

Dialyser membranes



*Andrew Davenport
UCL Department of Renal Medicine
Royal Free Hospital
University College London*



Potential conflicts of interest declaration

The content of the following speech is the result of efforts to achieve the maximum degree of impartiality and independence.

As a speaker, I wish to point out that there are personal connections to companies whose products are of interest within the context of the following speech. The companies concerned and connections are listed below:

Companies

NIPRO CORPORATION, JAPAN

FRESENIUS MEDICAL COMPANY, GERMANY

Connections

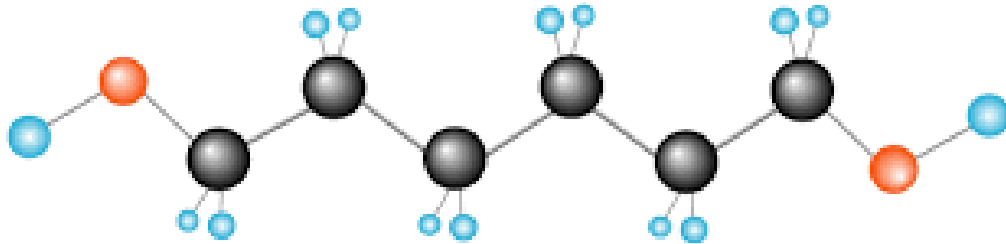
(Fee for activities associated with lecturing and in an advisory capacity expert reports and work as an author; fee for preparing training programmes; reimbursement for travel and accommodation costs; reimbursement of participation fees regarding training courses; patents; money from licences and royalties; fee for undertaking commissioned studies; receipt of research funds, etc.)

Advisory meetings & lectures

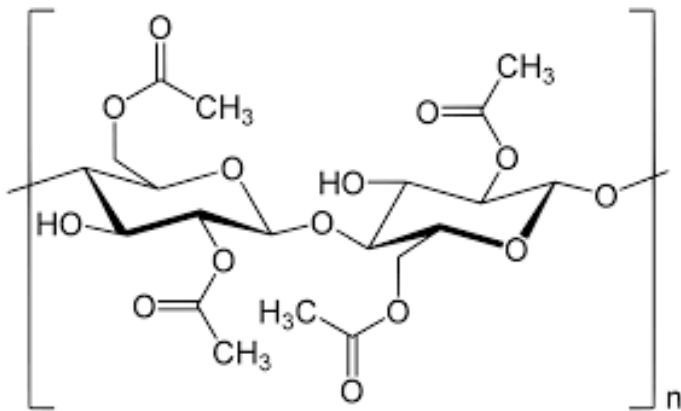
Advisory meetings & lectures

Polymers

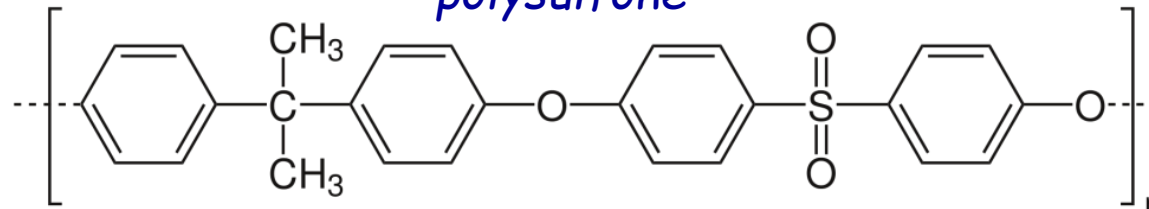
polymer



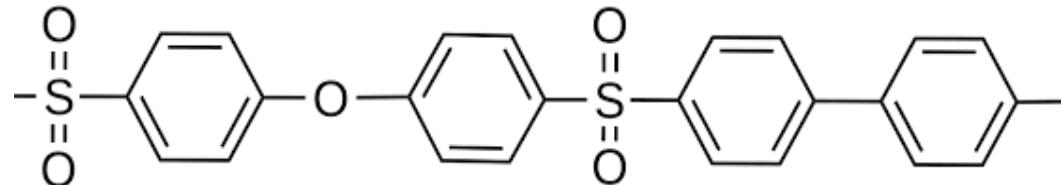
cellulose



polysulfone

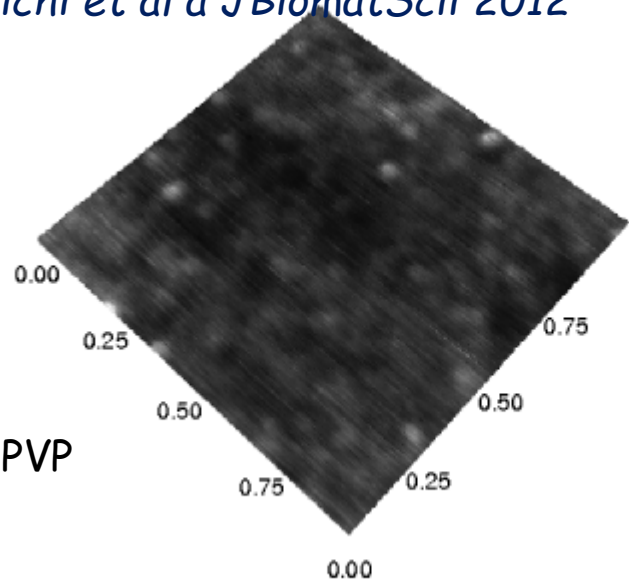


polyethersulfone

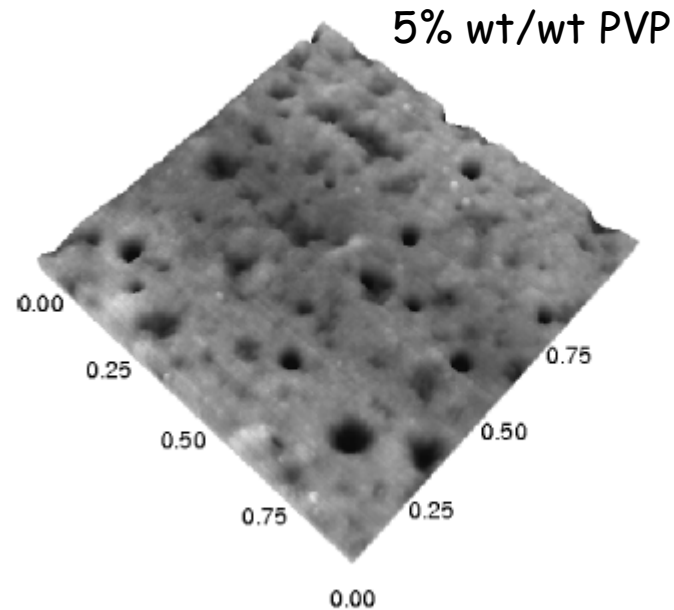
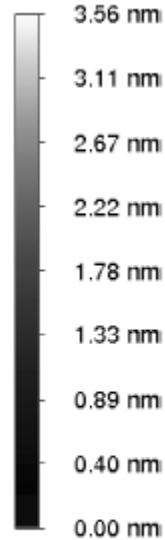


Polyvinly pyrrolidone addition to polysulfone

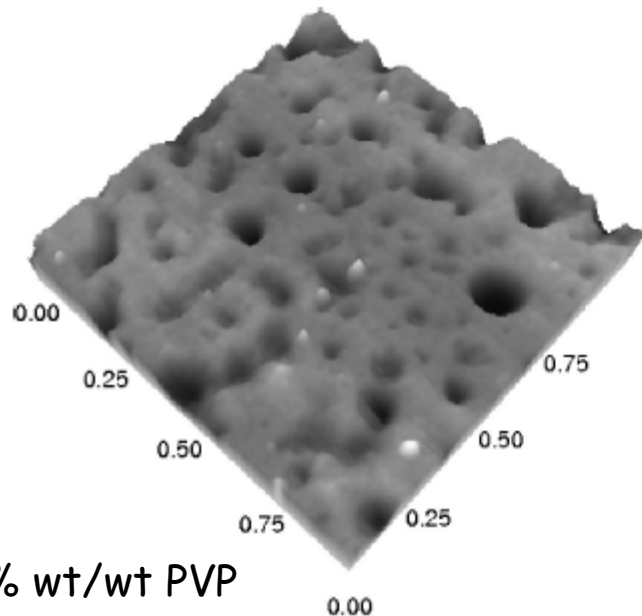
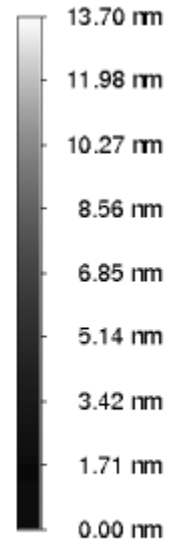
Omichi et al a JBiomatScii 2012



No PVP

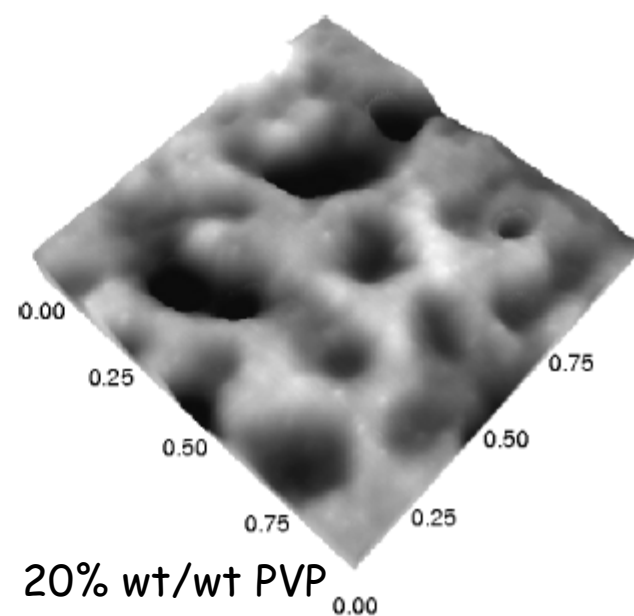


5% wt/wt PVP



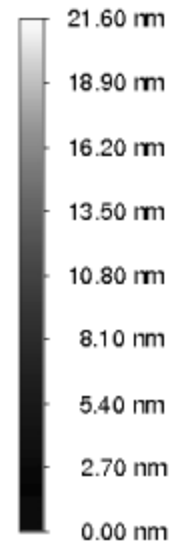
10% wt/wt PVP

1.00 x 1.00 [μm] Z-max 32.18 [nm]



