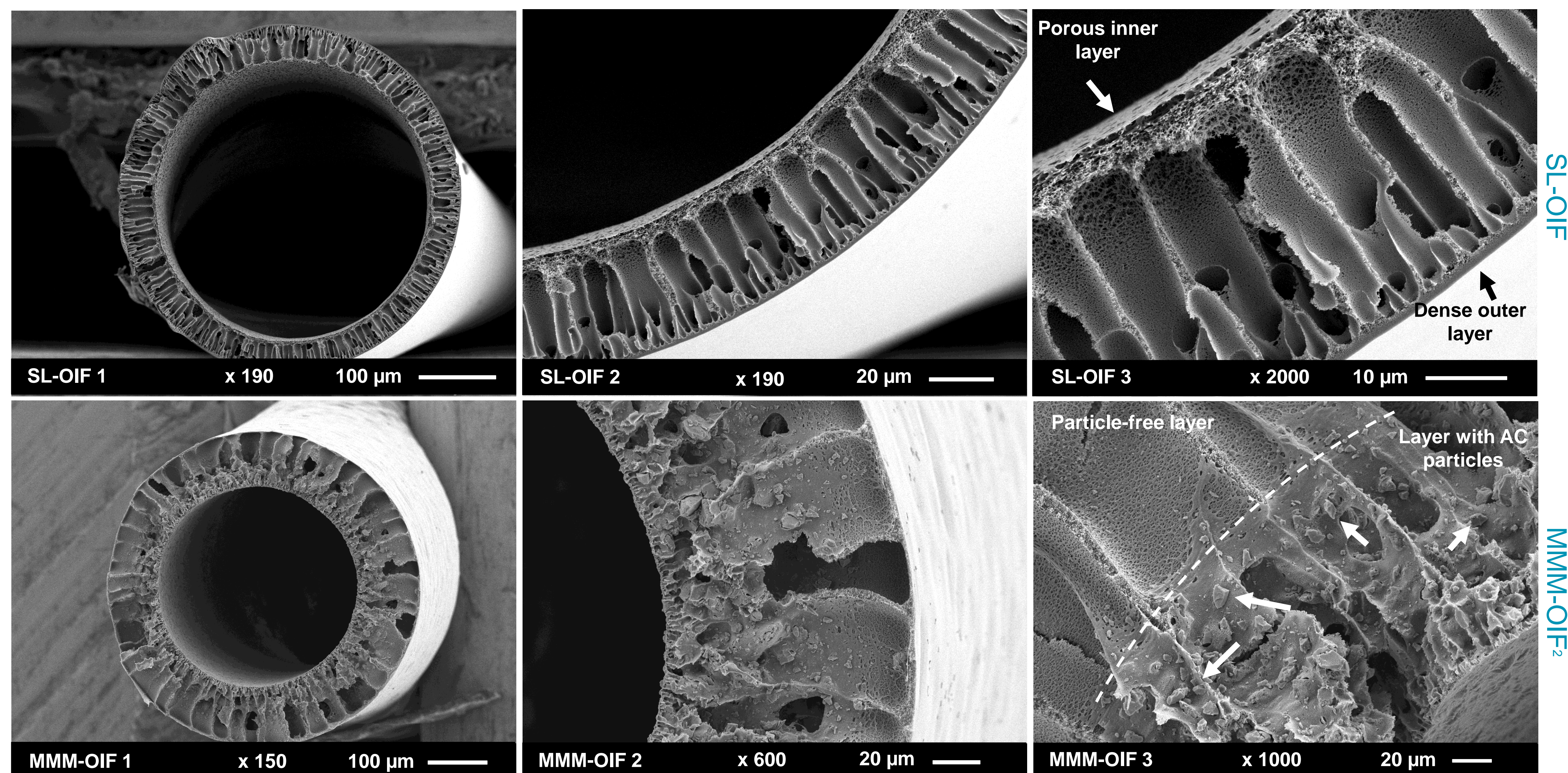
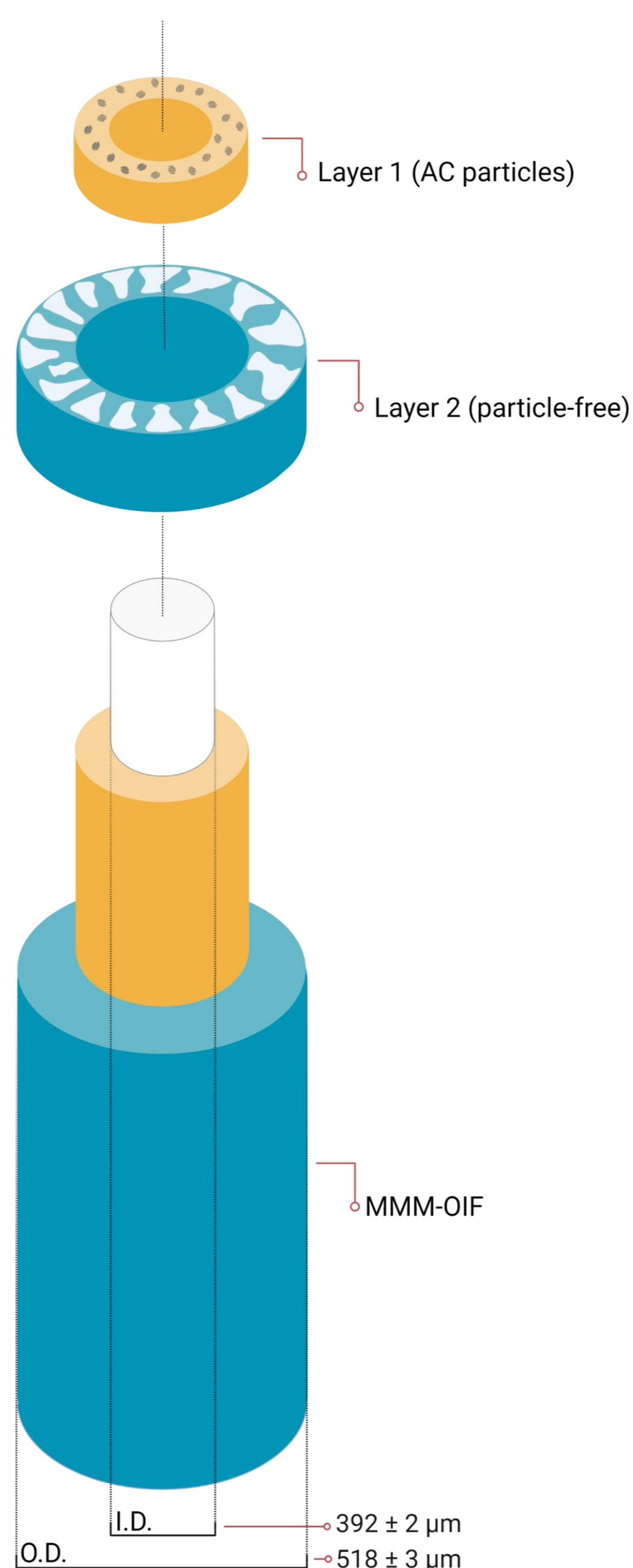
