

Anion Exchange Resins

TOYOPEARL DEAE-650C TOYOPEARL Q-600C AR TOYOPEARL QAE-550C TOYOPEARL SuperQ-650C

TOYOPEARL GigaCap[®] DEAE-650M TOYOPEARL GigaCap Q-650M

TOYOPEARL DEAE-650M TOYOPEARL SuperQ-650M

TOYOPEARL NH2-750F TOYOPEARL DEAE-650S TOYOPEARL GigaCap Q-650S TOYOPEARL SuperQ-650S

TSKgel DEAE-5PW (30) TSKgel SuperQ-5PW (30)

TSKgel DEAE-5PW (20) TSKgel SuperQ-5PW (20)

Cation Exchange Resins

TOYOPEARL MegaCap[®] II SP-550EC TOYOPEARL CM-650C TOYOPEARL SP-550C TOYOPEARL SP-650C

TOYOPEARL GigaCap CM-650M TOYOPEARL GigaCap S-650M

TOYOPEARL CM-650M TOYOPEARL SP-650M

TOYOPEARL Sulfate-650F TOYOPEARL CM-650S TOYOPEARL GigaCap S-650S TOYOPEARL SP-650S

TSKgel SP-3PW (30) TSKgel SP-5PW (30)

TSKgel SP-5PW (20)



The Role of Ion Exchange Chromatography in Process Purification

Ion Exchange Chromatography (IEX) plays a major role in the large scale purification of biomolecules. Today, IEX is one of the most commonly used techniques for the purification of proteins, nucleic acids, peptides, and other biomolecules. IEX can be further separated into anion (AEX) and cation (CEX) exchange techniques, both offering high resolution separations with high loading capacities. Ion exchange chromatography is capable of separating species that have minor differences in charges, for example two proteins differing by a single charged amino acid. These attributes make IEX ideally suited to be used at any point in the purification process including capture, intermediate purification, and polishing steps. The scalability of this technique allows it to be used from discovery and analysis through to commercial manufacturing operations.

lon exchange chromatography functions by separating molecules on the basis of charge differences. Molecules are diverse in their charge properties and interact with charged chromatography media based on differences in their charge density, net charge, and distribution of that charge across the surface of the molecule. Since all molecules with charged groups can be titrated, their net surface charge is largely pH dependent. The net surface charge of proteins, which contain

Table 1: Properties of TOYOPEARL ion exchange resins

many different amino acids of weakly acidic and basic groups, will change as the environmental pH of the proteins change. IEX chromatography takes advantage of the relationship between net surface charge and pH for each specific protein. In ion exchange chromatography, a reversible interaction between a charged molecule and an oppositely charged ligand are controlled to favor the binding or elution of specific molecules to achieve separation. A protein at a pH above its isoelectric point will bind to a positively charged medium (anion exchanger) and at a pH below its pl, a protein will bind to a negatively charged medium (cation exchanger). The ligand attached to a chromatographic resin determines the charge of an IEX medium, a positively-charged anion or a negativelycharged cation exchanger.

TOYOPEARL Ion Exchange Chromatography Resins

TOYOPEARL IEX resins are functionalized versions of the TOYOPEARL HW size exclusion resins and are therefore based on hydroxylated polymethacrylic polymer beads. Tosoh Bioscience offers five ligands for anion exchange (Q, SuperQ, QAE, DEAE, and NH₂) and four ligands for cation exchange chromatography (S, SP, Sulfate, and CM). Table 1 lists the properties of these TOYOPEARL IEX resins.

TOYOPEARL resins	Anion/Cation exchange	Base bead	Pore size	Bead diameter	Ligand pKa	DBC (g/L)	Pressure rating
NH2-750F	Weak Anion	HW-75	> 100 nm	45 µm	8.5	≥70	0.3 MPa
SuperQ-650C	Strong Anion	HW-65	100 nm	100 µm	12.2	105 - 155	0.3 MPa
DEAE-650C	Weak Anion	HW-65	100 nm	100 µm	11.5	25 - 35	0.3 MPa
QAE-550C	Strong Anion	HW-55	50 nm	100 µm	12.2	60 - 80	0.3 MPa
Q-600C AR	Strong Anion	HW-60	75 nm	100 µm	12.2	> 120	0.3 MPa
GigaCap Q-650M	Strong Anion	HW-65	100 nm	75 µm	12.2	≥ 162	0.3 MPa
GigaCap DEAE-650M	Weak Anion	HW-65	100 nm	75 µm	11.5	> 156	0.3 MPa
SuperQ-650M	Strong Anion	HW-65	100 nm	65 µm	12.2	105 - 155	0.3 MPa
DEAE-650M	Weak Anion	HW-65	100 nm	65 µm	11.5	25 - 35	0.3 MPa
SuperQ-650S	Strong Anion	HW-65	100 nm	35 µm	12.2	105 - 155	0.3 MPa
DEAE-650S	Weak Anion	HW-65	100 nm	35 µm	11.5	25 - 35	0.3 MPa
GigaCap Q-650S	Strong Anion	HW-65	100 nm	35 µm	12.2	> 170	0.3 MPa
Sulfate-650F	Strong Cation	HW-65	100 nm	45 µm	N/A	<u>≥</u> 114	0.3 MPa
MegaCap II SP-550EC	Strong Cation	HW-55	50 nm	200 µm	1.2	100 - 155	0.3 MPa
SP-650C	Strong Cation	HW-65	100 nm	100 µm	1.2	35 - 55	0.3 MPa
SP-550C	Strong Cation	HW-55	50 nm	100 µm	1.2	80 - 120	0.3 MPa
CM-650C	Weak Cation	HW-65	100 nm	100 µm	4.7	25 - 45	0.3 MPa
GigaCap S-650M	Strong Cation	HW-65	100 nm	75 µm	1.2	136 - 176	0.3 MPa
GigaCap CM-650M	Weak Cation	HW-65	100 nm	75 µm	3.6	> 110	0.3 MPa
SP-650M	Strong Cation	HW-65	100 nm	65 µm	1.2	40 - 60	0.3 MPa
CM-650M	Weak Cation	HW-65	100 nm	65 µm	4.7	30 - 50	0.3 MPa
SP-650S	Strong Cation	HW-65	100 nm	35 µm	1.2	40 - 60	0.3 MPa
CM-650S	Weak Cation	HW-65	100 nm	35 µm	3.6	30 - 50	0.3 MPa
GigaCap S-650S	Strong Cation	HW-65	100 nm	35 µm	1.2	> 150	0.3 MPa

