Spectra/Por®

Standard Grade Regenerated Cellulose Dialysis Membrane (Spectra/Por® 1 - 5, 6 & 7)



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Table of Contents

Introduction 1
Membrane Composition 1
Membrane Specifications 2
Comparison of Spectra/Por Standard RC Membranes 3
Metal Content in Spectra/Por® 1-6 Membranes 3
Membrane Selection 4
Membrane Permeability Characterization 4
MWCO Selection 5
Chemical Compatibility 5
Membrane Tubing “Flat Width” Selection 6
Closure Selection 6
Membrane Preparation 7
Spectra/Por® 1-6 7
Spectra/Por® 7 8
Membrane Handling and Use 8
Sample Recovery 9
Membrane Storage and Shelf Life 10
Membrane Sterilization 10
Product Specifications and Ordering Information
Spectra/Por® 1-5 Standard RC Dry Dialysis Tubing 11
Spectra/Por® 1-5 Standard RC Dry Dialysis Trial Kits . . . 13
Spectra/Por® 6 Standard RC
Pre-wetted Dialysis Tubing & Trial Kits 15
Spectra/Por® 7 Standard RC
Pre-treated Dialysis Tubing & Trial Kits 18
Spectra/Por® RC Discs and Flat Sheets 21
Spectra/Por® Ready-to-Use Dialysis Sacks 22
Heavy Metals Cleaning Solution 22

Spectra/Por® 1-7 Regenerated Cellulose Membranes

Introduction

Spectra/Por® Standard Grade Regenerated Cellulose (RC) membrane is a versatile membrane available for laboratory dialysis. It carries no fixed charge and does not adsorb most solutes.

Unlike native cellulose, which is highly crystalline and rigid, regenerated cellulose is largely amorphous and swollen by water. However, it still contains small regions of crystallinity that lock (cross-link) the structural chains in place to maintain membrane integrity. Depending on the manufacturing conditions, these locking regions may be numerous. The areas between cross-links, swollen with water, act as pores permitting sufficiently small solute molecules to pass through the membrane.

Due to the amorphous, gel-like nature of regenerated cellulose, mechanical strain will also alter the porosity of the membrane.

Membrane Composition and Specifications

Spectra/Por 1, 2, 3, 4, 5, 6 and 7 dialysis membranes are manufactured from natural cellulose reconstituted from cotton linters. These RC membranes carry no fixed charge and do not adsorb most solutes. Standard RC dialysis membranes are used for general laboratory dialysis functions, such as desalting, buffer exchange, or molecular separation.

These flexible, transparent membranes feature good chemi-

cal and pH resistance and high temperature tolerance.

Spectra/Por 1 through 6 contain trace levels of heavy metals and sulfides. Spectra/Por 7 membranes have been chemically treated to minimize the heavy metal and sulfur content, eliminating the need for special cleaning treatments.

During the manufacturing process, Spectra/Por 5 membrane is reinforced with a layer of porous paper to increase its wet strength for use in high shear or torque environments, resulting in a lower permeation rate compared to the other membranes.

Membrane Specifications

Standard Regenerated Cellulose (RC) Membrane

Membrane Type:	Symmetric Regenerated Cellulose Tubing
Physical Properties:	Transparent, flexible (Spectra/Por® 5 reinforced with porous paper layer)
PH limits:	2-12
Suggested temperature:	60° C
Organic Solvent Tolerance:	Good