20% wt/wt PVP

1.00 x 1.00 [μm] Z-max 21.60 [nm]



MEMBRANE STRUCTURES

Wall Thickness 5-15 μm



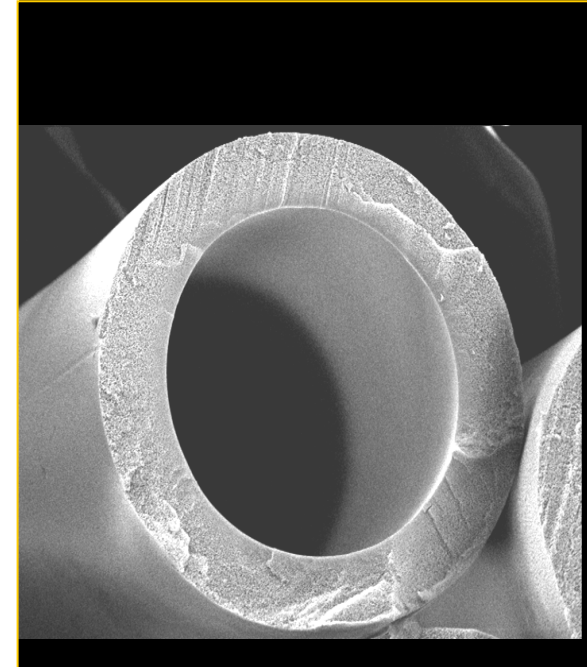
Natural Polymer
Hydrophilic (Hydrogel)
Low Hydraulic Permeability
 $D_m/D_w = 0.3$
Prevalent use in Diffusion

Wall Thickness 75-100 μm



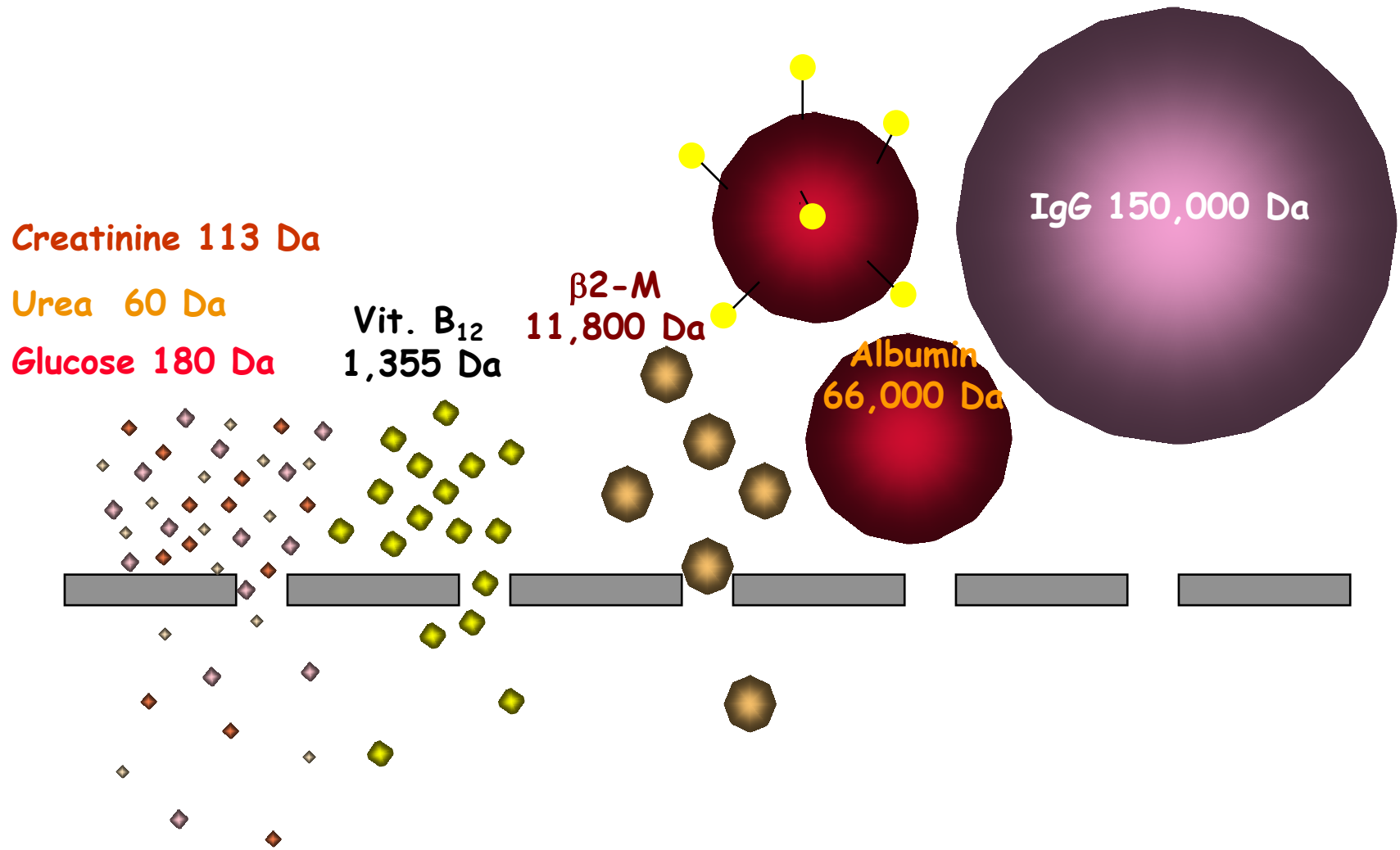
Synthetic Polymer (Asymm.)
Hydrophobic Structure
High Hydraulic Permeability
 $D_m/D_w = 0.6$
Exclusive use in Convection

Wall Thickness 30 μm

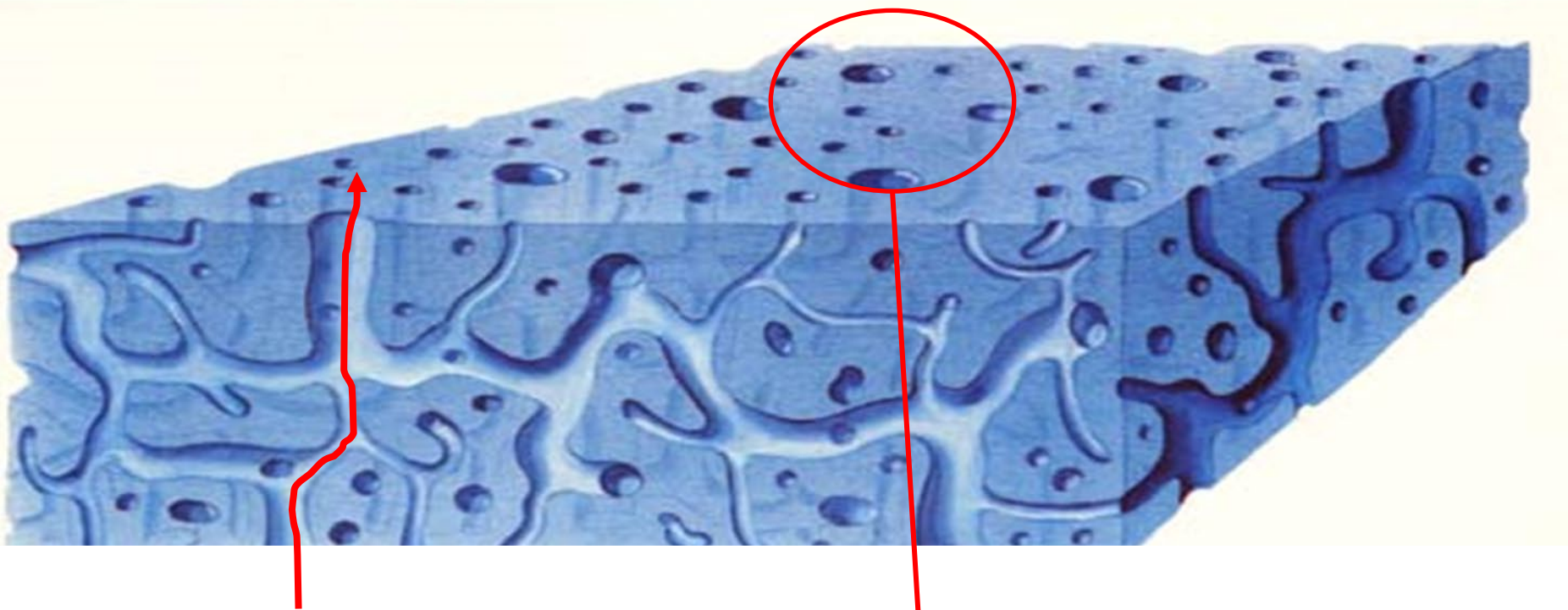


Synthetic Copolymer (Microp)
Hydrophobic-Hydrophilic
High Hydraulic Perm.
 $D_m/D_w = 0.6$
Comb. Diffusion-Convection