TSKgel Ion Exchange Chromatography Resins

The same SuperQ, DEAE, and SP ligands that are used for the TOYOPEARL resins are also available within the TSKgel IEX resin product line. The TSKgel IEX resins use the same methacrylic polymer chemistry as the TOYOPEARL resins but have a higher degree of crosslinking, making for a more rigid bead. This is necessitated by the higher pressures generated when using smaller particles for chromatography. Greater crosslinking decreases the number of sites available for ligand attachment and thus a TSKgel resin will have a lower dynamic binding capacity than the corresponding TOYOPEARL resin. The polymeric structure of these products also makes them resistant to a wide range of pH conditions and mobile phase ionic strengths. In addition, the hydroxylated surface of the base bead reduces non-specific binding of proteins. Table 2 lists the properties of these TSKgel IEX resins.

The semi-rigid backbone of both TOYOPEARL and TSKgel IEX resins permits high flow rates for maximum throughput and productivity. While TOYOPEARL IEX resins may be operated at pressures up to 0.3 MPa, TSKgel -5PW and -3PW resins may be operated up to 2.0 MPa. Depending on their bead size and the buffer system used, linear velocities of greater than 1,000 cm/hr can be achieved.

Table 3 shows the ligands and particle sizes available for TOYOPEARL and TSKgel IEX resins and is arranged in increasing levels of resolution by bead size (i.e. low, medium, and high resolution). The availability of smaller bead sizes for greater resolution while maintaining the same selectivity is particularly useful in the areas of oligonucleotide and peptide purification.

TSKgel resins	Anion/Cation exchange	Base bead	Pore size	Bead diameter	Ligand pKa	DBC (g/L)	Pressure rating
DEAE-5PW (20)	Weak Anion	G5000PW	100 nm	20 µm	11.5	25 - 45	2.0 MPa
DEAE-5PW (30)	Weak Anion	G5000PW	100 nm	30 µm	11.5	20 - 40	2.0 MPa
SuperQ-5PW (20)	Strong Anion	G5000PW	100 nm	20 µm	12.2	52 - 88	2.0 MPa
SuperQ-5PW (30)	Strong Anion	G5000PW	100 nm	30 µm	12.2	52 - 88	2.0 MPa
SP-3PW (30)	Strong Cation	G3000PW	25 nm	30 µm	1.2	> 65	2.0 MPa
SP-5PW (20)	Strong Cation	G5000PW	100 nm	20 µm	1.2	20 - 40	2.0 MPa
SP-5PW (30)	Strong Cation	G5000PW	100 nm	30 µm	1.2	20 - 40	2.0 MPa

Table 2: Properties of TSKgel ion exchange resins

Table 3: Resolution of TOYOPEARL and TSKgel ion exchange resins

	Provide the		Pore	Resins			
Resolution		(µm)	size (nm)	Anion	Cation		
		200	50		TOYOPEARL MegaCap II SP-550EC		
Low		100	100 100 50	TOYOPEARL SuperQ-650C TOYOPEARL DEAE-650C TOYOPEARL QAE-550C	TOYOPEARL SP-650C TOYOPEARL CM-650C TOYOPEARL SP-550C		
		75	100 100	TOYOPEARL GigaCap Q-650M TOYOPEARL GigaCap DEAE-650M	TOYOPEARL GigaCap S-650M TOYOPEARL GigaCap CM-650M		
Medium		65	100 100 75	TOYOPEARL SuperQ-650M TOYOPEARL DEAE-650M TOYOPEARL Q-600C-AR	TOYOPEARL SP-650M TOYOPEARL CM-650M		
		45	100	TOYOPEARL NH2-750F	TOYOPEARL Sulfate-650F		
		35	100 100 100	TOYOPEARL SuperQ-650S TOYOPEARL DEAE-650S TOYOPEARL GigaCap Q-650S	TOYOPEARL SP-650S TOYOPEARL CM-650S TOYOPEARL GigaCap S-650S		
High		30	100 100 200	TSKgel SuperQ-5PW (30) TSKgel DEAE-5PW (30)	TSKgel SP-5PW (30) TSKgel SP-3PW (30)		
		20	100 100	TSKgel SuperQ-5PW (20) TSKgel DEAE-5PW (20)	TSKgel SP-5PW (20)		