Spectra/Por® 1-7 Regenerated Cellulose Membranes

Comparison of Spectra/Por Standard RC Membranes

Spectra/Por® 1	2	3	4	5	6	7
6 - 8 kD	12 - 14 kD	3.5 kD	12 - 14 kD	12 - 14 kD	1, 2, 3.5, 8, 10, 15, 25 & 50 kD	1, 2, 3.5, 8, 10, 15, 25 & 50 kD
Standard Permeability	Higher Permeability or large FW	Standard Permeability	Standard Permeability	Re-inforced for weight	Pre-wetted for convenience	Pre-treated for heavy metals & sulfides
Tubing, Trial Kits, Discs & Sheets	Tubing, Trial Kits, Discs & Sheets	Tubing, Trial Kits, Discs & Sheets	Tubing, Trial Kits, Discs & Sheets	Tubing & Trial Kits	Tubing & Trial Kits	Tubing & Trial Kits
Dry with glycerin	Dry with glycerin	Dry with or without glycerin	Dry with glycerin	Dry without glycerin	Wet in 0.05% sodium azide	Wet in 0.05% sodium azide

Metal Content in Spectra/Por 1-6 Dialysis Membranes

The following are approximate concentration of heavy metal and sulfur found in the Spectra/Por 1 through 6 membranes.

Element	Concentration	Mg	50-100 ppm
Cd	<1 ppm		
Cr	<1 ppm	Ni	1-2 ppm
Cu	<1 ppm	Pb	2-6 ppm
Fe	20-60 ppm	Zn	5-10 ppm

Membrane Selection

Membrane Permeability Characterization

Dialysis membranes are universally characterized by the molecular weight cut off (MWCO). Spectrum determines the MWCO of a membrane by conducting a comprehensive dialysis test with a set of solutes of known molecular weight. The MWCO of the membrane is determined as the molecular weight of the smallest solute which is at least 90% retained during this test (the smallest solute for which the permeation is 10% or less).

Dialysis membrane may also be characterized by the rate at which a permeable species passes through the membrane. A rate test may be carried out by placing a solution of a permeable species on one side of a membrane and pure solvent on the other. If both the solution and the solvent are well stirred and the pure solvent is constantly changed (so that it never contains an appreciable concentration of solute), a first-order rate will be observed.

A very important variable in the rate of dialysis is the molecular weight of the solute. As the molecular weight of a permeable solute increases, the rate of dialysis decreases. At molecular weights far from the MWCO, the rate decrease is caused by the decrease of the diffusion rate with the increasing molecular weight. As the solute's molecular weight nears the MWCO, the rate will slow dramatically with further increases in molecular weight until the molecules become too large to pass through the membrane.

Spectra/Por® 1-7 Regenerated Cellulose Membranes

MWCO Selection

The effective size of many solute molecules will be affected by the pH and ionic strength of the solution in which they are dissolved.

Therefore, the listed MWCO values should be used merely as typical and not absolute values. To establish the optimal MWCO for any application, it may be necessary to test several membranes. To maximize the rate of dialysis, the membrane with the largest MWCO which will not cause excess loss of the desired species should be used.

The selecting of MWCO is based on the molecular weight of the macro molecules that are going to be retained inside the membrane and the molecular weight of the micromolecule contaminants to be removed. For reasonably efficient separation by means of dialysis with Spectra/Por membranes, the ratio of the molecular weights of the two compounds to be separated should be at least 25. A rule of thumb is to choose a MWCO by selecting an MWCO value about half of the molecular weight of the macromolecules to be retained in order to achieve a minimum 90% retention.

Chemical Compatibility

Spectra/Por® RC membranes have good chemical resistance. Variables in temperature, concentrations, durations of exposure and other factors may affect the use of the membrane. It is always advisable to test the membrane under your application conditions. These membranes are resistant to the following groups: halogenated hydrocar-

bons, alcohols, ketones, esters, oxides and solvents containing nitrogen. They are not recommended for use with >25% hydrochloric, nitric and perchloric acids; 96% sulfuric acid; 1N potassium hydroxide and 10% phenol. Refer to Spectrum's chemical compatibility table on our website for more information.

