Claims

1. A peritoneal dialysis filter device, which comprises:

a housing comprising:

a first compartment having a first port, and a second port;

a second compartment, having a third port, an inlet port and an outlet port;

a switching means or apparatus fluidly connected to the first and third ports and that is configured to be connected to a subject's peritoneum;

a head-space cavity portion that fluidly connects the first compartment to the second compartment;

a first hollow fibre membrane formed from hollow hydrophilic fibres within the first compartment of the housing, where each of the fibres have an inner surface and an outer surface and where the inner surface of the hollow hydrophilic fibres are aligned co-axially with respect to the alignment of the first port and the outer surface of the hollow fibres is aligned perpendicularly with respect to the alignment of the second port; and

a second hollow fibre membrane formed from hollow hydrophobic fibres within the second compartment of the housing, where each of the fibres have an inner surface and an outer surface, where the inner surface of the hollow hydrophobic fibres are aligned co-axially with respect to the alignment of the third port and the outer surface of the hollow fibres is aligned perpendicularly with respect to the alignment of the inlet and/or outlet ports, such that, when in use:

a dialysate from a subject enters the first compartment of the filter device through the first port and exits the first compartment of the filter device *via* the second port in an outflow direction; and

a regenerated dialysate from a sorbent system enters the first compartment of the filter device through the second port, passes through the head-space cavity into the second compartment, where the hollow hydrophobic fibres degasses the regenerated dialysate before it exits through the third port, with the removed gas exiting the system *via* the outlet port.

2. The peritoneal dialysis filter device according to Claim 1, wherein the device further comprises a post-filtration system, which comprises:

(a) a fluid pathway situated between the third port of the housing and the switching means or apparatus, which fluid pathway comprises a post-filtration sorbent compartment, where the post-filtration sorbent compartment comprises a sorbent that is suitable for removing one or more of water-soluble uremic toxins, protein-bound uremic toxins, low-molecular weight proteins, endotoxins, exotoxins, inflammatory mediators and microorganisms; and/or

(b) a post-filtration sorbent placed within the head-space cavity portion, where said sorbent is suitable for removing one or more of water-soluble uremic toxins, protein-bound uremic toxins, low-molecular weight proteins, endotoxins, exotoxins, inflammatory mediators and microorganisms.

3. A peritoneal dialysis filter device, which comprises:

a housing comprising:

a first compartment having a first port, and a second port;

a second compartment, having a third port, a fourth port, an inlet port and an outlet port;

a switching means or apparatus fluidly connected to the first and third ports and that is configured to be connected to a subject's peritoneum;

a first hollow fibre membrane formed from hollow hydrophilic fibres within the first compartment of the housing, where each of the fibres have an inner surface and an outer surface and where the inner surface of the hollow hydrophilic fibres are aligned co-axially with respect to the alignment of the first port and the outer surface of the hollow fibres is aligned perpendicularly with respect to the alignment of the second port; and

a second hollow fibre membrane formed from hollow hydrophobic fibres within the second compartment of the housing, where each of the fibres have an inner surface and an outer surface, where the inner surface of the hollow hydrophobic fibres are aligned co-axially with respect to the alignment of the third and fourth ports and the outer surface of the hollow fibres is aligned perpendicularly with respect to the alignment of the inlet and/or outlet ports.

4. The peritoneal dialysis filter device according to Claim 3, wherein the device further comprises a post-filtration system, which:

(a) comprises a fluid pathway situated between the third port of the housing and the switching means or apparatus, which fluid pathway comprises a post-filtration sorbent compartment, where the post-filtration sorbent compartment comprises a sorbent that is suitable for removing one or more of water-soluble uremic toxins, protein-bound uremic toxins, low-molecular weight proteins, endotoxins, exotoxins, inflammatory mediators and microorganisms; and/or

(b) further comprises a post-filtration sorbent placed within the head-space cavity portion, where said sorbent is suitable for removing one or more of water-soluble uremic toxins, protein-bound uremic toxins, low-molecular weight proteins, endotoxins, exotoxins, inflammatory mediators and microorganisms.