Table 4: DBCs of different chromatography modes

Separation mode	Binding capacity for standard proteins (g/L)	Binding capacity in production processes (g/L)		
lon Exchange	100 - 200	50 - 100		
Hydrophobic Interaction	40 - 60	10 - 30		
Affinity (group specific ligands)	40 - 100	20 - 60		
Reversed Phase (polymeric media)	60 - 100	30 - 50		

Due to the high dynamic binding capacities of ion exchange resins relative to those of the other chromatographic modes (Table 4), IEX is the chromatographic technique selected by many developers for the capture or concentration step.

Because TOYOPEARL and TSKgel IEX resins have the same backbone polymer chemistry, the selectivity for proteins and impurities will be unchanged. Due to this continuity between the TOYOPEARL and TSKgel resins, the chromatographic conditions that work for one particle size will work for all particle sizes with a given ligand functionality. The elution order of the feedstock components will remain the same with increasing resolution as the particle size gets smaller (Figure 1).



Figure 1: Scale up or down using the same ligand

The TOYOPEARL GigaCap M-grade resins have a particle size of 50-100 μ m, which is slightly larger than the normal TOYOPEARL M-grade, 40-90 μ m beads. This particle size difference generates a lower back pressure (Figure 2) than the more traditional TOYOPEARL M-grade ion exchange products. The TOYOPEARL GigaCap M-grade resins are high throughput resins that can be used for capture, intermediate, and polishing chromatographic steps.

Figure 2: Pressure-flow curve comparison of TOYOPEARL resins



TOYOPEARL and TSKgel IEX resins are chemically stable from pH 3-13. This allows a constant packing volume over a wide range of salt concentrations and cleaning in place (CIP) with acid or base. Also, these resins can be run at elevated temperatures (4-60 °C) and are autoclavable at 121 °C. Tosoh has focused on improving the alkaline stability of its newer ion exchange resins. Higher capacity resins can bind not only more of the target molecule, but the impurities and isoforms as well. In some cases more rigorous cleaning agents like 0.5 mol/L NaOH and even 1.0 mol/L NaOH are needed to ensure proper resin regeneration. Naturally, the resins need to tolerate these more stringent conditions.

TOYOPEARL IEX resins are available in a broad range of base bead pore sizes (Table 5). Of these, four different mean pore diameters are used: 100 nm, 75 nm, 50 nm, and 20 nm (Table 6). The TSKgel IEX resins have a base bead pore size of 100 nm with the exception of TSKgel SP-3PW, which has a pore size of 25 nm. A bead with a small pore size has theoretically more surface area than the same size bead with a larger pore. Please refer to Table 2 in the SEC section of this catalog (page 5) for the molar mass range of biomolecules covered by each pore size. Figure 3 shows insulin binding capacity on six different pore size beads. As the pore size increases to the point where the insulin has greatest access to the internal surface area, the insulin capacity increases. However, there is a point of diminishing return. Because the absolute surface area decreases as the pores become larger, the insulin capacity decreases accordingly.

Table 5: Methacrylic base beads available for IEC

Pore size (nm)	5	12.5	40-50	75	100	>100	>170
Resin							
TOYOPEARL HW-type:	40	50	55	60	65	75	80
TSKgel PW-type:	G1000	G2000	G4000		G5000	G6000	

Increasing pore surface area

Table 6: Mean pore diameters used in TOYOPEARL and TSKgel IEX resins

Base bead	TOYOPEARL HW-75	TOYOPEARL HW-65 or TSKgel G5000PW	TOYOPEARL HW-60	TOYOPEARL HW-55	TSKgelG3000PW
Pore diameter	>100 nm	100 nm	75 nm	50 nm	25 nm
Resin	TOYOPEARL NH₂-750	TOYOPEARL GigaCap S-650 TOYOPEARL GigaCap CM-650 TOYOPEARL GigaCap Q-650 TOYOPEARL SuperQ-650 TOYOPEARL DEAE-650 TOYOPEARL SP-650 TOYOPEARL CM-650 TSKgel SuperQ-5PW TSKgel DEAE-5PW TOYOPEARL Sulfate-650	ΤΟΥΟΡΕΑRL Q-600C AR	TOYOPEARL SP-550 TOYOPEARL MegaCap II SP-550 TOYOPEARL QAE-550	TSKgel SP-3PW



Figure 3: Optimization of insulin binding capacity as a function of pore size of experimental TSKgel SP-type resins



Additional modifications to ligand and bead chemistry resulted in the TOYOPEARL Q-600C AR (alkaline resistant) resin. This is a high capacity, alkaline resistant, Q anion exchange media. TOYOPEARL Q-600C AR resin (using first generation ligand attachment chemistry) was developed by Tosoh for CIP of difficult to remove impurities. This resin has a slightly smaller pore size than TOYOPEARL GigaCap Q-650M resin and has a typical BSA binding capacity of 100 g/L. As shown in Figure 4, after 100 days of exposure to 1.0 mol/L NaOH, the DBC of TOYOPEARL Q-600C AR resin remains unchanged. Figure 5 shows the preservation of selectivity after extensive exposure to caustic.

