

# Ultrafiltration Membranes

## Ultrafiltration Membranes for Macromolecule Processing



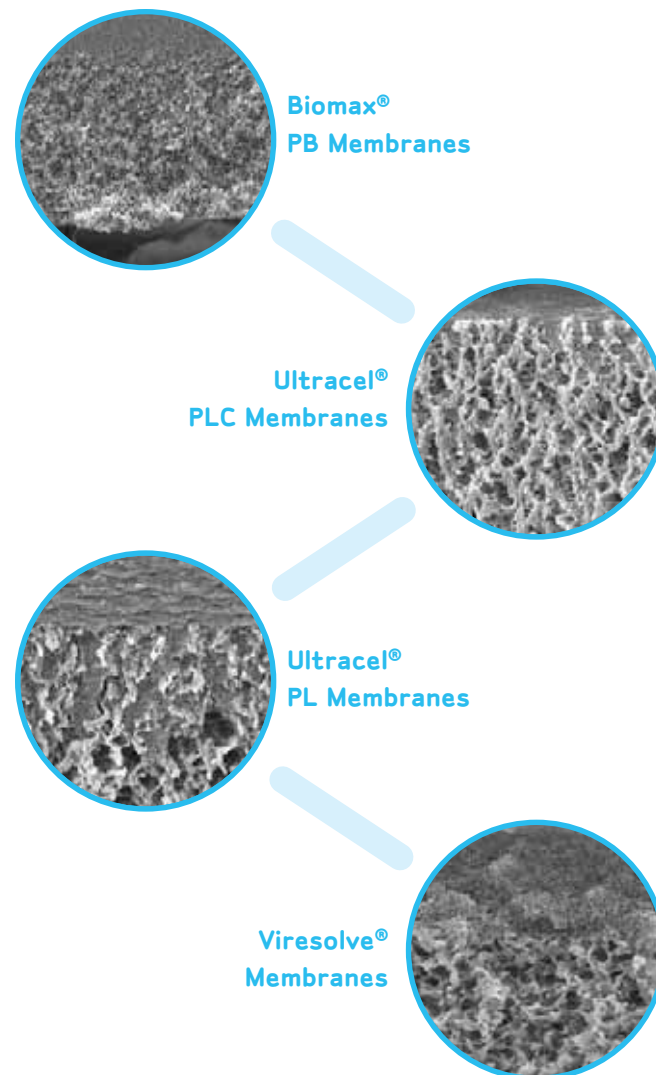
# Ultrafiltration Membranes for Macromolecule Processing

Ultrafiltration (UF) is the process of separating extremely small particles and dissolved molecules from fluids. The primary basis for separation is molecular size – particles ranging from 1,000 to 1,000,000 molecular weight are retained by ultrafiltration membranes.



Millipore's UF membranes are manufactured in our world class facility in Jaffrey, New Hampshire. This state-of-the-art facility is dedicated to the reliable production of our high quality UF membranes, deploying GMP practices and ISO compliant measures. The 44,000 sq ft facility is a Commissioned Class 100K controlled environment; containing the most innovative manufacturing equipment and processes in the industry.

This guide provides an introduction to Millipore's family of Ultrafiltration Membranes and an overview of the key criteria and product characteristics to consider when selecting an UF membrane for your application or medical device. Using this guide will help ensure high levels of retention; however optimization through experimentation should always be conducted to find a suitable balance between retention and flow rate levels.



## BIOMAX PB MEMBRANES

Biomax PB membranes are well suited for applications requiring high flux, low to moderate protein binding, and harsh chemical cleaning and/ or sanitization. Made of polyethersulfone (PES), these void-free membranes are caustic and chlorine resistant, and are modified to reduce non-specific protein binding and fouling. The high flux and high retention of Biomax membranes result in faster processing speeds with higher yields. This allows shorter processing time and more compact processing systems.