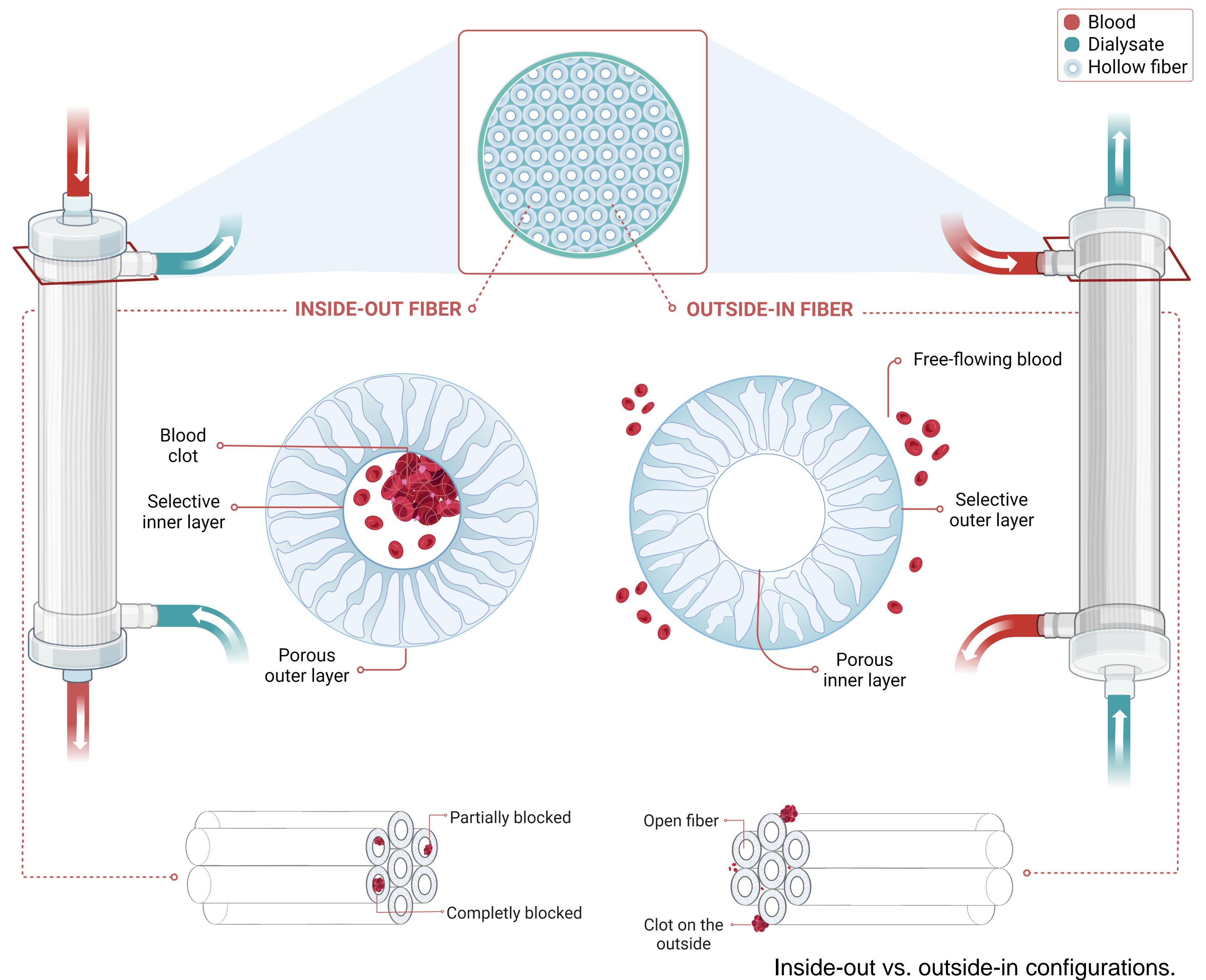
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## INTRODUCTION