Figure 4: TOYOPEARL Q-600C AR resin DBC as a function of sodium hydroxide exposure







A 2% solution of benzyl alcohol in water has been identified as a suitable alternative to 20% ethanol as a preservative in resin storage solutions. A sample of TOYOPEARL SuperQ-650M resin was prepared by adding 100 mL of aqueous 2% benzyl alcohol to 100 mL of suction filtered resin. A 100 mL aliquot of DI water was added to the filtered resin and stirred to make a slurry. This resin/ DI water slurry was allowed to stand for 5 minutes and was then suction filtered to remove the supernatant. This procedure was repeated 14 more times, for a total of 15 washes.

Samples of the filtered supernatant from the TOYOPEARL SuperQ-650M resin was taken after the 5th, 10th, and 15th washes and analyzed for benzyl alcohol concentration (Figure 6). As demonstrated in the figure, a 2% benzyl alcohol solution can be effectively removed from the TOYOPEARL SuperQ-650M resin by thorough washing with DI water.

Figure 6: Concentration of benzyl alcohol in resin supernatant (batch wash)





Following is an explanation of the three ligand attachment chemistries used by Tosoh for TOYOPEARL and TSKgel IEX resins:

Attachment type	TOYOPEARL resins	TSKgel resins
The "traditional" ligand attachment method consists of attaching the ion exchange ligand directly to the resin surface through a proprietary spacer arm.	SP-650 MegaCap II SP-550 EC SP-550 Q-550 DEAE-650 CM-650	SP-3PW SP-5PW DEAE-5PW
The second generation ligand attachment method, for the purpose of increasing protein binding within the accessible surface area, adds a carbon spacer network between the bead surface and the ligand. It is also possible to attach ligand groups along the length of the spacer network, thus improving capacity.	SuperQ-650	SuperQ-5PW
The third generation ligand attachment method improves the accessible location of the ligand groups. This ligand chemistry moves the charged groups to the larger pores where the protein has better access to them. The result of this modification is significantly increased capacity and improved mass transfer. Improved mass transfer also reduces the target molecule elution volume.	GigaCap Q-650 GigaCap CM-650 GigaCap S-650 GigaCap DEAE-650 NH2-750F Sulfate-650F	

Table 7 contains DBC data for five TOYOPEARL resins using three different size proteins. There are three different pore sizes and three different ligand attachment methods represented. TOYOPEARL GigaCap Q-650M resin has the highest capacity for all combinations of pore size and attachment chemistries.

Table 7: DBC varies with protein size

Resin		Pore size (nm)	Binding capacity (g/L-gel)			
			BSA 66 kDa	Human IgG 160 kDa	Thyroglobulin 660 kDa	
TOYOPEARL GigaCap Q-650M		100	173	108	71	
TOYOPEARL SuperQ-650M		100	145	13	3	
TOYOPEARL Q-600C AR		75	108	90	26	
TOYOPEARL QAE-550C		50	29	32	6	
TOYOPEARL DEAE-650M		100	25	31	3	
Column size: 6. Mobile phase: Bu I Bu Flow rate: 21 Detection: UV Samples: BS	6.0 mm ID × 4 cm Buffer A: BSA 0.05 mol/L Tris-HCl, pH 8.5 Human IgG 0.05 mol/L Tris-HCl, pH 8.7 Thyroglobulin 0.05 mol/L Tris-HCl, pH 8.7 + 0.15 mol/L NaCl Buffer B: 0.05 mol/L Tris-HCl buffer + 1.0 mol/L NaCl, pH 8.5 212 cm/hr (1.0 mL/min) UV @ 280 nm BSA buman IgG thyroglobulin, each at 1.0 g/L					

The following guidelines may be helpful when selecting a resin that is available in different pore sizes with the same ligand and ligand attachment chemistry:

For bind/elute chromatography:	 Select the smallest pore size resin appropriate for the size of the target molecule. Select a larger particle size for a capture step, a smaller one for intermediate or polishing steps.
For flow through chromatography:	• If the target molecule's size is larger than most components of the feed stream, select a pore size which will tend to exclude it (known as kinetic exclusion, this technique can also be used under binding conditions as the excluded molecule only sees 1% of the resin surface area and the capacity/recovery loss is minimal).
For large molecule impurity clearance:	 Select a pore size which includes the target molecule, but excludes the impurity (see the calibration curves of the TOYOPEARL base beads in the SEC section of the catalog as an aid).



TOYOPEARL Sulfate-650F Resin

TOYOPEARL Sulfate-650F resin is a novel strong cation exchange resin that exhibits high salt tolerance. This resin offers the strongest capture of monoclonal antibody (mAb) aggregates over a wide pH range without losing its binding capacity for mAb. With the use of optimized binding conditions, a dynamic binding capacity of ≥114 g/L of mAb can be easily achieved with TOYOPEARL Sulfate-650F resin. This high dynamic binding capacity translates into lower operating costs per gram of antibody produced.