Membrane Tubing "Flat Width" Selection

The selection of the tubing flat width depends on the size of the sample volume and the dialysis reservoir. The smaller tubing (which has a higher surface area to volume ratio) will dialyze more quickly, and larger tubing will dialyze more slowly due to the longer diffusion distances involved. For easy handling of the membrane tubing, the suggested total length including closures and head space should be approximately 10 to 15 cm. The "Volume/Length" ratio (ml/cm) is provided on our website.

Closure Selection

It is recommended to select a closure width of 4 to 10 mm longer than the flat width of the membrane tubing. This will allow the closure to seal the tubing securely when the sample solution is being filled inside.

Closures are available in two types of material: polypropylene (Spectra/Por) or nylon (Universal).

Spectra/Por® Closures (polypropylene)

The following Spectra/Por Closures are only for use with RC membranes.

Spectra/Por® 1-7 Regenerated Cellulose Membranes

- **Standard Closure:** Aids in sample buoyancy when applied to the top of the membrane tubing.
- **Weighted Closure:** Contains an embedded stainless steel weight to keep membrane in vertical floating position when applied to bottom of membrane tubing.
- **Magnetic Weighted Closure**: Contains an embedded magnetic stir bar, eliminating the need for a magnetic stir bar when the magnetic weighted closure is applied at the bottom of the membrane tubing.

Universal Closures (nylon)

Nylon closures may be used for all types of membrane tubing. These Universal closures sink on their own and allow the membrane tubing to float vertically with a head space. Universal Closures are not autoclavable.

Membrane Preparation

Spectra/Por 1-6

For most applications, the membrane can be soaked in distilled water at room temperature for 30 minutes to remove the preservative (glycerine or sodium azide). Then, rinse the membrane thoroughly in distilled water.

If the presence of heavy metals is anticipated to cause interferences, the membranes can be treated with Spectrum Heavy Metals Cleaning Solution. This cleaning process takes less than 10 minutes to complete. The Heavy Metals Cleaning solution is a chelating rinse which strips the heavy metals from the membrane.

Spectra/Por 7

Spectra/Por 7 membrane has been chemically treated to minimize the content of heavy metals and sulfide contaminants; therefore, it is only necessary to soak the membrane in a large volume of deionized or distilled water for 30 minutes to remove the sodium azide preservant agent. Then, rinse thoroughly with running deionized or distilled water.

Membrane Handling and Use

The following is a general protocol for typical dialysis. There are many variables that should be considered before starting dialysis; including solute concentrations, sample and dialysate volumes, solvents, chemical compatibility, temperature, etc. Therefore, some application-specific changes to the following dialysis procedure may be necessary.

1. Fill a Spectra/Por Dialysis Reservoir with a large volume of appropriate dialysate (buffer). The dialysate volume should be ≥ 100X the sample volume. (Example: dialyze 10 ml sample in 1 L dialysate.)
2. Cut dialysis tubing into an appropriate length. Allow 10-20% extra tubing length for air head space to insure sample buoyancy above rotating stir bar. Prepare the tubing according to the directions for use (see page 7-8).
3. Open the first Closure and clamp onto the dialysis tubing 3-5 cm from the bottom.
4. Load the sample through the open end of the dialysis tubing. Clamp the second Closure at least 5 cm from the top end of the dialysis tubing while allowing enough head space for buoyancy.
5. Place the dialysis sample in appropriate dialysis buffer.
6. Drop an appropriate-sized magnetic stir-bar into the dialysis reservoir. Place the dialysis reservoir on a stir-plate and adjust the stir speed to rotate the sample without pulling it down into the vortex.
7. Typically, dialysis is allowed to continue overnight. The dialysate (buffer) may be changed several times during dialysis, making sure to allow 2-4 hours of dialysis after the last dialysate change.

   Note: Samples with higher contaminant concentrations, may need to dialyze for a longer duration with more frequent changes of dialysate solution.

Sample Recovery

Hold the portion of the tubing that extends above the top closure, open the top closure and then pipette or pour out the sample into a container.