5. A peritoneal dialysis system, comprising,

a filter device; and

a sorbent device,

wherein

the filter device is arranged to receive and filter the entirety of dialysate from a subject and to provide the filtered dialysate to the sorbent device when operated in an outflow direction; and

the filter device is arranged to receive at least part of a regenerated dialysate from the sorbent device when operated in an inflow direction,

wherein the filter device comprises:

a housing comprising a first port and a second port; and

a hollow fibre membrane formed from hollow hydrophilic fibres within the housing, where each of the fibres have an inner surface and an outer surface,

wherein:

the hollow hydrophilic fibres comprise a porous wall matrix; and

the inner surface of the hollow hydrophilic fibres are aligned co-axially with respect to the first port and the outer surface of the hollow fibres is aligned perpendicularly with respect to the second port, such that, when used:

a dialysate from a subject enters the filter device through the first port, is filtered through the porous wall matrix, and the filtered dialysate exits *via* the second port in an outflow direction; and

a regenerated dialysate from the sorbent device enters the filter device through the second port, passes through the porous wall matrix, and exits *via* the first port in an inflow direction,

wherein the filter device further comprises a post-filtration system, which comprises:

a first fluid pathway, which does not comprise a post-filtration compartment;

a second fluid pathway, which comprises a post-filtration compartment; and

a switch for selecting between the first and second fluid pathways,

where the first fluid pathway is situated between the first port of the housing and the switch and is further connectable to a subject's peritoneum,

where the second fluid pathway is situated between the first port of the housing, the switch and the post-filtration compartment and is further connectable to a subject's peritoneum,

where the post-filtration compartment comprises a post-filtration sorbent that is suitable for removing one or more of water-soluble uremic toxins, protein-bound uremic toxins, low-molecular weight proteins, endotoxins, exotoxins, inflammatory mediators and microorganisms.

6. A peritoneal dialysis system, comprising,

a filter device; and

a sorbent device,

wherein

the filter device is arranged to receive and filter the entirety of dialysate from a subject and to provide the filtered dialysate to the sorbent device when operated in an outflow direction; and

the filter device is arranged to receive at least part of a regenerated dialysate from the sorbent device when operated in an inflow direction,

wherein the filter device comprises:

a housing comprising:

a first compartment having a first port, and a second port;

a second compartment, having a third port, an inlet port and an outlet port;

a switching means or apparatus fluidly connected to the first and third ports and that is configured to be connected to a subject's peritoneum; and

a head-space cavity portion that fluidly connects the first compartment to the second compartment;

a first hollow fibre membrane formed from hollow hydrophilic fibres within the first compartment of the housing, where each of the fibres have an inner surface and an outer surface and where the inner surface of the hollow hydrophilic fibres are aligned co-axially with respect to the alignment of the first port and the outer surface of the hollow fibres is aligned perpendicularly with respect to the alignment of the second port; and

a second hollow fibre membrane formed from hollow hydrophobic fibres within the second compartment of the housing, where each of the fibres have an inner surface and an outer surface, where the inner surface of the hollow hydrophobic fibres are aligned co-axially with respect to the alignment of the third port and the outer surface of the hollow fibres is aligned perpendicularly with respect to the alignment of the inlet and/or outlet ports,

where the hollow hydrophilic fibres comprise a porous wall matrix;

such that, when in use:

a dialysate from a subject enters the first compartment of the filter device through the first port and exits the first compartment of the filter device *via* the second port in an outflow direction; and

a regenerated dialysate from the sorbent device enters the first compartment of the filter device through the second port, passes through the head-space cavity into the second compartment, where the hollow hydrophobic fibres degasses the regenerated dialysate before it exits through the third port, with the removed gas exiting the system *via* the outlet port.

7. The peritoneal dialysis system according to Claim 6, wherein the filter device further comprises a post-filtration system, which comprises:

(a) a fluid pathway situated between the third port of the housing and the switching means or apparatus, which fluid pathway comprises a post-filtration sorbent compartment, where the post-filtration sorbent compartment comprises a sorbent that is suitable for removing one or more of water-soluble uremic toxins, protein-bound uremic toxins, low-molecular weight proteins, endotoxins, exotoxins, inflammatory mediators and microorganisms; and/or

(b) further comprises a post-filtration sorbent placed within the head-space cavity portion, where said sorbent is suitable for removing one or more of water-soluble uremic toxins, protein-bound uremic toxins, low-molecular weight proteins, endotoxins, exotoxins, inflammatory mediators and microorganisms.