A TOYOPEARL HW-65F polymeric bead has been functionalized with a sulfate (SO₄⁻) group. The 100 nm pore size of this resin, along with proprietary bonding technology, makes TOYOPEARL Sulfate-650F resin ideal for applications performed in physiological conditions or for post-protein A removal of aggregates. The 45 μ m particle size is stable up to 0.3 MPa.

TOYOPEARL Sulfate-650F resin offers:

- Effective removal of aggregates from IgG
- Wide pH working range works well with pH 5.0 to 6.0 without losing its binding capacity for IgG
- · High dynamic binding capacity
- High salt concentration tolerance Samples containing ≥150 mmol/L can be loaded on the resin
- Excellent pressure-flow stability >600 cm/hr at 0.2 MPa
- Durability at high pH no sign of losing DBC when resin exposed to 0.5 mol/L NaOH >60 days

Effective Removal of Aggregates from IgG

TOYOPEARL Sulfate-650F resin is effective at removing aggregates from lgG, as demonstrated in Figure 7. A protein A-purified lgG sample was loaded onto a TOYOPEARL Sulfate-650F column, fractions were collected using an ÄKTA and further analyzed using a TSKgel G3000SWxL HPLC column. The comparison between TOYOPEARL Sulfate-650F resin and a competitor SO₃- resin shows that TOYOPEARL Sulfate-650F resin provides stronger binding of mAb aggregates, resulting in the high resolution separation of monomer and aggregates.





ÄKTA avant 25

Instrument

The monomer peak was fractioned and analyzed using SEC analysis of the eluate pool at 260 mmol/L NaCl, 9 column volumes. The peaks from the SEC column were analyzed for the total amount of high molecular weight, HCP and protein A ligand content. Table 8 shows that after passing through the TOYOPEARL Sulfate-650F resin, the collected IgG peak has significantly reduced amounts of HMW, HCP and protein A ligand. This suggests that TOYOPEARL Sulfate-650F resin can effectively remove and reduce the impurities of IgG.

Table 8: The reduction of impurities from IgG sample, post-protein /	4,
after passing through TOYOPEARL Sulfate-650F resin	

Impurity	ProA eluate	Sulfate eluate
Dimer (%)	3.9	2.4
HMW (%)	0.54	0.07
HCP (ppm)	1260	134
ProA (ppm)	1.2	0.040

Wide pH Working Range

The strong cation characteristics of the sulfate group and the proprietary bonding technology of TOYOPEARL Sulfate-650F allows this resin to have a wide working pH range while still maintaining its elution profiles for IgG, as shown in Figure 12. The retention time is shifted but the selectivity remains unchanged. This benefit allows users the flexibility to select a pH that is more suitable to their sample.TOYOPEARL Sulfate-650F resin can be used within a wide pH range (Figure 8). This allows users the flexibility to select a pH that is more suitable to their sample.

Figure 8: Wide working range of pH



High Dynamic Binding Capacity

TOYOPEARL Sulfate-650F offers high dynamic binding capacities for IgG. These capacities can be obtainable even at higher flow rates, as shown in Figure 9.







High Salt Concentration Tolerance

The increased salt tolerance of the TOYOPEARL Sulfate-650F resin as compared to another cation exchange resin can be seen in Figure 10. The mAb peak begins to elute from the TOYOPEARL Sulfate-650F column at a concentration of approximately 0.3 mol/L NaCl compared to 0.15 mol/L for the other anion exchange resin.

Figure 10: Salt tolerance comparison



Excellent Pressure-Flow Stability

Figure 11 demonstrates the excellent pressure-flow rate properties of the TOYOPEARL Sulfate-650F resin. A flow rate of >600 cm/hr on a large process column is easily achieved at a pressure drop of only 0.2 MPa.





Durability at High pH

TOYOPEARL Sulfate-650F resin is stable in 0.5 mol/L NaOH (Figure 12). It can be stored in this solution for up to 8 weeks without loss in its binding capacity..







TOYOPEARL NH2-750F Resin

TOYOPEARL NH₂-750F resin is a salt tolerant anion exchange resin for process scale applications. This resin is ideal for the intermediate purification of mAbs and other proteins where aggregates and other negatively charged impurities, such as DNA, endotoxins and viruses, are removed from the target of interest within a single step without having to dilute or buffer exchange the product prior to loading. This resin is based on the TOYOPEARL HW-75F size exclusion resin functionalized with primary amine groups. This allows the TOYOPEARL NH₂-750F resin to maintain its capacity at conductivities up to 15 mS/cm.

TOYOPEARL NH2-750F resin offers:

- Effective endotoxin and viral removal in flowthrough chromatography mode; a clearance of >4 logs can be achieved
- **Removal of mAb aggregates** in bind-and-elute and flowthrough chromatography mode
- High salt tolerance samples containing ≥150 mmol/L NaCl can be loaded on the resin
- Excellent pressure-flow characteristics resin can tolerate >600 cm/hr
- Alkaline stability resin can be exposed to 0.5 mol/L NaOH

Effective Endotoxin Removal

TOYOPEARL NH₂-750F is a very effective anion exchange resin for the removal of endotoxin in a flowthrough chromatography mode. To demonstrate this, a solution of *E. coli* lipopolysaccharide was prepared in water, giving a starting endotoxin concentration of 89,000 EU/mL with a total load of 4,450,000 EU (89,000 EU/ mL × 50 mL). The column was then loaded with spiked equilibration buffer and 2 CV (10 mL) flowthrough fractions were collected. Fractions were also collected for both wash and strip steps.