Spectra/Por® 1-7 Regenerated Cellulose Membranes

Membrane Storage and Shelf Life

Since the useful life of dialysis membranes can be affected by storage conditions, it is important to store under optimal conditions.

Dry membrane (Spectra/Por 1-5) should be stored in original packaging at ambient conditions protected from moisture and extreme temperatures or in a polyethylene bag at 4-8 °C. Properly stored dry membrane has a shelf life of 5 years.

Wet membrane (Spectra/Por 6 and 7) and dry membrane (Spectra/Por 1-5) that has been wetted for storage should be stored at 4-8 °C in a solution of 0.05% sodium azide, 1% sodium benzoate or 1% formaldehyde. This preservative solution should be changed at least every 6 months. Properly stored wet membrane has a shelf life of 3 years.

Membrane Sterilization

The common method of membrane sterilization is exposure to ethylene oxide (EtO) gas. Alternative sterilization methods are either irradiation or steam autoclaving. However, Spectrum does not recommend boiling or steam autoclaving Regenerated Cellulose membranes, since temperatures greater than 60° C will change the structure of membrane by decreasing the permeability after sterilization. Membranes may be autoclaved at 121° C for no more than 15 minutes (cycle should be kept as short as possible) immersed in distilled water. However, it is essential that

Spectra/Por® 1-7 Regenerated Cellulose Membranes

steam autoclaved RC membranes should be recharacterized to compensate for any change in permeation characteristics or MWCO.

Spectra/Por 1 - 5 Standard RC Dry Dialysis Tubing

Product Specifications:

Membrane Type	Purpose	MWCO	14 Flat Widths (mm)
Spectra/Por 1	Basic dialysis	6-8 kD	10, 23, 32, 40, 50, 100, 120
Spectra/Por 2	Higher permeability	12-14 kD	10, 25, 45, 105, 120
Spectra/Por 3	Basic dialysis	3.5 kD	18, 45, 54
Spectra/Por 4	Basic dialysis	12-14 kD	10, 25, 32, 45, 75
Spectra/Por 5	Reinforced for weight	12-14 kD	75, 140

Properties:	Hydrophilic, symmetric porosity
Quantity:	15 or 30 m roll (depending on Type and Flat Width)
Packaging:	Dry with Glycerin (soak in water)
	or
	Dry without Glycerin (no soaking required)
Shelf Life:	5 years from date manufactured

Ordering Information: Spectra/Por 1 - 5 Standard RC Dry Dialysis Tubing

	MWCO	Glycerin (yes/no)	Flat Width (mm)	Dia (mm)	Volume/ Length (ml/cm)	Length (m)	Part No.
Spectra/Por 1	6-8 kD	yes	10	6.4	0.32	15	132645
		yes	23	14.6	1.7	30	132650
		yes	32	20.4	3.3	30	132655
		yes	40	25.5	5.1	30	132660
		yes	50	32	7.9	30	132665
		yes	100	64	32	15	132670
		yes	120	76	46	15	132675
Spectra/Por 2	12-14 kD	yes	10	6.4	0.32	15	132676
		yes	25	16	2	15	132678
		yes	45	29	6.4	15	132680
		yes	105	67	34	15	132682
		yes	120	76	46	15	132684
Spectra/Por 3	3.5 kD	yes	18	11.5	1.1	15	132720
		no	45	29	6.4	15	132724
		no	54	34	9.3	15	132725
Spectra/Por 4	12-14 kD	yes	10	6.4	0.32	30	132697
		yes	25	16	2	30	132700
		yes	32	20.4	3.3	30	132703
		yes	45	29	6.4	30	132706
		yes	75	48	18	15	132709
Spectra/Por 5	12-14 kD	no	75	48	18	15	132754
		no	140	89	62	15	132757

Spectra/Por® 1-7 Regenerated Cellulose Membranes

Spectra/Por 1 - 5 Standard RC Dry Dialysis Trial Kits

Product Specifications:

Membrane Type	Purpose	MWCO	14 Flat Widths (mm)
Spectra/Por 1	Basic dialysis	6-8 kD	10, 23, 32, 40, 50, 100, 120
Spectra/Por 2	Higher permeability	12-14 kD	10, 25, 45, 105, 120
Spectra/Por 3	Basic dialysis	3.5 kD	18, 45, 54
Spectra/Por 4	Basic dialysis	12-14 kD	32, 45, 75
Spectra/Por 5	Reinforced for weight	12-14 kD	75, 140

Properties: Hydrophilic, symmetric porosity

Quantity: 1 m/kit or 5 m/kit

Packaging: Dry with Glycerin (soak in water)
or
Dry without Glycerin (no soaking required)

Shelf Life: 5 years from date manufactured

Kit Includes: 1m or 5m of Spectra/Por 1, 2, 3, 4 or 5 dialysis tubing
1 Standard Spectra/Por Closure (for buoyance)
1 weighted Spectra/Por Closure (for orientation)

Ordering Information: Spectra/Por 1 - 5 Standard RC Dry Dialysis Trial Kits

	MWCO	Glycerin (yes/no)	Flat Width (mm)	Dia (mm)	Volume/ Length (ml/cm)	Trial Kit 1 meter length	Trial Kit 5 meter length
Spectra/Por 1	6-8 kD	yes	10	6.4	0.32	132645T1	132645T
		yes	23	14.6	1.7	132650T1	132650T
		yes	32	20.4	3.3	132655T1	132655T
		yes	40	25.5	5.1	132660T1	132660T
		yes	50	32	7.9	132665T1	132665T
		yes	100	64	32	132670T1	132670T
		yes	120	76	46	132675T1	132675T
Spectra/Por 2	12-14 kD	yes	10	6.4	0.32	132676T1	132676T
		yes	25	16	2	132678T1	132678T
		yes	45	29	6.4	132680T1	132680T
		yes	105	67	34	132682T1	132682T
		yes	120	76	46	132684T1	132684T
Spectra/Por 3	3.5 kD	yes	18	11.5	1.1	132720T1	132720T
		no	45	29	6.4	132724T1	132724T
		no	54	34	9.3	132725T1	132725T
Spectra/Por 4	12-14 kD	yes	32	20.4	3.3	132703T1	132703T
		yes	75	48	18	132709T1	132709T
Spectra/Por 5	12-14 kD	no	75	48	18	132754T1	132754T
		no	140	89	62	132757T1	132757T

Spectra/Por® 1-7 Regenerated Cellulose Membranes

Spectra/Por 6 Standard RC Pre-wetted Dialysis Tubing & Trial Kits

Product Specifications:

8 MWCO's:	1 kD, 2 kD, 3.5 kD, 8 kD, 10 kD, 15 kD, 25 kD & 50 kD
12 Flat Widths:	8 mm, 12 mm, 18 mm, 24 mm, 28 mm, 32 mm, 34 mm, 40 mm, 45 mm, 50 mm & 54 mm
Properties:	Hydrophilic, symmetric porosity
Quantity:	Tubing - 10 meters/roll
	Trial Kits - 1 meter/roll
Packaging:	Wet in 0.05% sodium azide
Kit Includes:	1 meter of Spectra/Por 6 Dialysis Tubing
	1 Standard Spectra/Por Closure (for buoyancy)
	1 Weighted Spectra/Por Closure (for orientation)
	5 Tubing Opening Picks
Shelf Life:	3 years from date manufactured

Ordering Information:

Spectra/Por 6 Standard RC Pre-wetted Dialysis Tubing & Trial Kits

MWCO	Flat Width (mm)	Diameter (mm)	Volume/ Length (ml/cm)	Tubing 10 m/length	Trial Kit 1 m/length
1 kD	18	11.5	1.1	132636	132636T
	38	24	4.6	132638	132638T
	45	29	6.4	132640	132640T
2 kD	18	11.5	1.1	132620	132620T
	38	24	4.6	132625	132625T
	45	29	6.4	132633	132633T
3.5 kD		11.5	1.1	132590	132590T
	45	29	6.4	132592	132592T
	54	34	9.3	132594	132594T
8 kD	8	5.1	0.2	128056	-
	12	7.5	0.45	132579	132579T
	18	11.5	1.1	128058	-
	24	15	1.8	132580	132580T
	32	20.4	3.3	132582	132582T
	40	25.5	5.1	132584	132584T
	50	32	7.9	132586	132586T
10 kD	8	5.1	0.2	128106	-
	12	7.5	0.45	132570	132570T

Spectra/Por® 1-7 Regenerated Cellulose Membranes

Ordering Information:

Spectra/Por 6 Standard RC Pre-wetted Dialysis Tubing & Trial Kits

MWCO	Flat Width (mm)	Diameter (mm)	Volume/ Length (ml/cm)	Tubing 10 m/length	Trial Kit 1 m/length
10 kD	18	11.5	1.1	128118	-
	24	15	1.8	132572	132572T
	32	20.4	3.3	132574	132574T
	45	29	6.4	132576	132576T
15 kD	8	5.1	0.2	128156	-
	12	7.5	0.45	132560	132560T
	18	11.5	1.1	128158	-
	24	15	1.8	132562	132562T
	32	20.4	3.3	132564	132564T
	45	29	6.4	132566	132566T
25 kD	8	5.1	0.2	128206	-
	12	7.5	0.45	132550	132550T
	18	11.5	1.1	128218	-
	24	15	1.8	128224	-
	28	18	2.5	132552	132552T
	34	22	3.7	132554	132554T
50 kD	10	6.4	0.32	132539	132539T
	12	7.5	0.45	132540	132540T
	28	18	2.5	132542	132542T
	34	22	3.7	132544	132544T

Spectra/Por 7 Standard RC
Pre-treated Dialysis Tubing & Trial Kits

Product Specifications:

8 MWCO's:	1 kD, 2 kD, 3.5 kD, 8 kD, 10 kD, 15 kD, 25 kD & 50 kD
12 Flat Widths:	8 mm, 12 mm, 18 mm, 24 mm, 32 mm,
	34 mm, 40 mm, 45 mm, 50 mm & 54 mm
Properties:	Hydrophilic, symmetric porosity
Quantity:	Tubing - 5 meters/roll
	Trial Kits - 1 meter/roll
Packaging:	Wet in 0.05% sodium azide
Kit Includes:	1 meter of Spectra/Por 7 Dialysis Tubing
	1 Standard Spectra/Por Closure (for buoyancy)
	1 Weighted Spectra/Por Closure (for orientation)
	5 Tubing Opening Picks
Shelf Life:	3 years from date manufactured

Spectra/Por® 1-7 Regenerated Cellulose Membranes

Ordering Information:

Spectra/Por 7 Standard RC Pre-treated Dialysis Tubing & Trial Kits

MWCO	Flat Width (mm)	Diameter (mm)	Volume/ Length (ml/cm)	Tubing 5 m/length	Trial Kit 1 m/length
1 kD	18	11.5	1.1	132103	132103T
	38	24	4.6	132104	132104T
	45	29	6.4	132105	132105T
2 kD	18	11.5	1.1	132107	132107T
	38	24	4.6	132108	132108T
	45	29	6.4	132109	132109T
3.5 kD	18	11.5	1.1	132110	132110T
	45	29	6.4	132111	132111T
	54	34	9.3	132112	132112T
8 kD	8	5.1	0.2	128356	-
	12	7.5	0.45	132113	132113T
	18	11.5	1.1	128358	-
	24	15	1.8	132114	132114T
	32	20.4	3.3	132115	132115T
	40	25.5	5.1	132116	132116T
	50	32	7.9	132131	132131T
10 kD	8	5.1	0.2	128406	-
	12	7.5	0.45	132117	132117T

Ordering Information:

Spectra/Por 7 Standard RC Pre-treated Dialysis Tubing & Trial Kits (cont.)