Molecular size and Clearance



MEMBRANE STRUCTURES



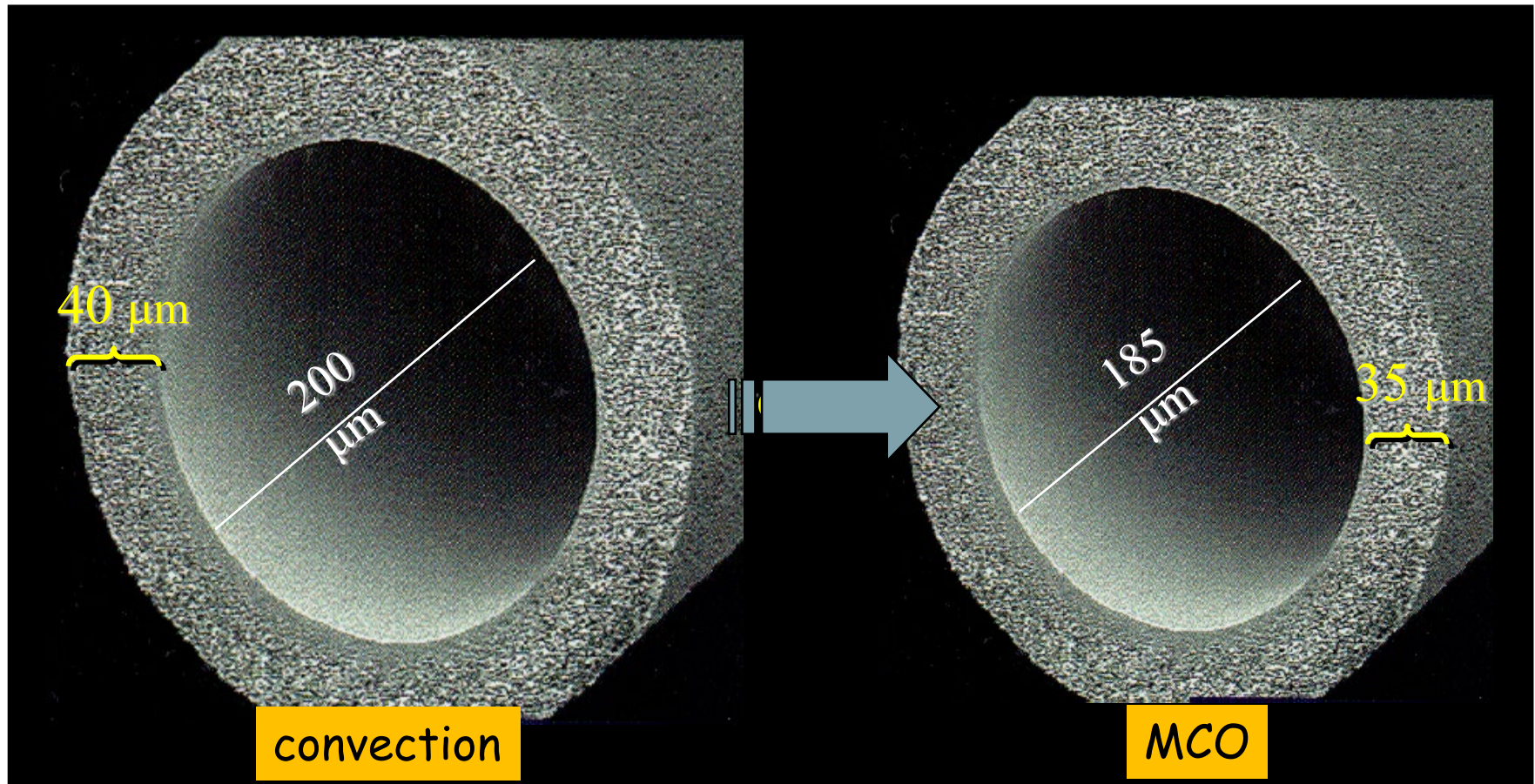
Pore structure

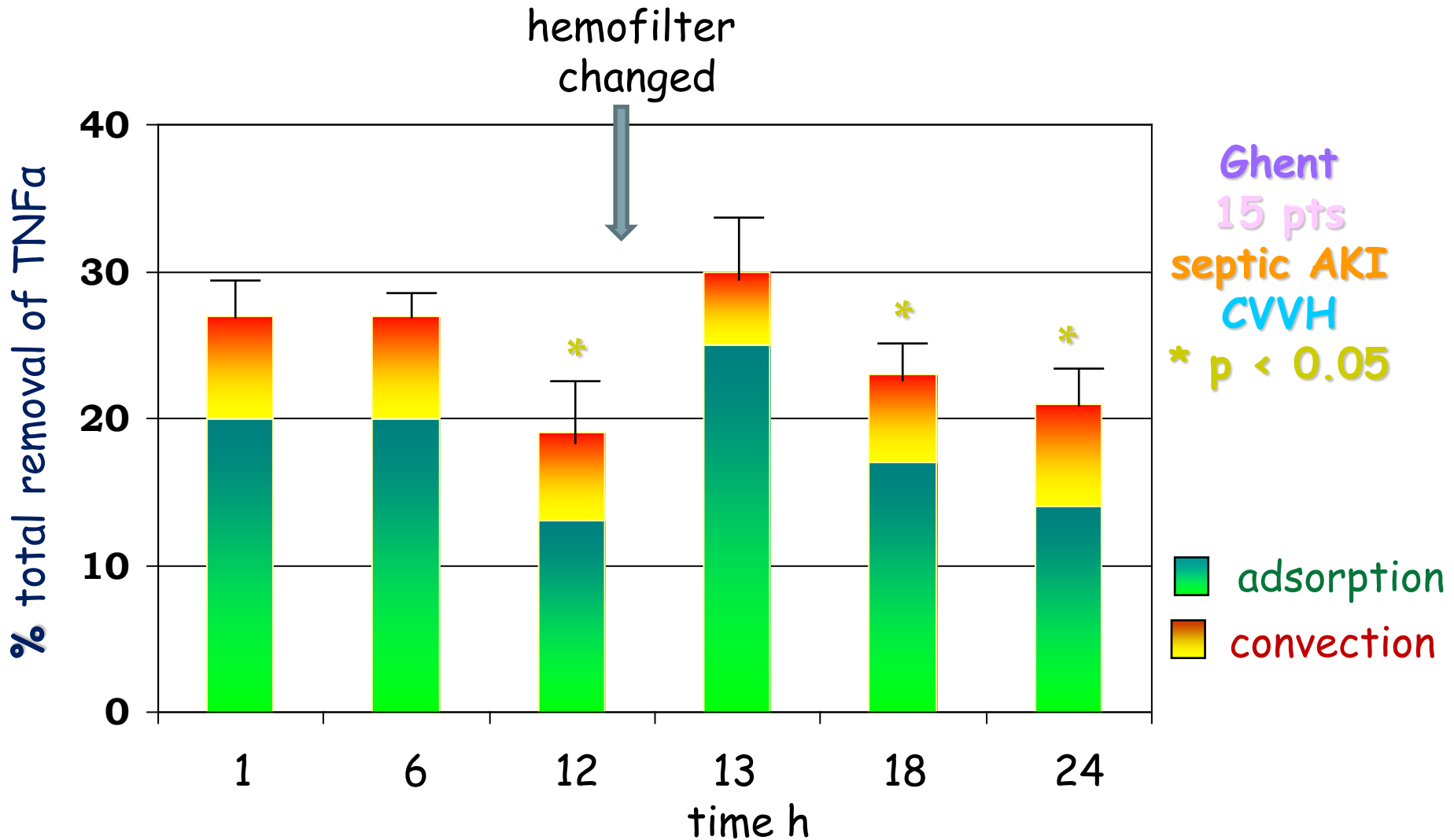
Width
Length
Configuration
Surface smoothness