8. The peritoneal dialysis system according to Claim 6 or Claim 7, wherein the system further comprises a bypass means or apparatus, which comprises:

(a) a bypass fluid pathway connected to the sorbent device and arranged to return a regenerated dialysate to the subject without passing through any part of the filter device; and

a switching means or apparatus that selects between sending a regenerated dialysate to the filter device or to the bypass fluid pathway; or

(b) a bypass fluid pathway connected to the sorbent device and arranged to return a regenerated dialysate to the subject which passes through the second compartment of the filter device, which comprises a fourth port, such that the dialysate enters the second compartment through the fourth port and exits through the third port; and

a switching means or apparatus that selects between sending a regenerated dialysate to the second port or fourth port of filter device.

9. A peritoneal dialysis system, comprising,

a filter device; and

a sorbent device,

wherein

the filter device is arranged to receive and filter the entirety of dialysate from a subject and to provide the filtered dialysate to the sorbent device when operated in an outflow direction; and

the filter device is arranged to receive at least part of a regenerated dialysate from the sorbent device when operated in an inflow direction,

wherein the filter device comprises:

a housing comprising:

a first compartment having a first port, and a second port;

a second compartment, having a third port, a fourth port, an inlet port and an outlet port;

a switching means or apparatus fluidly connected to the first and third ports and that is configured to be connected to a subject's peritoneum;

a first hollow fibre membrane formed from hollow hydrophilic fibres within the first compartment of the housing, where each of the fibres have an inner surface and an outer surface and where the inner surface of the hollow hydrophilic fibres are aligned co-axially with respect to the alignment of the first port and the outer surface of the hollow fibres is aligned perpendicularly with respect to the alignment of the second port; and

a second hollow fibre membrane formed from hollow hydrophobic fibres within the second compartment of the housing, where each of the fibres have an inner surface and an outer surface, where the inner surface of the hollow hydrophobic fibres are aligned co-axially with respect to the alignment of the third and fourth ports and the outer surface of the hollow fibres is aligned perpendicularly with respect to the alignment of the inlet and/or outlet ports.

10. The peritoneal dialysis system according to Claim 9, wherein:

(i) the filter device further comprises a post-filtration system, which:

(a) comprises a fluid pathway situated between the third port of the housing and the switching means or apparatus, which fluid pathway comprises a post-filtration sorbent compartment, where the post-filtration sorbent compartment comprises a sorbent that is suitable for removing one or more of water-soluble uremic toxins, protein-bound uremic toxins, low-molecular weight proteins, endotoxins, exotoxins, inflammatory mediators and microorganisms; and/or

(b) comprises a post-filtration sorbent placed within the head-space cavity portion, where said sorbent is suitable for removing one or more of water-soluble uremic toxins, protein-bound uremic toxins, low-molecular weight proteins, endotoxins, exotoxins, inflammatory mediators and microorganisms; and/or

(ii) the system further comprises a bypass means or apparatus, which comprises:

(ab) a bypass fluid pathway connected to the sorbent device and arranged to return a regenerated dialysate to the subject without passing through any part of the filter device; and

a switching means or apparatus that selects between sending a regenerated dialysate to the filter device or to the bypass fluid pathway; or

(bb) a bypass fluid pathway connected to the sorbent device and arranged to return a regenerated dialysate to the subject which passes through the second compartment of the filter device, such that the dialysate enters the second compartment through the fourth port and exits through the third port; and

a switching means or apparatus that selects between sending a regenerated dialysate to the second port or fourth port of filter device.

11. The peritoneal dialysis system according to any one of Claims 5, 6 to 8 and 9 to 10, wherein the system further comprises a bypass means or apparatus, which comprises:

a bypass fluid pathway connected to the sorbent device and arranged to return a regenerated dialysate to the subject without passing through the filter device; and

a switching means or apparatus that selects between sending a regenerated dialysate to the filter device or to the bypass fluid pathway.

12. A method of peritoneal dialysis using a peritoneal dialysis system as described in any one of Claims 5 to 11, the method comprising the steps of

(a) connecting a subject to a peritoneal dialysis system as described in any one of Claims 5 to 11; and

(b) operating the system, such that:

in an outflow direction, dialysate is withdrawn from the peritoneum of the subject and passes through the filter device before passing to the sorbent device to provide a regenerated dialysate; and

in an inflow direction, the regenerated dialysate is returned to the peritoneum of the subject, wherein

at least part of the regenerated dialysate passes through the hydrophilic fibres of the filter device.

13. The method according to Claim 12, wherein the peritoneal dialysis system is as described in Claim 6, such that a first portion of the regenerated dialysate passes through the hydrophilic fibres of the filter device and a second portion of the regenerated dialysate passes through the bypass means or apparatus in the inflow direction.