### Product Features

- Composite PES membrane provides a stable hydraulic environment for excellent mechanical strength and integrity.
- Void-free structure results in higher flux, excellent retention, and higher yields.
- Low to moderate protein binding – for use with protein solutions containing more than 0.1 mg/mL of protein.
- Available in a broad range of molecular weight cut-offs to suit a variety of applications.

## ULTRACEL PLC MEMBRANES

Ultracel PLC membranes are the membranes of choice for high-recovery purification. These void-free membranes combine ultra-low protein binding and low fouling with solvent resistance and superb mechanical strength. Casting the regenerated cellulose membrane onto a microporous polyethylene substrate creates a uniform, robust structure, with high integrity and greater resistance to back pressure.

### Product Features

- Void-free structure results in excellent retention and improved integrity.
- Ultra-low protein binding – for use with protein solutions (less than 0.1 mg/mL).
- Composite structure gives the membrane improved back pressure resistance.
- Available in a broad range of molecular weight cut-offs to suit a variety of applications.

## ULTRACEL PL MEMBRANES

Ultracel PL membranes are ideal for the concentration and desalination of solutes especially when only small volumes or low concentrations are available. The membrane's permeability is optimized for improved performance with high solute retention and higher flux levels. In addition, the regular non-voided support layer is also more resistant to damage due to handling, manufacture or process condition variations.

### Product Features

- Available in a broad range of molecular weight cut-offs.
- Polypropylene backing material provides support without impeding flow.
- Low to moderate protein binding.

## VIRESOLVE MEMBRANES

Virus contamination poses a threat to the safety of clinical compounds derived from recombinant or human plasma sources. Patented, composite Viresolve membranes provide reliable and consistent viral clearance. Viresolve membranes are available in varieties suitable for normal-flow and tangential-flow filtration.

### Product Features

- Low-binding polyvinylidene fluoride structure yields high protein recovery (greater than 90%).
- Greater than 3 log removal of viruses for quantifiable virus load reduction.
- Suitable for normal-flow and tangential-flow filtration applications.

Biomax PB Membranes

HIGH FLUX

| Membrane Name      | Biomax 5            | Biomax 8            | Biomax 10           | Biomax 30           | Biomax 50           | Biomax 100          | Biomax 300          | Biomax 500              | Biomax 1000             | PBSEQ               |
|--------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|-------------------------|-------------------------|---------------------|
| NMWL Cutoff        | 5 kiloDalton        | 8 kiloDalton        | 10 kiloDalton       | 30 kiloDalton       | 50 kiloDalton       | 100 kiloDalton      | 300 kiloDalton      | 500 kiloDalton          | 1000 kiloDalton         | 8 kiloDalton        |
| Membrane Material  | Polyethersulfone    | Polyethersulfone    | Polyethersulfone    | Polyethersulfone    | Polyethersulfone    | Polyethersulfone    | Polyethersulfone    | Polyethersulfone        | Polyethersulfone        | Polyethersulfone    |
| Support Material   | Polyolefin Nonwoven | Polyolefin Nonwoven | Polyolefin Nonwoven | Polyolefin Nonwoven | Polyolefin Nonwoven | Polyolefin Nonwoven | Polyolefin Nonwoven | Polyolefin Nonwoven     | Polyolefin Nonwoven     | Polyolefin Nonwoven |
| Dextran Retention  | 90% at 10 kD        | 90% at 18 kD        | 90% at 15 kD        | 90% at 70 kD        | 90% at 95 kD        | 90% at 160 kD       | BP ≥ 80 psi         | BP ≥ 45 psi to ≤ 90 psi | BP ≥ 30 psi to ≤ 55 psi | 90% at 18 kD        |
| Thickness          | 280 microns         | 280 microns         | 280 microns         | 280 microns         | 280 microns         | 280 microns         | 280 microns         | 280 microns             | 280 microns             | 280 microns         |
| Air Permeability   | 0 at 30 psi         | 0 at 30 psi         | 0 at 30 psi         | 0 at 30 psi         | 0 at 30 psi         | 0 at 30 psi         | 0 at 30 psi         | 0 at 30 psi             | 1 ml/min at 10 psi      | 0 at 30 psi         |
| Water Flux         | 3.5 lmh/psi         | 10 lmh/psi          | 27 lmh/psi          | 37.5 lmh/psi        | 47.5 lmh/psi        | 95 lmp/psi          | 230 lmh/psi         | 390 lmh/psi             | 750 lmh/psi             | 15 lmh/psi          |
| Membrane Code      | PBCC                | PBFC                | PBGC                | PBTK                | PBQK                | PBHK                | PBMK                | PBVK                    | PBXK                    | PBSEQ               |
| pH range           | 1–14                | 1–14                | 1–14                | 1–14                | 1–14                | 1–14                | 1–14                | 1–14                    | 1–14                    | 1–14                |
| Max Operating Temp | 80 °C               | 80 °C               | 80 °C               | 80 °C               | 80 °C               | 80 °C               | 80 °C               | 80 °C                   | 80 °C                   | 80 °C               |
| Max Support Width  | 30 inches*          | 15 inches**         | 30 inches*          | 30 inches*          | 30 inches*          | 30 inches*          | 15 inches**         | 15 inches**             | 30 inches*              | 15 inches**         |
| Standard Length    | 400 feet            | 400 feet            | 400 feet            | 400 feet            | 400 feet            | 400 feet            | 400 feet            | 400 feet                | 400 feet                | 400 feet            |