As can be seen in Figure 13, a graphical representation of the log endotoxin clearance for each step in the process, the endotoxin concentration of the flowthrough fractions was less than the limit of detection for an LAL assay (0.1 EU/mL); therefore, the minimum log reduction value for each flowthrough fraction was 6.7. Although there was some minor breakthrough of endotoxin during the wash phase (the log reduction value for this fraction was 5.82), this represents a breakthrough of less than 0.0002% of endotoxin from the original load material.



Effective Viral Removal

Two chromatography steps in the purification of a monoclonal antibody for viral clearance were evaluated using four model viruses. Studies were performed as spike/chase experiments, where a known quantity of virus is added to unprocessed material and remaining virus is quantitated following processing.

Protein A-purified mAb was spiked with 1% (Reo, MVM) or 5% (MuLV, PRV) (v/v) and was then passed through TOYOPEARL NH₂-750F resin. As shown in Figure 14, TOYOPEARL NH₂-750F resin effectively removed all viruses with a clearance of >4 logs.

Figure 14: Viral Clearance results from flowthrough mode using TOYOPEARL NH2-750F resin





Removal of mAb Aggregates

TOYOPEARL NH₂-750F is effective at removing aggregates from mAbs, in both bind-and-elute mode as well as in flow-through, as demonstrated in Figures 15a and 15b. SEC analysis of the peaks (data not shown) shows that high molecular weight aggregates are completely removed from the main mAb peak.

Figure 15a: Removal of aggregates from IgG, monomer on TOYOPEARL NH2-750F



Figure 15b: Flow-through removal of aggregates from mAb monomer on TOYOPEARL NH2-750F



High Salt Tolerance

Increased salt tolerance of TOYOPEARL NH₂-750F as compared to other TOYOPEARL anion exchange resins can be seen in Figure 16. The BSA peak begins to elute from the TOYOPEARL NH₂-750F column at a concentration of approximately 1.0 mol/L NaCl compared to 0.14 – 0.40 mol/L for the other anion exchange resins.





TOYOPEARL NH₂-750F resin also shows that it can withstand pH changes without greatly modifying its selectivity, as demonstrated in Figure 17. This allows for a large design space in which to develop a separation protocol.

Figure 17: Selectivity of TOYOPEARL NH₂-750F resin when pH buffer is changed



Excellent Pressure-Flow Characteristics

TOYOPEARL NH₂-750F resin is based on the well proven polymethacrylate matrix used for all TOYOPEARL resins. Figure 18 shows the pressure-flow curve for this resin packed in a 4.4 cm column with a bed height of 28 cm. Linear velocities up to 600 cm/hr can easily be applied to columns packed with TOYOPEARL NH₂-750F resin.





Alkaline Stability

TOYOPEARL NH₂-750F is alkaline stable in 0.5 mol/L NaOH and can be stored in this solution for up to 8 weeks with little appreciable loss of capacity (Figure 19).

Figure 19: Alkaline stability of TOYOPEARL NH2-750F resin





TOYOPEARL GigaCap Resins

TOYOPEARL GigaCap resins have both higher capacity and improved elution kinetics compared to corresponding TOYOPEARL IEX resins. When these parameters are combined, they may significantly reduce elution pool volumes by as much as 75%. The TOYOPEARL GigaCap ligand attachment chemistry results in preferential placement of the functional groups into the larger more protein-accessible pores promoting both higher protein dynamic binding capacities and improved resin binding and desorption.

Unmodified TOYOPEARL HW-65 resin is utilized as the base bead for the TOYOPEARL GigaCap M-grade resins. The average particle size of the TOYOPEARL GigaCap M-grade resins, 75 µm, provides for enhanced efficiency and higher resolution than other larger particle size materials, while improved pressure-flow properties are obtained over smaller particle size materials. Figures 20, 21, and 22 show the breakthrough curves for three TOYOPEARL GigaCap M-grade resins. They are compared where possible with the most current equivalent competitive resin. Each trace shows the dynamic binding capacity of the resin up to 10% breakthrough plus the elution profile for the target molecule. Please note the significant reduction in elution pool volumes of the TOYOPEARL GigaCap resins when compared to other products. The concentration of the eluted peak is proportionally increased as well.









Figure 22: Elution pool volume of TOYOPEARL GigaCap CM-650M resin



TOYOPEARL GigaCap S-650M resin was specifically developed for the purification of monoclonal antibodies. It has excellent elution kinetics (Figure 20) and maintains reasonably high capacities at higher linear velocities (Figure 23). The slightly larger particle size (50-100 μ m) has been optimized to give a unique combination of improved pressure-flow characteristics (Figure 24) with excellent resolution at high loads (Figure 25). In separate studies it was established that DBC values for smaller proteins, such as insulin and lysozyme, were also notably improved with typical values of 133 g/L and 167 g/L, respectively.