Pore density

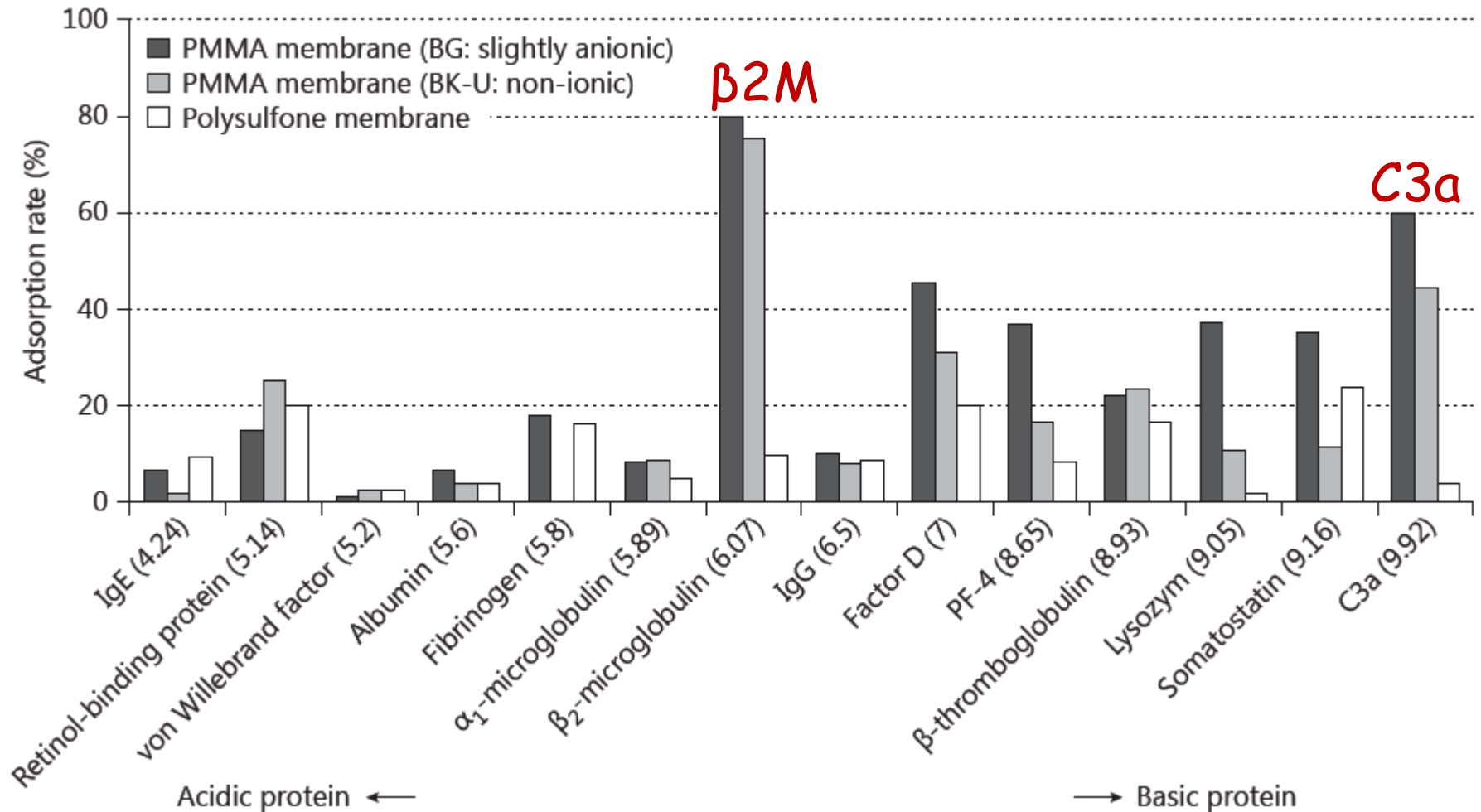
decrease internal diameter

increases wall shear rates and internal diafiltration

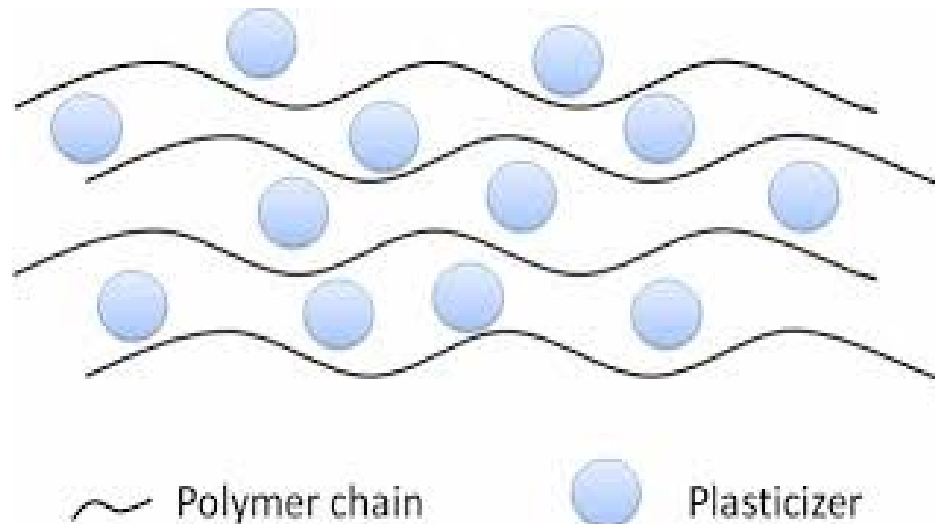
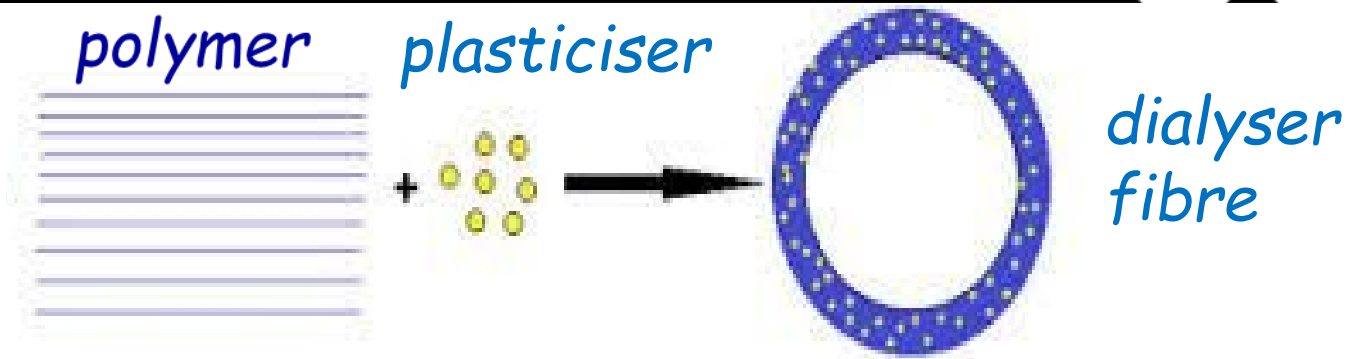




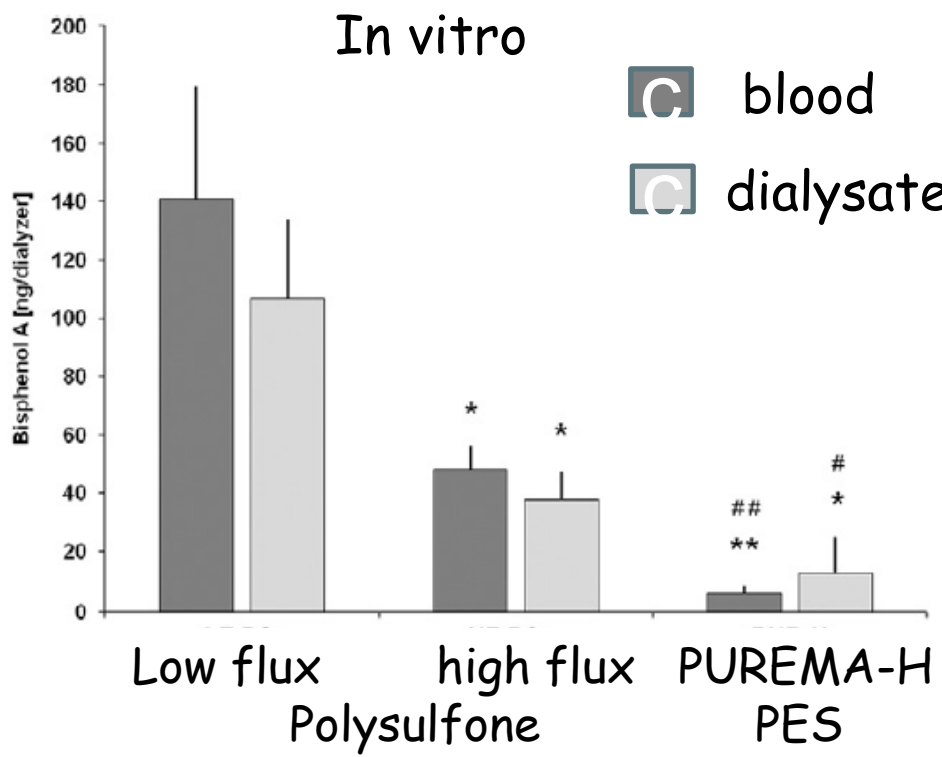
Dialyzer surface adsorption



Plasticisers

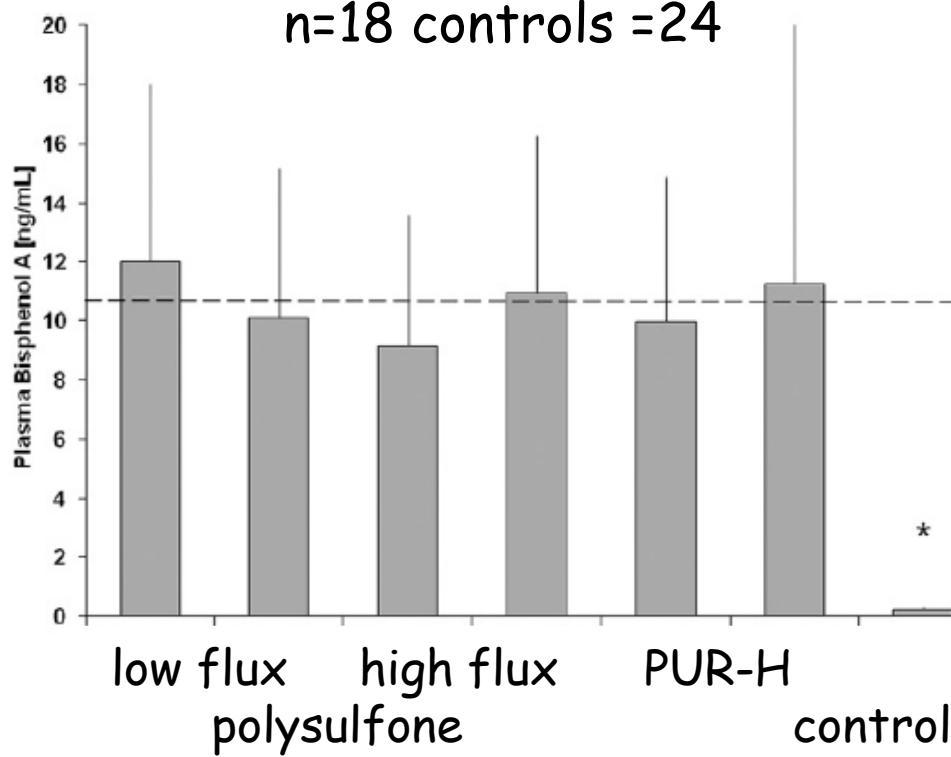


Bisphenol A leaching from dialyzers



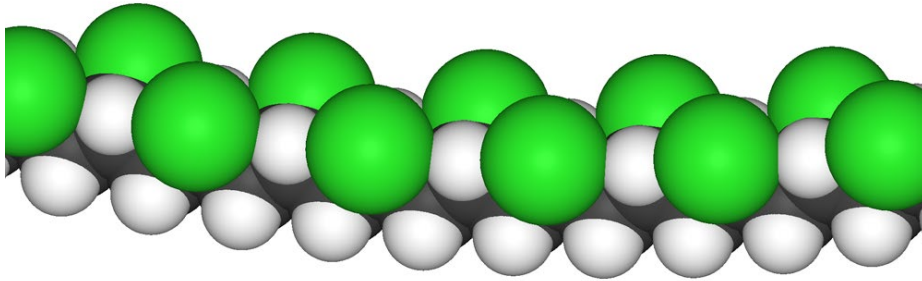
Bisphenol used in manufacture of polycarbonate