Ultracel PLC Membranes

MAXIMUM RETENTION/LOWEST BINDING

| Membrane Name      | Ultracel 5 kD         | Ultracel 8 kD         | Ultracel 10 kD        | Ultracel 20 kD        | Ultracel 30 kD        | Ultracel 100 kD       | Ultracel 300 kD        | Ultracel 1000 kD       |
|--------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------------|------------------------|
| NMWL Cutoff        | 5 kiloDalton          | 8 kiloDalton          | 10 kiloDalton         | 20 kiloDalton         | 30 kiloDalton         | 100 kiloDalton        | 300 kiloDalton         | 1000 kiloDalton        |
| Membrane Material  | Regenerated Cellulose | Regenerated Cellulose | Regenerated Cellulose | Regenerated Cellulose | Regenerated Cellulose | Regenerated Cellulose | Regenerated Cellulose  | Regenerated Cellulose  |
| Support Material   | UHMW Polyethylene     | UHMW Polyethylene     | UHMW Polyethylene     | UHMW Polyethylene     | UHMW Polyethylene     | UHMW Polyethylene     | UHMW Polyethylene      | UHMW Polyethylene      |
| Dextran Retention  | 90% at 5 kD           | 90% at 8 kD           | 90% at 5 kD           | 90% at 10 kD          | 90% at 30 kD          | 90% at 100 kD         | 90% at 300 kD          | 90% at 840 kD          |
| Average Thickness  | 130 microns           | 200 microns           | 130 microns           | 130 microns           | 130 microns           | 130 microns           | 130 microns            | 130 microns            |
| Air Permeability   | 0 at 70 psi           | 0 at 70 psi           | 0 at 70 psi           | 0 at 70 psi           | 0 at 30 psi           | 0 at 30 psi           | ≤ 2.5 cc/min at 30 psi | ≤ 2.5 cc/min at 30 psi |
| Ave Water Flux     | 1 lmh/psi             | 3.5 lmh/psi           | 4.2 lmh/psi           | 9 lmh/psi             | 21.5 lmh/psi          | 94.5 lmh/psi          | 272 lmh/psi            | 300 lmh/psi            |
| Membrane Code      | PLCCC                 | PLGCD                 | PLC010                | PLCGC                 | PLCTK                 | PLCHK                 | PLCMK                  | PLCXX                  |
| pH range           | 2–13                  | 2–13                  | 2–13                  | 2–13                  | 2 –13                 | 2 –13                 | 2 –13                  | 2 –13                  |
| Max Operating Temp | 80 °C                 | 80 °C                 | 80 °C                 | 80 °C                 | 80 °C                 | 80 °C                 | 80 °C                  | 80 °C                  |
| Max Width          | 13 inches             | 13 inches             | 13 inches             | 13 inches             | 13 inches             | 13 inches             | 13 inches              | 13 inches              |
| Standard Length    | 350 feet              | 350 feet              | 350 feet              | 350 feet              | 350 feet              | 350 feet              | 350 feet               | 350 feet               |