MWCO	Flat Width (mm)	Diameter (mm)	Volume/ Length (ml/cm)	Tubing 5 m/length	Trial Kit 1 m/length
10 kD	18	11.5	1.1	128418	-
	24	15	1.8	132118	132118T
	32	20.4	3.3	132119	132119T
	45	29	6.4	132120	132120T
15 kD	8	5.1	0.2	128456	-
	12	7.5	0.45	132121	132121T
	18	11.5	1.1	128458	-
	24	15	1.8	132122	132122T
	32	20.4	3.3	132123	132123T
	45	29	6.4	132124	132124T
25 kD	8	5.1	0.2	128506	-
	12	7.5	0.45	132125	132125T
	18	11.5	1.1	128518	-
	24	15	1.8	128524	-
	28	18	2.5	132126	132126T
	34	22	3.7	132127	132127T
50 kD	12	7.5	0.45	132128	132128T
	28	18	2.5	132129	132129T
	34	22	3.7	132130	132130T

Spectra/Por® 1-7 Regenerated Cellulose Membranes

Spectra/Por RC Dialysis Membrane Discs and Flat Sheets

- Precut membrane discs are packaged 50 per pack
- Flat sheet membranes are packaged 25 per pack
- Membrane supplied dry with glycerol as a humectant

Ordering Information:

Spectra/Por 1 - 4 Standard RC Dialysis Membrane Discs

	MWCO	Disc Diameter 33 mm	47 mm	100 mm	Qty
Spectra/Por 1	6-8 kD	132478	132476	132474	50 discs
Spectra/Por 2	12-14 kD	132482	132480	132477	
Spectra/Por 3	3.5 kD	132488	132486	132484	
Spectra/Por 4	12-14 kD	132498	132496	132494	

Ordering Information:

Spectra/Por 1 - 4 Standard RC Dialysis Membrane Flat Sheets

	MWCO	Size (mm)	Qty	Part No.
Spectra/Por 1	6-8 kD	240 x 240	25 sheets	132677
Spectra/Por 2	12-14 kD	200 x 200		132686
Spectra/Por 3	3.5 kD	108 x 108		132723
Spectra/Por 4	12-14 kD	150 x 150		132712

Spectra/Por Ready-to-Use Dialysis Sacks

Spectra/Por Ready-to-Use Dialysis Sacks feature regenerated cellulose tubing sealed at one end with a closure and open at the other. These sacks have a funnel attached to the top for easy sample filling. Supplied in a 0.05% sodium azide preservant, sacks should be rinsed prior to use. Each Dialysis Sack is 60 cm in length for volumes of 50 to 400 ml. Supplied 10/package in three MWCO choices

Ordering Information:

Spectra/Por 1 - 4 Standard RC Ready-to-Use Dialysis Sacks

	MWCO	Flat Width (mm)	Dia (mm)	Volume/ Length (ml/cm)	Volume (ml)	Qty	Part No.
Spectra/Por 1	6-8 kD	50	32	7.9	80-400	10 sacks	132666
Spectra/Por 2	12-14 kD	45	29	6.4	80-320		132681
Spectra/Por 3	3.5 kD	54	34	9.3	90-450		132726
Spectra/Por 4	12-14 kD	45	29	6.4	80-320		132707

Heavy Metals Cleaning Solution

Spectra/Por 1, 2, 3, 4, 5, and 6 membranes contain traces of heavy metals. For ultracritical work, chelate wash the membranes with Heavy Metals Cleaning solution before use.

Product No.	Description
132908	Heavy Metals Cleaning Kit, 8 oz.

To place an order go to www.spectrumlabs.com or:

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