4 weeks dialysis
n=18 controls =24

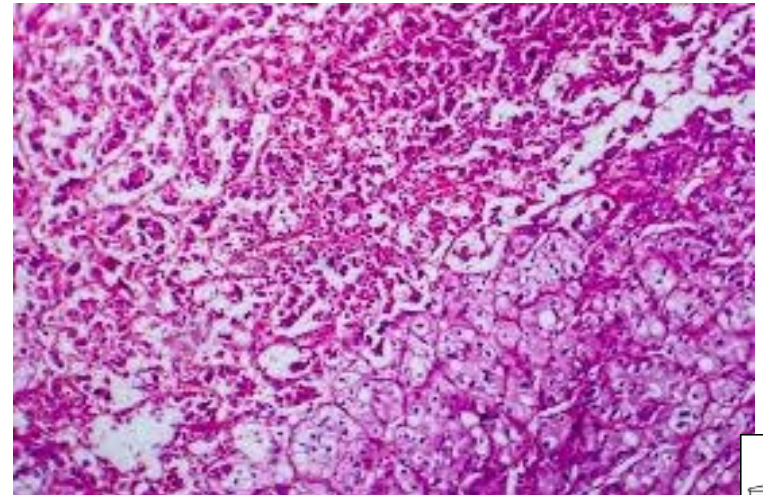


No increase in serum levels after 4 weeks but levels $\geq 10 \times$ normal

Plastics & plasticizers

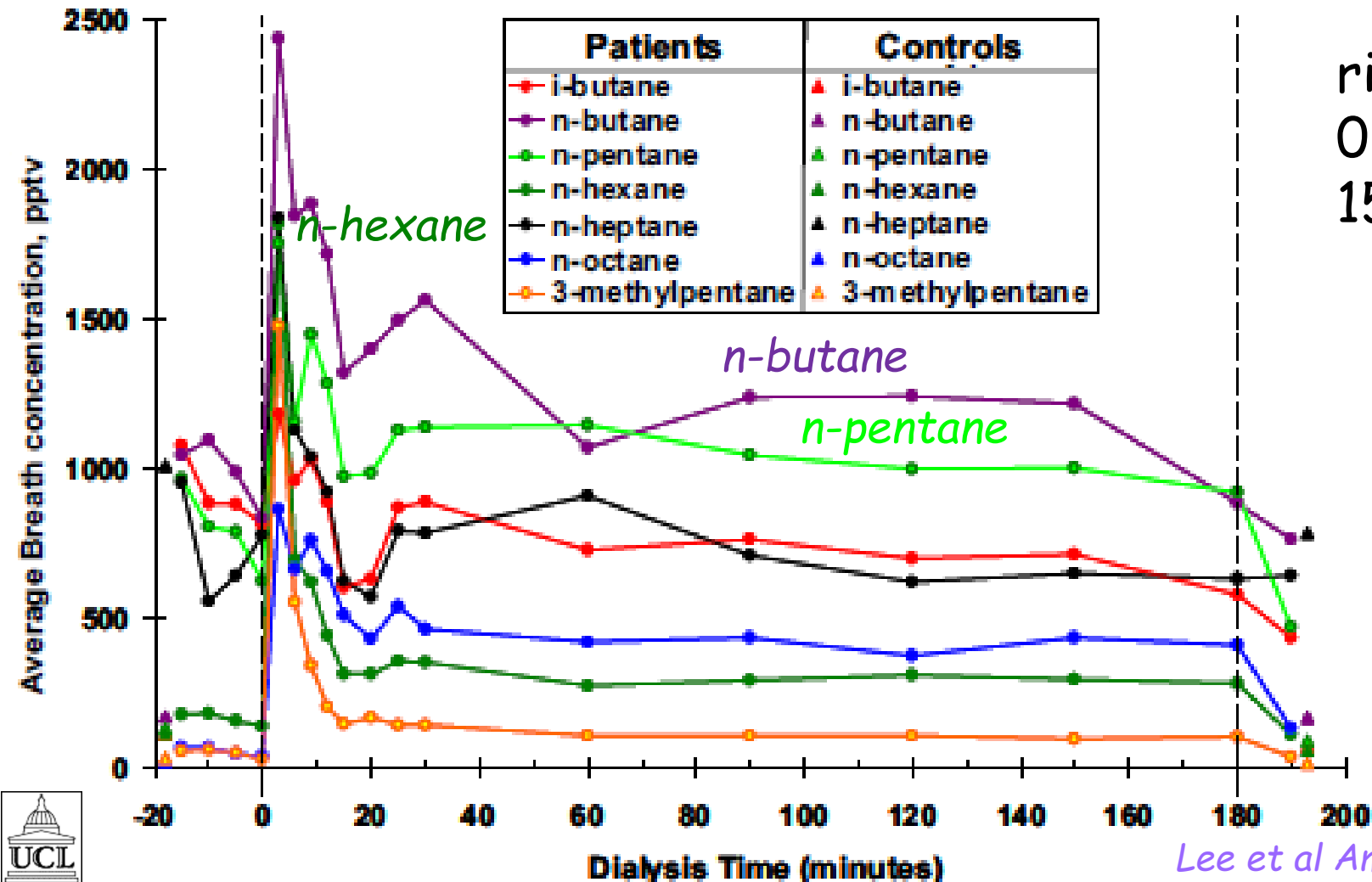


Phthalates are most common class of plasticizers used in PVC
Low MWt phthalates such as DEHP and DBP have increased health risks and are being phased out. High-MWt phthalates such as DINP, DIDP are generally **thought to be safer**



Patients with ESRD on dialysis have more than 100 times greater risk of RCC than age-matched healthy controls