Figure 23: TOYOPEARL GigaCap S-650M human IgG breakthrough curves at various linear velocities





Figure 24: Pressure flow data for TOYOPEARL GigaCap S-650M

TOYOPEARL GigaCap S-650M was packed into a 36 cm ID × 25 cm bed height Eastern Rivers BioStream column to measure the pressure-flow characteristics. The resin had similar profiles when packed and run in both H₂O and 1.0 mol/L NaCl.







TOYOPEARL GigaCap CM-650M resin was designed for the purification of monoclonal antibodies that require a different chromatographic selectivity than is available with TOYOPEARL GigaCap S-650M resin (Figure 26). Excellent kinetic properties and high capacity are maintained at high linear flow velocities. Since TOYOPEARL GigaCap CM-650M resin is based on the same particle size base beads as the other resins within the TOYOPEARL GigaCap series, very good pressure-flow properties are obtained for this resin as well (Figure 27).





3. lysozyme (3.8 g/L) (B) 1. trypsinogen (3.8 g/L) 2. ribonuclease A (5.0 g/L) 3. lysozyme (3.8 g/L)

 Gradient:
 60 min linear gradient from but

 Flow rate:
 212 cm/hr (1.0 mL/min)

 Detection:
 UV @ 280 nm

 Injection vol.:
 25 μL

 Samples:
 (A) 1. ribonuclease A (5.0 g/L)

 2. cytochrome C (1.9 g/L)

Figure 27: TOYOPEARL GigaCap CM-650M pressure-flow properties



TOYOPEARL GigaCap Q-650M resin was primarily designed for the capture and purification of proteins, although it can also be used for polishing in flow-through chromatography. Of particular note is the excellent capacity of TOYOPEARL GigaCap Q-650M for such large proteins as thyroglobulin when compared to other high capacity resins (Figure 28).

Figure 28: Dynamic binding capacity of proteins with different molar masses @ 212 cm/hr





TOYOPEARL GigaCap DEAE-650M resin was designed for the purification proteins that require a different chromatographic selectivity (Figure 29) than is available with TOYOPEARL GigaCap Q-650M resin. As with other TOYOPEARL GigaCap M-grade resins, excellent kinetic properties and high capacity are maintained at high linear flow velocities (Figure 30). Since TOYOPEARL GigaCap DEAE-650M resin is based on the same particle size base beads as the other resins within the TOYOPEARL GigaCap series, very good pressure-flow properties are obtained for this resin as well (Figure 31).

Figure 29: Selectivity comparisons



Figure 30: DBC vs. flow rate and residence time



Figure 31: TOYOPEARL GigaCap DEAE-650M pressure-flow curves





TOYOPEARL GigaCap Q-650 and S-650 resins are also available in a 35 μ m S-grade, which is ideal for high resolution applications such as oligonucleotide, peptide, and antibody-drug conjugate purifications. TOYOPEARL GigaCap Q-650S and TOYOPEARL GigaCap S-650S maintain the superior dynamic binding capacities (Tables 9 and 10)

and selectivities (Figures 32 and 33) of the M-grade TOYOPEARL GigaCap resins with the benefit of greater resolution due to their smaller bead size. Pressure-flow properties (Figures 34 and 35) are also maintained with the TOYOPEARL GigaCap S-grade resins.

T / / A /	,			•.	
Table 9' Anion	exchange	resin	hindina	canacity	comparisons
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Desir	Particle pH		Developed	lon exchange	Binding capacity (g/L)		DBC	DBC elution
Kesin	size (µm)	stability	Base bead	(meq/L)	Static	Dynamic*	recovery (%)	(CV)
TOYOPEARL GigaCap Q-650S	20 - 50	3 - 13	polymethacrylic	0.20	200	191	99	1.7
TOYOPEARL GigaCap Q-650M	50 - 100	3 - 13	polymethacrylic	0.17	191	172	97	15.8
Capto™ Q ImpRes	36 - 44	2 - 12	agarose	0.12	92	40	100	ND**
Q Sepharose™ HP	24 - 44	2 - 12	agarose	0.15	114	81	99	ND**

*Dynamic binding capacities were determined at 10% breakthrough **Values not determined

Dynamic Binding Capacity (DBC) Conditions: 6 mm ID × 4 cm Column size:

Mobile phase	A: 50 mmol/L Tris-HCl buffer, pH 8.5 B: mobile phase A + 0.5 mol/L NaCl
Flow rate:	212 cm/hr (1.0 mL/min)
Detection:	UV @ 280 nm
Sample:	1.0 g/L BSA

Static Binding Capacity (SBC) Conditions:

Adsorption buffer: Protein concentration:

50 mmol/L Tris-HCl, pH 8.5 10.0 g/L

Table 10: Cation exchange resin binding capacity comparisons

Decia	Particle pH		Decelored	lon exchange	Binding capacity (g/L)		DBC	DBC elution
nesiii	size (μm)	stability	Dase beau	(meq/L)	Static	Dynamic*	(%)	(CV)
TOYOPEARL GigaCap S-650S	20 - 50	3 - 13	polymethacrylic	0.24	177	164	99	4.0
TOYOPEARL GigaCap S-650M	50 - 100	3 - 13	polymethacrylic	0.16	156	145	98	13.5
Capto SP ImpRes	36 - 44	2 - 12	agarose	0.12	89	27	100	ND**
SP Sepharose™ HP	24 - 44	2 - 12	agarose	0.15	105	65	100	ND**