14. The method according to Claim 13, wherein the peritoneal dialysis system is as described in Claim 12, such that a first portion of the regenerated dialysate passes through

the hydrophilic fibres of the filter device and a second portion of the regenerated dialysate passes through the bypass means or apparatus in the inflow direction.

15. A haemodialysis device, which comprises:

a housing comprising:

an exchange compartment having a blood inlet port, and a dialysate inlet port and a dialysate outlet port;

a blood degassing compartment having a blood outlet port, a degassing gas inlet port and a negative pressure/gas outlet port;

a head-space cavity portion that fluidly connects the exchange compartment to the blood degassing compartment;

a first hollow fibre membrane formed from hollow hydrophilic fibres within the exchange compartment of the housing, where each of the fibres have an inner surface and an outer surface and where the inner surface of the hollow hydrophilic fibres are aligned co-axially with respect to the alignment of the blood inlet port and the outer surface of the hollow fibres is aligned perpendicularly with respect to the alignment of the dialysate inlet and outlet ports;

a second hollow fibre membrane formed from hollow hydrophobic fibres within the blood degassing compartment of the housing, where each of the fibres have an inner surface and an outer surface, where the inner surface of the hollow hydrophobic fibres are aligned co-axially with respect to the alignment of the blood outlet port and the outer surface of the hollow fibres is aligned perpendicularly with respect to the alignment of the gas inlet and/or negative pressure ports.

16. A haemodialysis device, which comprises:

a housing comprising:

an exchange compartment having a blood inlet port, a blood outlet port and a dialysate outlet port;

a dialysate degassing compartment having a dialysate inlet port, a degassing gas inlet port and a negative pressure/gas outlet port;

a wall defining a fluid-impermeable boundary between the exchange compartment and the dialysate degassing compartment;

a dialysate fluid portal allowing a dialysate to move from the dialysate degassing compartment to the exchange compartment;

a first hollow fibre membrane formed from hollow hydrophilic fibres within the exchange compartment of the housing, where each of the fibres have an inner surface and an outer surface and where the inner surface of the hollow hydrophilic fibres are aligned co-axially with

respect to the alignment of the blood inlet and outlet ports, and the outer surface of the hollow fibres is aligned perpendicularly with respect to the alignment of the dialysate outlet port; and

a second hollow fibre membrane formed from hollow hydrophobic fibres within the dialysate degassing compartment of the housing, where each of the fibres have an inner surface and an outer surface, where the inner surface of the hollow hydrophobic fibres are aligned co-axially with respect to the alignment of the degassing gas inlet port and the negative pressure/gas outlet port, and the outer surface of the hollow fibres is aligned perpendicularly with respect to the alignment of the dialysate inlet port and the dialysate fluid portal, optionally wherein:

(a) the dialysate fluid portal is located in the wall; and/or

(b) the device further comprises a device for regenerating dialysate.

17. A haemodialysis device, which comprises:

a housing comprising:

an exchange compartment having a blood inlet port, a blood outlet port, a first dialysate inlet port and a first dialysate outlet port;

a dialysate degassing compartment having a second dialysate inlet port, a second dialysate outlet port, a degassing gas inlet port and a negative pressure/gas outlet port;

a wall defining a fluid-impermeable boundary between the exchange compartment and the dialysate degassing compartment;

a first hollow fibre membrane formed from hollow hydrophilic fibres within the exchange compartment of the housing, where each of the fibres have an inner surface and an outer surface and where the inner surface of the hollow hydrophilic fibres are aligned co-axially with respect to the alignment of the blood inlet and outlet ports, and the outer surface of the hollow fibres is aligned perpendicularly with respect to the alignment of the first dialysate inlet and outlet ports; and

a second hollow fibre membrane formed from hollow hydrophobic fibres within the dialysate degassing compartment of the housing, where each of the fibres have an inner surface and an outer surface, where the inner surface of the hollow fibres is aligned co-axially with respect to the alignment of the second dialysate inlet and outlet ports and the outer surface of the hollow fibres is aligned perpendicularly with respect to the alignment of the degassing gas inlet port and the negative pressure/gas outlet port, optionally wherein the device further comprises a device for regenerating dialysate.

18. A method of haemodialysis comprising the steps of treating a subject in need thereof with a haemodialysis device as described in any one of Claims 15 to 17.