Rinsing dialysis circuit



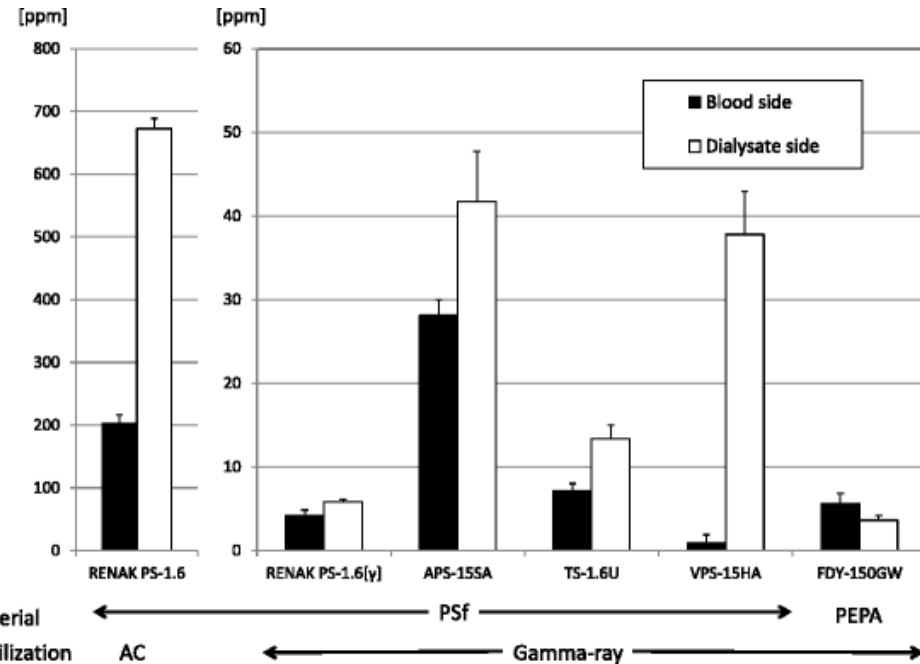
rinsing
0.5 L saline
150 ml/min

Sterilisation

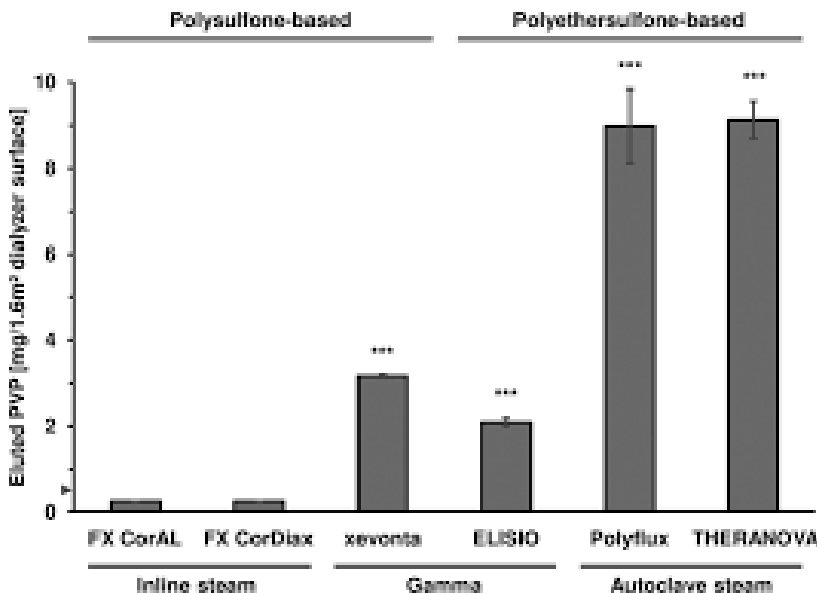


ethylene oxide is classified as a human carcinogen

major allergic reactions such as hives, rash, asthma anaphylactic shock

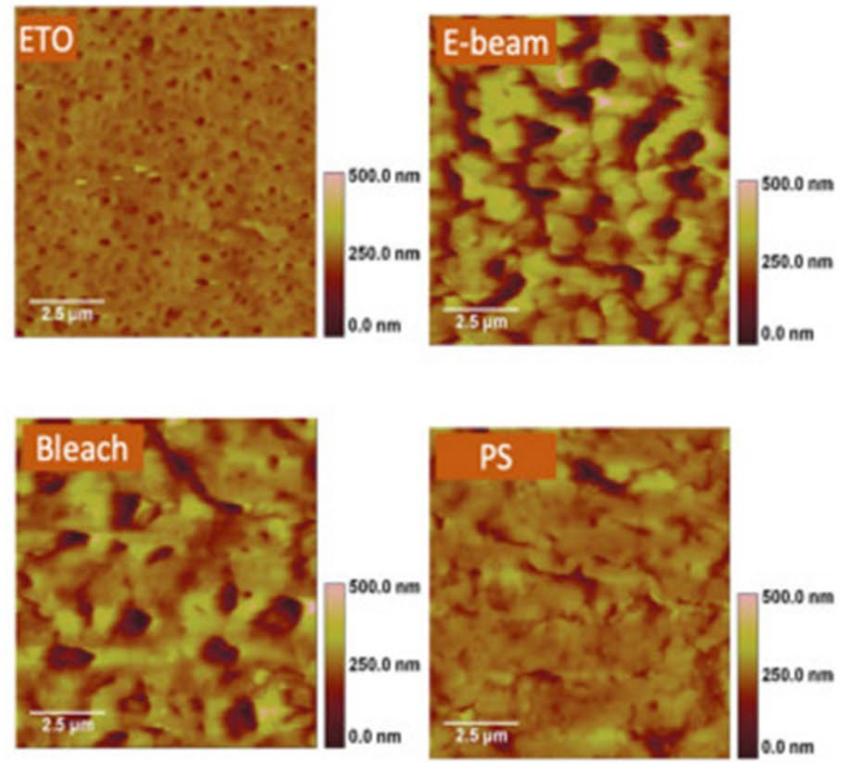
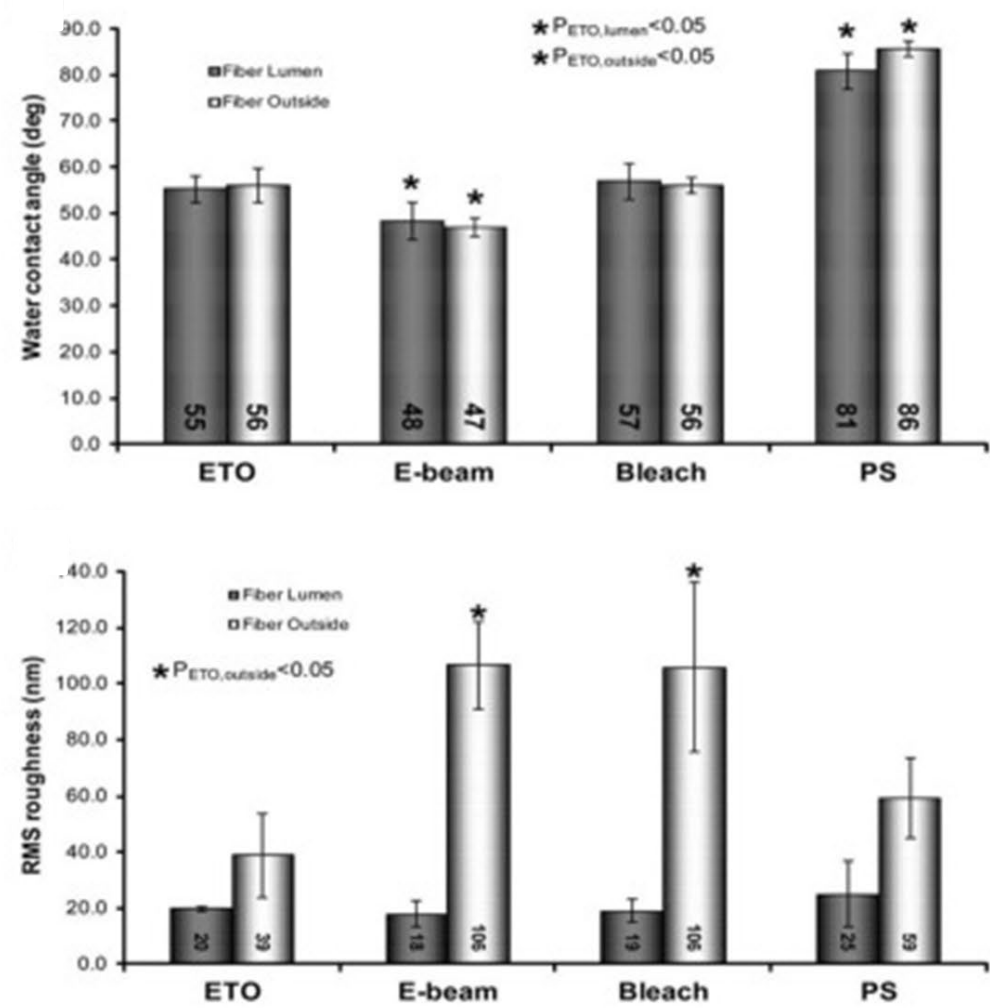