Standard dialyzers used in hemodialysis (HD) therapy function by flowing the patients' blood through the lumen of each fiber, while the dialysate passes along the inter-fiber space. In this "inside-out" configuration, red blood cell accumulation can occur, forming clots and effectively reducing the efficacy and longevity of the dialyzer. A permutation of the fluids' inlets (named "outside-in" –OIF) effectively lowers the risk of clogging and increases the potential duration of the HD treatment<sup>1</sup>.

## METHODS

Outside-in hollow single-layer (SL) and (mixed matrix membrane) MMM fibers were prepared by dry-wet spinning for OIF mode using PES/PVP blends and activated carbon particles for MMM fibers.



SEM images of SL (above) and MMM fibers (below).

SL and MMM fiber performance vs. a commercial fiber.

	SL-OIF (outside-in)	MMM-OIF <sup>2</sup> (outside-in)	Polyflux 2H <sup>2</sup> (outside-in)
$K_{uf}$ (mL h <sup>-1</sup> m <sup>-2</sup> mmHg <sup>-1</sup> )	20*	100 ± 19	144 ± 25
DL <sub>p</sub> HA (mL min <sup>-1</sup> m <sup>-2</sup> )	*	370	99
DL <sub>d</sub> HA (mL min <sup>-1</sup> m <sup>-2</sup> )	*	42	101
DL <sub>p</sub> IS (mL min <sup>-1</sup> m <sup>-2</sup> )	*	145	49
DL <sub>d</sub> IS (mL min <sup>-1</sup> m <sup>-2</sup> )	*	1	10

Abbreviations: Membrane ultrafiltration coefficient ( $K_{uf}$ ), plasma dialysance (DL<sub>p</sub>), dialysis fluid dialysance (DL<sub>d</sub>), Hippuric acid (HA) and Indoxyl sulfate (IS)

\*On-going studies, results not final

## MEMBRANE FIBERS FOR OUTSIDE-IN FILTRATION

New OIF SL and MMM hollow fibers show great promise for achieving increased efficiency in HD treatments by decreasing clogging risk. The addition of activated carbon particles demonstrate superior removal of HA and IS compared with commercial dialyzers in outside-in mode. Future work will focus on determining the removal performance of SL fibers and full blood and hemocompatibility studies for both types of fibers.

## ACKNOWLEDGEMENTS

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<sup>1</sup>Dukhin, S., et al., Outside-in hemofiltration for prolonged operation without clogging, Journal of Membrane Science, 464 (2014), p. 173-178.

<sup>2</sup>ter Beek et. al., In vitro study of dual layer mixed matrix hollow fiber membranes for outside-in filtration of human blood plasma. Acta Biomaterialia, 123 (2020), 244-253.