Ultracel PL Membranes

MAXIMUM RETENTION/LOWEST BINDING

| Membrane Code      | PLAC                   | PLBC                   | PLCC                   | PLGC                   | PLTK                   | PLHK                   |
|--------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| NMWL Cutoff        | 1 kiloDalton           | 3 kiloDalton           | 5 kiloDalton           | 10 kiloDalton          | 30 kiloDalton          | 100 kiloDalton         |
| Membrane Material  | Regenerated Cellulose  | Regenerated Cellulose  | Regenerated Cellulose  | Regenerated Cellulose  | Regenerated Cellulose  | Regenerated Cellulose  |
| Support Material   | Polypropylene Nonwoven | Polypropylene Nonwoven | Polypropylene Nonwoven | Polypropylene Nonwoven | Polypropylene Nonwoven | Polypropylene Nonwoven |
| Dextran Retention  | 90% at 1 kD            | 90% at 3 kD            | 90% at 5 kD            | 90% at 10 kD           | 90% at 30 kD           | 90% at 100kD           |
| Thickness          | 230 microns            | 230 microns            | 230 microns            | 230 microns            | 230 microns            | 230 microns            |
| Air Permeability   | < 5 mL/min at 30 psi   | < 5 mL/min at 30 psi   | < 5 mL/min at 30 psi   | < 5 mL/min at 30 psi   | < 5 mL/min at 30 psi   | < 5mL/min at 30 psi    |
| Water Flux         | 0.5 lmh/psi            | 1.0 lmh/psi            | 1.5 lmh/psi            | 7.5 lmh/psi            | 25 lmh/psi             | 30 lmh / PSI           |
| Membrane Code      | PLAC                   | PLBC                   | PLCC                   | PLGC                   | PLTK                   | PLHK                   |
| pH Range           | 2 – 10                 | 2 – 10                 | 2 – 10                 | 2 – 10                 | 2 – 10                 | 2 – 10                 |
| Max Operating Temp | 80 °C                  | 80 °C                  | 80 °C                  | 80 °C                  | 80 °C                  | 80 °C                  |
| Max Width          | 27 inches              | 27 inches              | 27 inches              | 27 inches              | 27 inches              | 27 inches              |
| Standard Length    | 200 feet               | 200 feet               | 200 feet               | 200 feet               | 200 feet               | 200 feet               |

Coated UF Width: \* 27.5 inches, \*\* 13.25 inches

Viresolve Membranes

VIRUS CLEARANCE

| Membrane Name      | Viresolve 180  | Viresolve 180 (Normal Flow Filtration) | Retrovirus Membrane |
|--------------------|----------------|----------------------------------------|---------------------|
| NMWL Cutoff        | 180 kiloDalton | 180 kiloDalton                         | NA                  |
| Membrane Material  | PVDF           | PVDF                                   | PES (asymmetric)    |
| Support Material   | None           | None                                   | None                |
| Thickness          | 150 μm         | 150 μ m                                | 140 μm              |
| Water Permeability | 63 lmh/psi     | 63 lmh/psi                             | 110 lmh/psi         |
| Membrane Code      | PPVG           | PPVGNF                                 | RVRM                |
| Endotoxins         | < 0.5 Eu/mL    | < 0.5 Eu/mL                            | < 0.5 Eu/mL         |
| Extractables       | ≤ 0.3 %        | ≤ 0.3 %                                | < 10 μg C/cm2       |
| Virus Retention    | LRV > 1.5      | LRV > 1.5                              | LRV > 6             |
| pH range           | 4–8            | 4–8                                    | 4–8                 |
| Max Operating Temp | 37 °C          | 37 °C                                  | 80 °C               |
| Max Width          | 12 inches      | 12 inches                              | 11 inches           |
| Standard Length    | 500 feet       | 500 feet                               | 1,000 feet          |