19. A kit of parts comprising:

(i) a peritoneal dialysis filter device according to Claim 1; and

(ii) a post-filtration system, which comprises:

(a) a fluid pathway situated between the third port of the housing and the switching means or apparatus, which fluid pathway comprises a post-filtration sorbent compartment, where the post-filtration sorbent compartment comprises a sorbent that is suitable for removing one or more of water-soluble uremic toxins, protein-bound uremic toxins, low-molecular weight proteins, endotoxins, exotoxins, inflammatory mediators and microorganisms; and/or

(b) a post-filtration sorbent placed within the head-space cavity portion, where said sorbent is suitable for removing one or more of water-soluble uremic toxins, protein-bound uremic toxins, low-molecular weight proteins, endotoxins, exotoxins, inflammatory mediators and microorganisms.

20. A kit of parts comprising:

(i) a peritoneal dialysis filter device according to Claim 3; and

(ii) a post-filtration system, which:

(a) comprises a fluid pathway situated between the third port of the housing and the switching means or apparatus, which fluid pathway comprises a post-filtration sorbent compartment, where the post-filtration sorbent compartment comprises a sorbent that is suitable for removing one or more of water-soluble uremic toxins, protein-bound uremic toxins, low-molecular weight proteins, endotoxins, exotoxins, inflammatory mediators and microorganisms; and/or

(b) further comprises a post-filtration sorbent placed within the head-space cavity portion, where said sorbent is suitable for removing one or more of water-soluble uremic toxins, protein-bound uremic toxins, low-molecular weight proteins, endotoxins, exotoxins, inflammatory mediators and microorganisms.

21. A device for use in peritoneal dialysis consisting of:

(i) a filter device; and

(ii) a post-filtration system,

wherein the filter device comprises:

a housing comprising a first port and a second port; and

a hollow fibre membrane formed from hollow hydrophilic fibres within the housing, where each of the fibres have an inner surface and an outer surface, wherein

the hollow hydrophilic fibres comprise a porous wall matrix; and

the inner surface of the hollow hydrophilic fibres are aligned co-axially with respect to the alignment of the first port and the outer surface of the hollow fibres is aligned perpendicularly with respect to the alignment of the second port, such that, when used:

a dialysate from a subject enters the filter device through the first port is filtered through the porous wall matrix, and the filtered dialysate exits *via* the second port in an outflow direction; and

a regenerated dialysate from a sorbent system enters the filter device through the second port, passes through the porous wall matrix, and exits *via* the first port in an inflow direction,

and wherein the post-filtration system consists of:

(a) a switch;

(b) a post-filtration sorbent compartment; and

(c) fluid connections connecting the post-filtration sorbent compartment, the switch and the first port of the housing,

wherein the post-filtration system and filter device together form:

a first fluid pathway consisting of the first port of the housing, the switch and a fluid connection therebetween; and

a second fluid pathway consisting of the first port of the housing, the switch, the post-filtration sorbent compartment, and a fluid connection therebetween;

where the switch is suitable for selecting between the first and second fluid pathways,

where the first and second fluid pathways are both fluidly connected to the first port of the housing *via* the switch,

where the post-filtration sorbent compartment comprises a post-filtration sorbent that is suitable for removing one or more of water-soluble uremic toxins, protein-bound uremic toxins, low-molecular weight proteins, endotoxins, exotoxins, inflammatory mediators and microorganisms.

22. The device according to Claim 21, wherein:

the first fluid pathway is connectable to a subject's peritoneum *via* the switch; and

the second fluid pathway is connectable to a subject's peritoneum *via* the post-filtration sorbent compartment

23. A kit of parts comprising:

(a) a peritoneal dialysis filter device as defined in Claim 21; and

(b) a post-filtration system consisting of:

(i) a switch;

(ii) a post-filtration sorbent compartment; and

(iii) fluid connections connecting the post-filtration sorbent compartment and the switch,

wherein the switch of the post-filtration system and the first port of the housing of the filter device are connectable to form:

a first fluid pathway consisting of the first port of the housing, the switch and a fluid connection therebetween; and

a second fluid pathway consisting of the first port of the housing, the switch, the post-filtration sorbent compartment, and a fluid connection therebetween;

where the switch is suitable for selecting between the first and second fluid pathways,

where the first and second fluid pathways are both fluidly connected to the first port of the housing *via* the switch,

where the post-filtration sorbent compartment comprises a post-filtration sorbent that is suitable for removing one or more of water-soluble uremic toxins, protein-bound uremic toxins, low-molecular weight proteins, endotoxins, exotoxins, inflammatory mediators and microorganisms.