release PVP



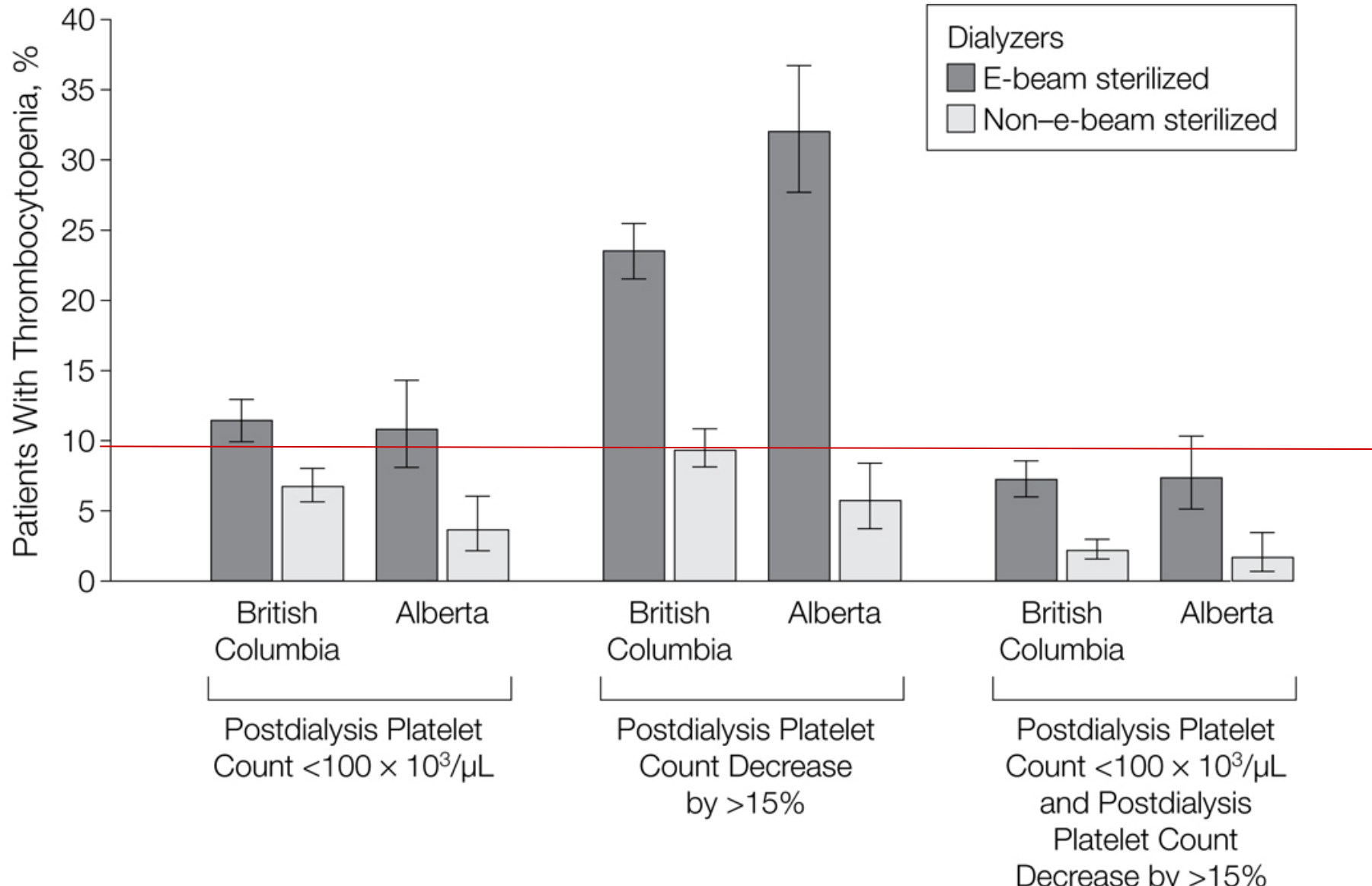
Effects of sterilisation

Masden et al JApplPolymSci 2010

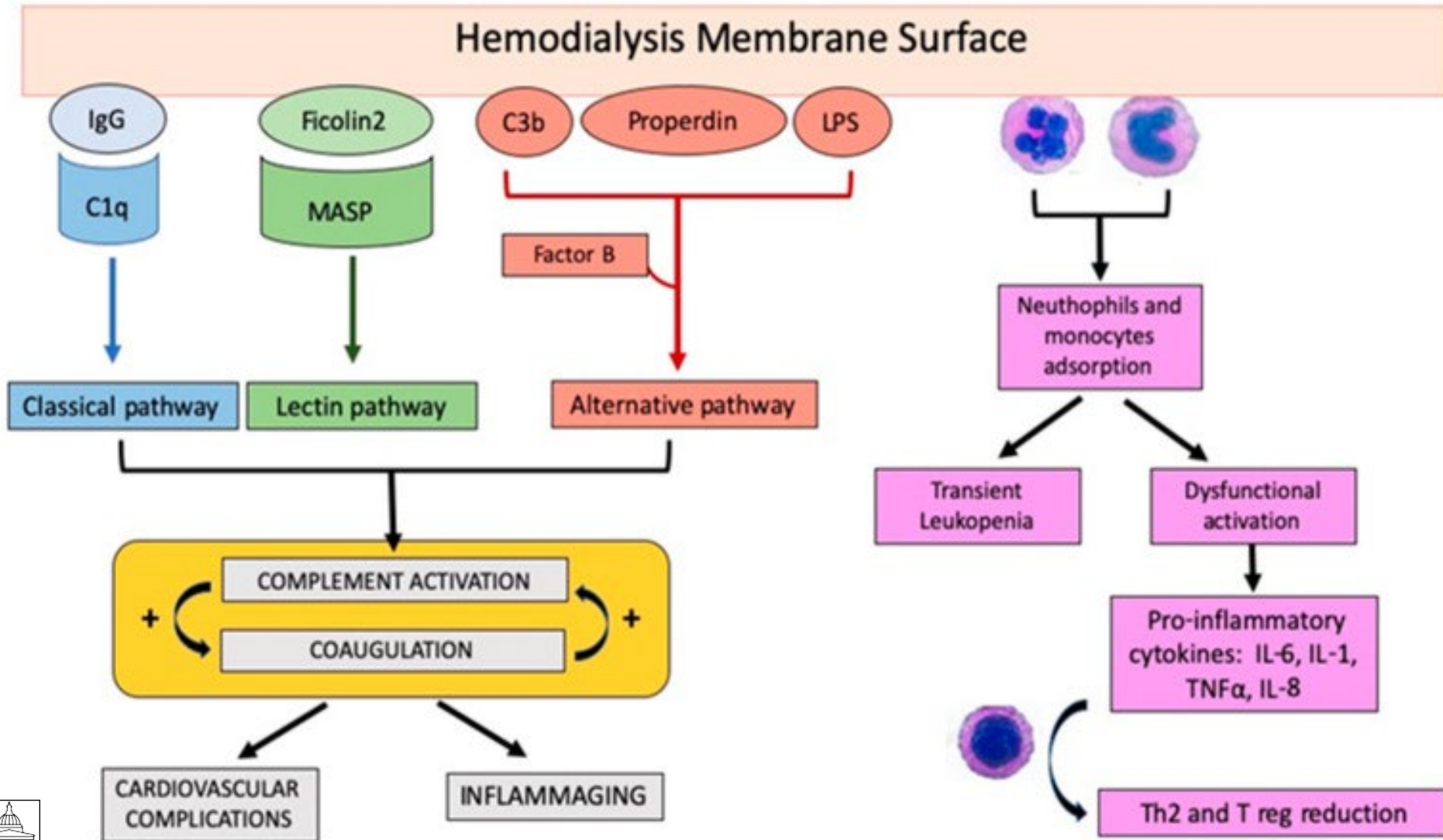


Thrombocytopenia and dialysers

Kiaii et al JAMA 2011

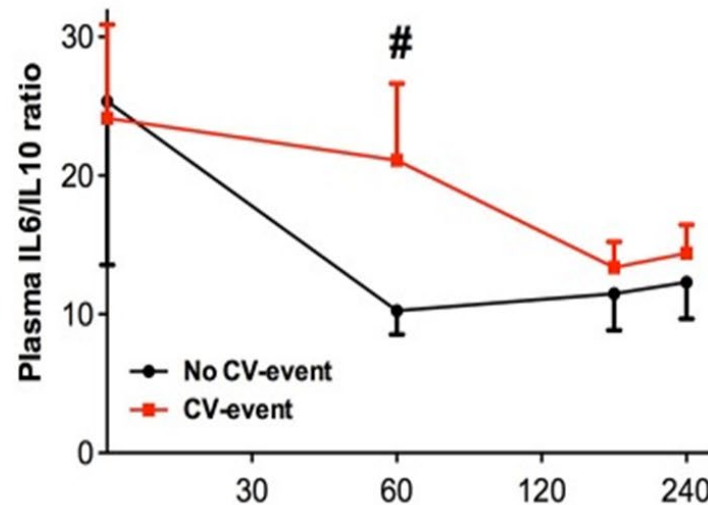
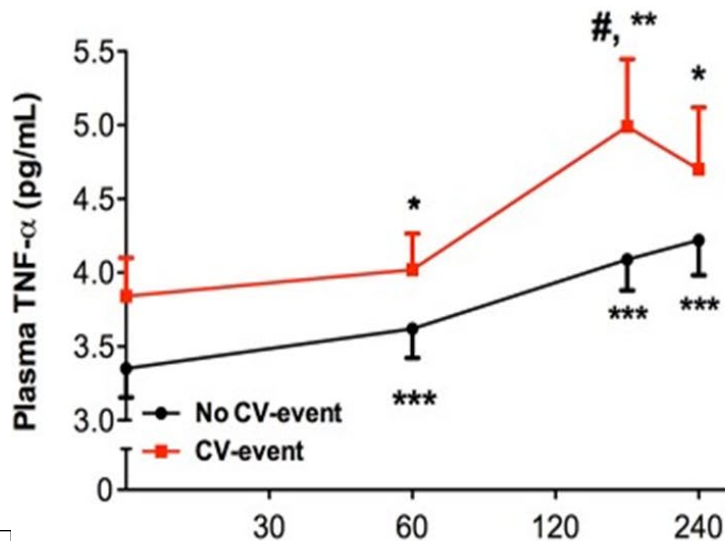
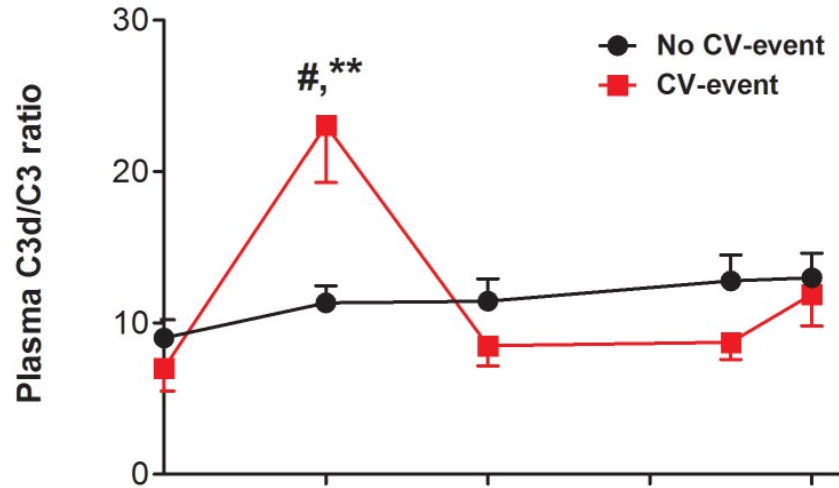


Complement pathway activation with dialysis



Complement activation during haemodialysis

Poppelaars et al FrontImmunol 2018



Dialyser clotting



Usual practice	dialyzer	success	Success rate
Saline flushes	Evodial	49/61	80.3(67.8-87.7)*
100-300 mL x 30 min	control	38/62	61.3(48.0-71.7)
Pre-dilution	Evodial	36/63	57.1 (44.1-67.9)
1.0-2.0 L/h	control	26/65	40.0 (28.3-51.4)

Success

Grade 4 clotting - totally clotted unable to perform dialysis

No additional saline flushes

No change dialyzer or blood lines

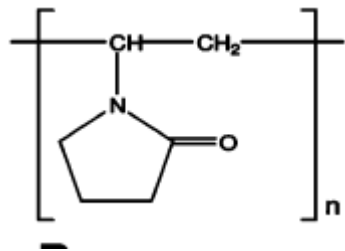
Early termination of dialysis session

Dialysis

Kt/V Evodial 1.15 (0.96-1.37) vs control (1.19 (0.98-1.39)