SELECTING THE NOMINAL MOLECULAR WEIGHT LIMIT (NMWL) RATING FOR CONCENTRATING, DESALTING, AND BUFFER EXCHANGE OF MACROMOLECULES

This rating reflects the molecular weight of solutes retained by the membrane. Reference the chart to select an appropriate Millipore ultrafiltration membrane based on NMWL cutoff. The chart is accurate for applications requiring the membrane to pass only water, salts, and other low molecular weight molecules.

For Macromolecules:

- 1 Determine the molecular weight (in kiloDaltons) of the macromolecule the membrane should retain. Locate the molecular weight on the x-axis of the chart.
- 2 Move vertically from the molecular weight until you intersect one the diagonal lines. If your macromolecule

is globular or is a protein, stop at the light blue line; if your macromolecule is linear or is a polysaccharide, stop at the dark blue line. This point corresponds on the y-axis to the Stokes radius (in nm) of that macromolecule in aqueous solutions.

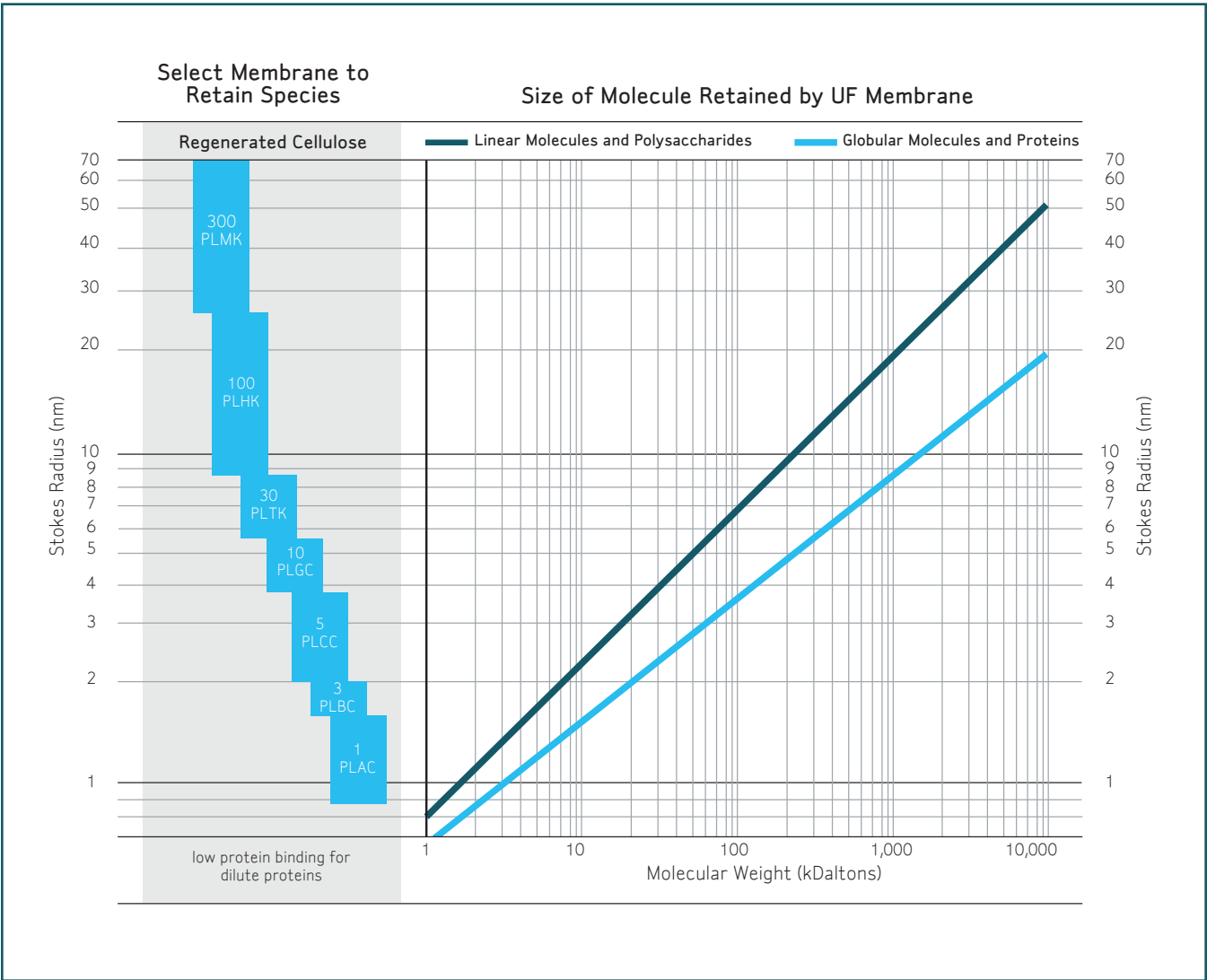
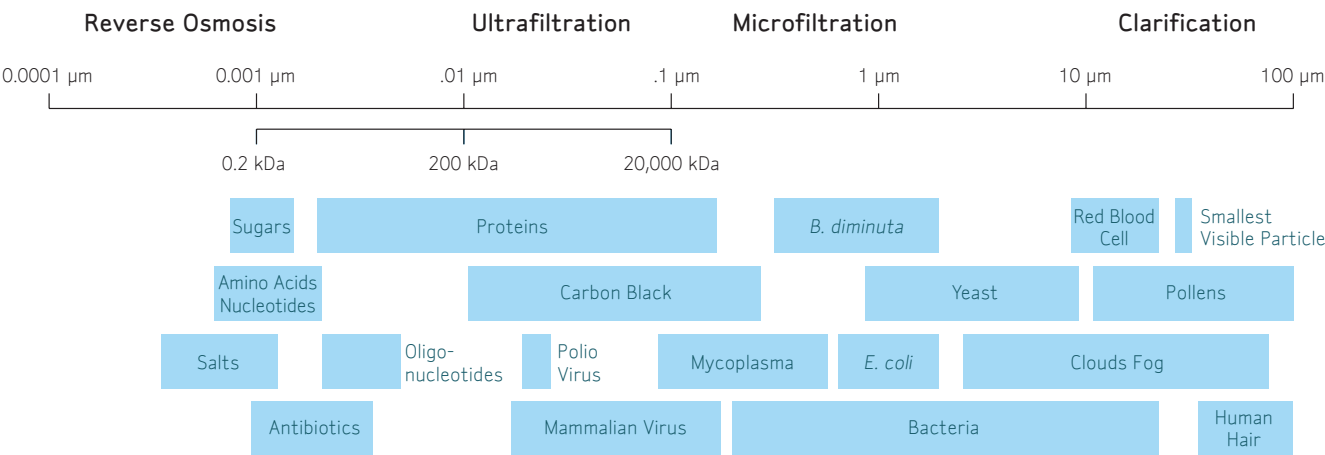
- 3 To determine the radius move horizontally to the left to determine the recommended Millipore ultrafiltration membrane for your application.

For Viruses and Colloids:

- 1 Determine the radius of the smallest virus or colloid particles in nanometers.
- 2 Locate that radius on the left hand side y-axis of the chart.
- 3 From the radius move horizontally to the right to determine the recommended Millipore ultrafiltration membrane for your application.

COMPARISON OF ULTRAFILTRATION WITH OTHER COMMONLY USED MEMBRANE SEPARATION TECHNIQUES

This table is an overview of common filtrates and particles with the recommended filtration/separation technology based on the size and/or type of filtrate or particle.



## FOR MORE INFORMATION



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