Ultrafiltration 2.0 (1.0-2.5) vs control 1.8 (1.1-2.9) L/session

Preventing coagulation by adding TM

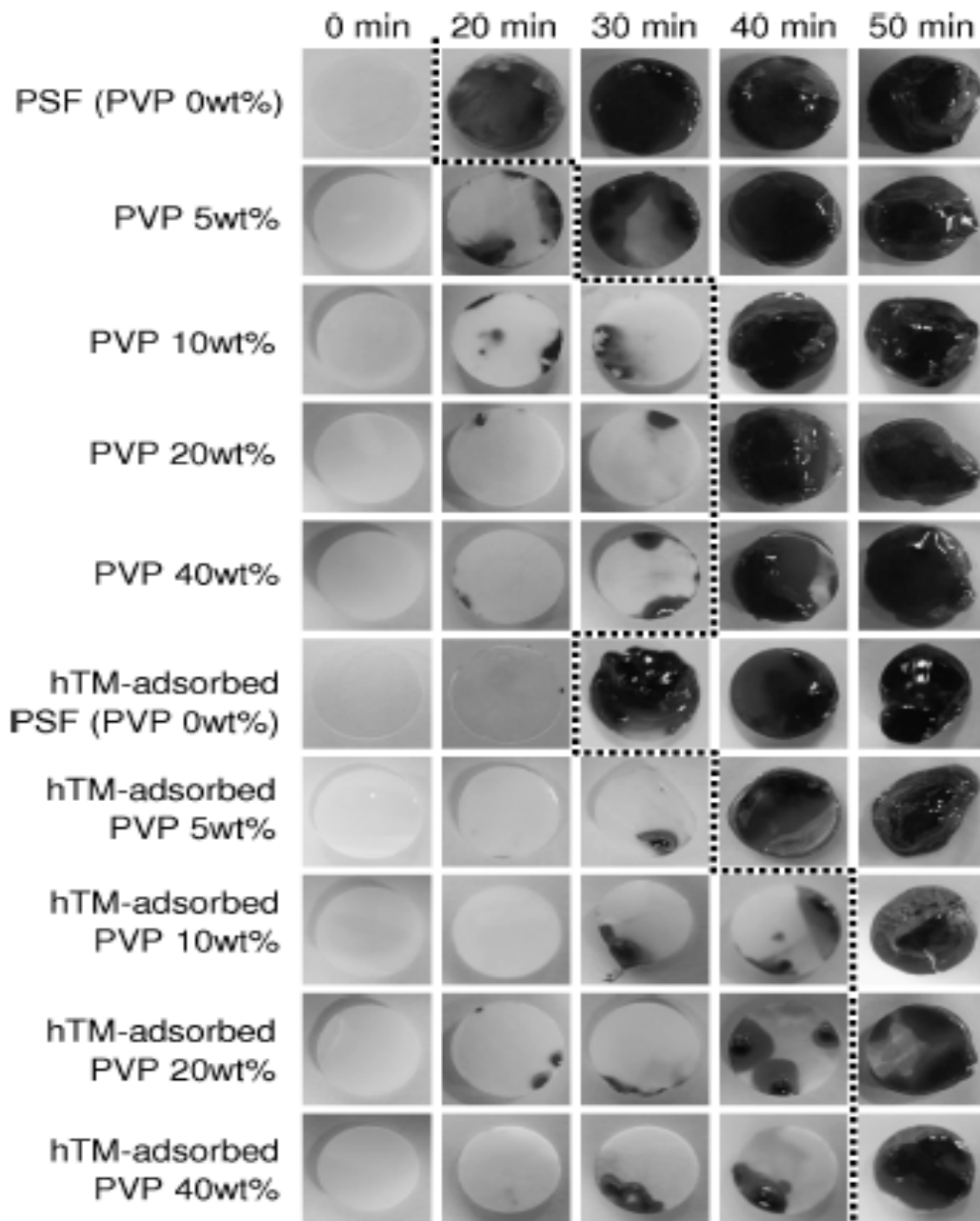


polyvinlyl pyrrolidine



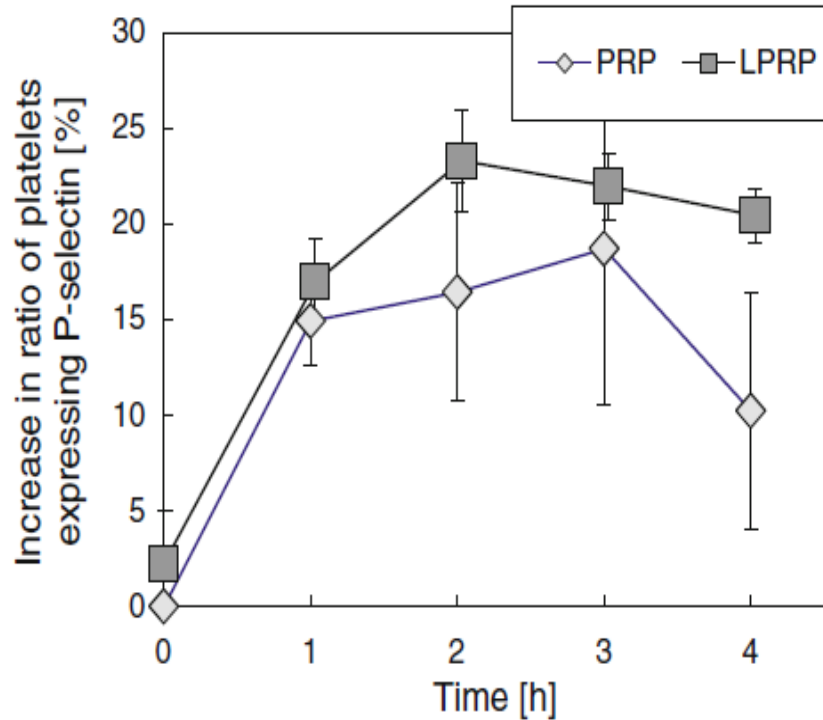
thrombomodulin

polyvinlyl pyrrolidine

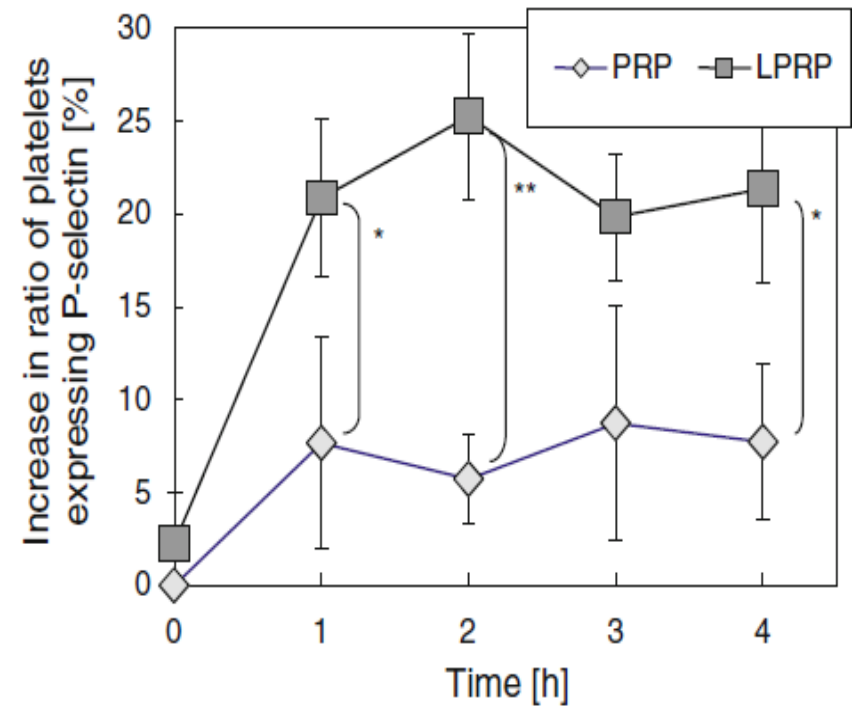


Vitamin E coated dialyzers

Tsuakao et al *J Artif Organs* 2013

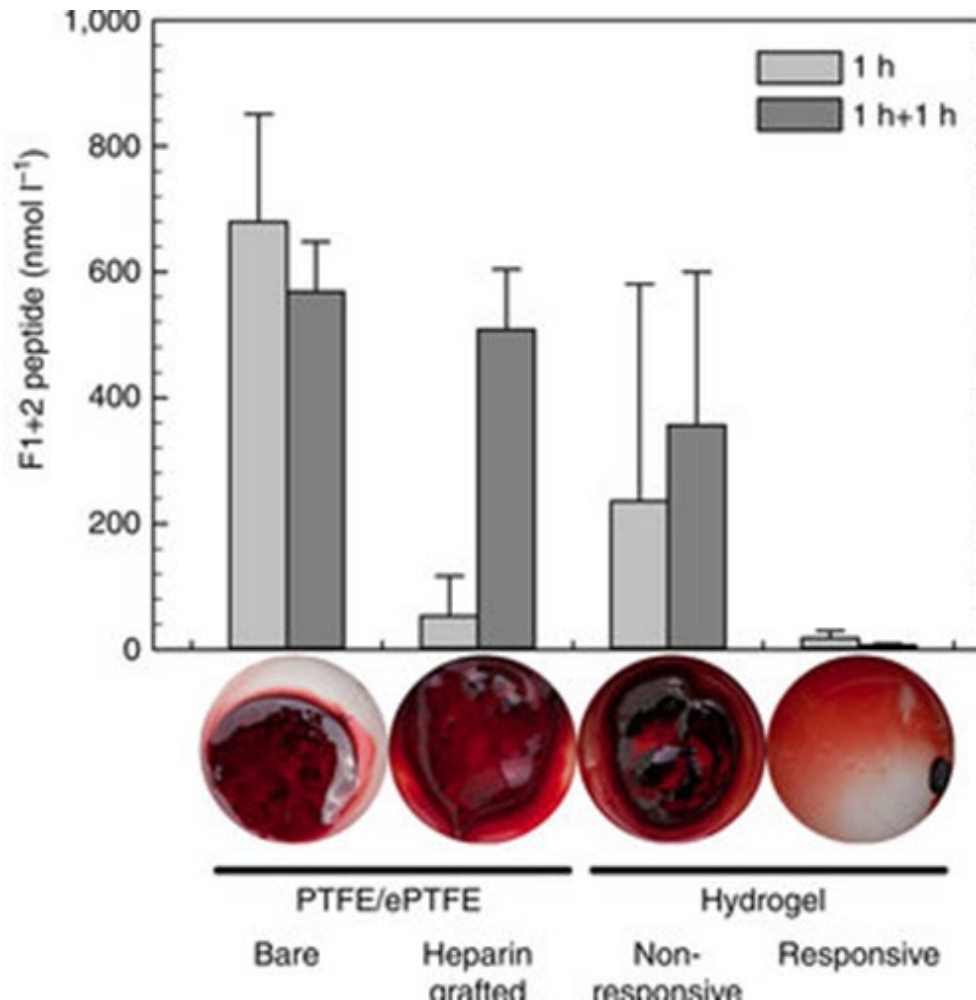


In-vivo



In-vitro

Hydrogels to prevent clotting



Reviewed

- Dialyser biomaterials
 - Polymers
 - Plasticisers
- Effect of sterilisation
 - Leaching of organic compounds
- Dialyser coatings

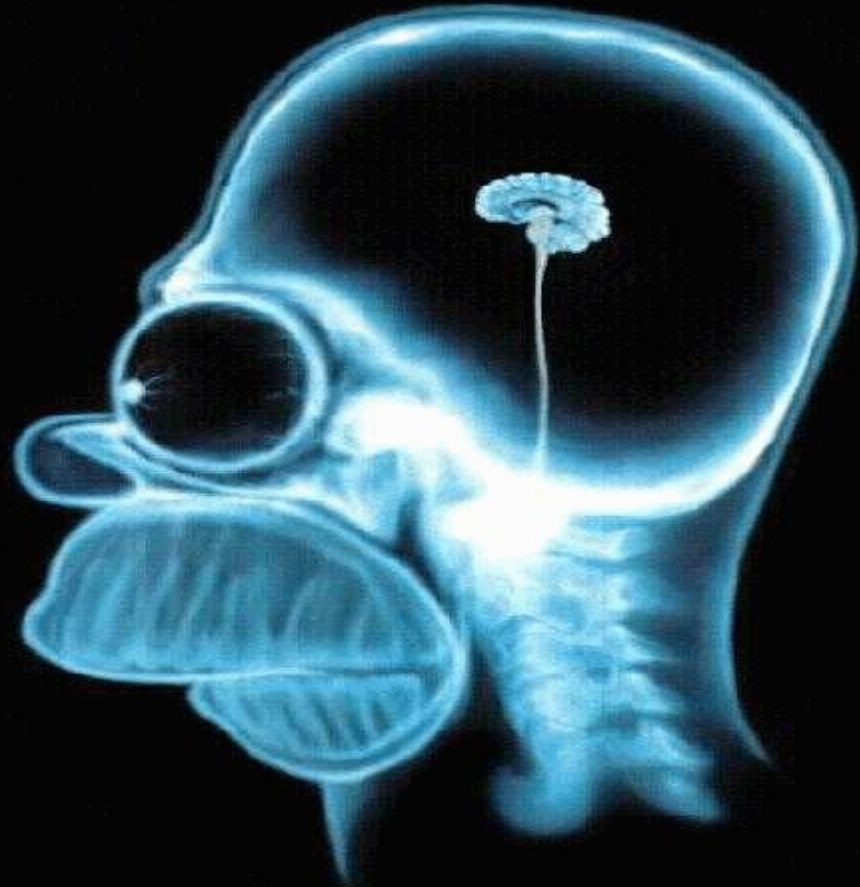
Choosing a dialyser



UCL

AHAJOKES.COM

Are all dialysers are equal ?



MODERN LAMINEX MEDIUM 054028 L

H. J. SIMPSON