*Dynamic binding capacities were determined at 10% breakthrough **Values not determined

Dynamic Binding Capacity (DBC) Conditions:

Column size:	6 mm ID × 4 cm
Mobile phase:	A: 50 mmol/L acetate buffer, pH 4.7
	B: mobile phase A + 0.5 mol/L NaCl
Flow rate:	212 cm/hr (1.0 mL/min)
Detection:	UV @ 280 nm
Sample:	1.0 g/L γ-globulin

Static Binding Capacity (SBC) Conditions:

Adsorption buffer: 50 mmol/L acetate buffer, pH 4.7 Sample: 10.0 g/L γ-globulin

Figure 32: Selectivity comparisons of anion exchange resins



Figure 34: Selectivity comparisons of cation exchange resins



Figure 33: Comparison of TOYOPEARL GigaCap Q-650S and Q Sepharose HP pressure-flow curves



Figure 35: Comparison of TOYOPEARL GigaCap S-650S and SP Sepharose HP pressure-flow curves





TSKgel SuperQ-5PW Resin

TSKgel SuperQ-5PW resin (offered in 20 and 30 µm particle size) is a strong anion exchange resin used for large and small biomolecules. TSKgel SuperQ-5PW analytical columns have the same backbone chemistry and selectivity as the bulk process scale TSKgel SuperQ-5PW resin, allowing seamless scale-up from analytical to manufacturing. In downstream processing of proteins, TSKgel SuperQ-5PW can be used for intermediate purification and polishing steps.

TSKgel SuperQ-5PW (20) resin is the product of choice for oligonucleotide purification. This resin does an excellent job as a capture resin isolating the full length oligonucleotide from the n-1, n+1, and other impurities generated during synthesis.

Figure 36 shows a comparison of one competitive product, of a smaller particle size, which initially has better resolution than TSKgel SuperQ-5PW (20) resin at 1 g oligonucleotide/L of resin. At 20 g oligonucleotide/L of resin, however, the resolution of peaks on the competitive product deteriorates significantly. The TSKgel SuperQ-5PW (20) resin retains excellent resolution even at this higher oligonucleotide concentration. Under higher loading conditions (Figure 36), the TSKgel SuperQ-type resins maintain their resolution much better than smaller particle, lower capacity resins. The smaller particle products may start out with a slight separation advantage under low oligonucleotide loading conditions, but this vanishes as the feedstock load is increased.





Applications for Tosoh Bioscience Ion Exchange Chromatography Resins

Purification of Oligonucleotides

Table 11 shows the different particle sizes that are available in the TSKgel and TOYOPEARL anion exchange resins used for oligonucleotides, and the cation exchange resins used for peptide purifications. The relative binding capacities and predicted resolution of the different particle size resins are depicted by a series of "+" characters. The more "+" characters listed in the table the better one resin is relative to another for that parameter. If a process is developed using one of the resins and more resolution is needed, select an appropriate smaller particle size product. Similarly if more product throughput is needed and resolution is not a critical issue, a larger particle size resin can be selected.

The very high capacity TOYOPEARL GigaCap Q-650 resins (also shown in Table 11) can be used for oligonucleotide purifications, although the selectivity of this resin is somewhat different than the TSKgel and TOYOPEARL SuperQ-type resins. As seen in Figures 37-42, the TOYOPEARL GigaCap Q-650S performs similarly to the TSKgel SuperQ-5PW (20) resin for the purification of oligonucleotides. Table 12 compares the performance of these two resins for purity and recovery of an oligonucleotide from crude feedstock.

Table 11: Oligonucleotide purification products

Resin	Bead size (mean µm)	Binding capacity g DNA oligo/L	Resolution	Bead type	Attachment method
TSKgel SuperQ-5PW (20)	20	45	+++++	methacrylic	Туре А
TSKgel SuperQ-5PW (30)	30	40	++++	methacrylic	Туре А
TOYOPEARL SuperQ-650S	35	54	+++	methacrylic	Туре А
TOYOPEARL GigaCap Q-650S	35	40	+++	methacrylic	Туре В
TOYOPEARL SuperQ-650M	65	50	++	methacrylic	Туре А
TOYOPEARL GigaCap Ω-650M	75	55	++	methacrylic	Туре В
TOYOPEARL SuperQ-650C	100	50+(est.)	+	methacrylic	Туре А
TOYOPEARL Q-600 C AR	100	50	+	methacrylic	Type C

Figure 37: TSKgel SuperQ-5PW (20), 1.0 mg load



Figure 38: TOYOPEARL GigaCap Q-650S, 1.0 mg load



Resin:	TOYOPEARL GigaCap Q-650S
Column size:	6.6 mm ID × 18.5 cm (6.3 mL)
Mobile phase:	Buffer A: 20 mmol/L NaOH
	Buffer B: 20 mmol/L NaOH, 3.0 mol/L NaCl
Gradient:	50% B (2 CV)
	50-100% B (15 CV)
	100% B (2 CV)
Flow rate:	200 cm/hr (1.14 mL/min)
Detection:	UV @ 254 nm
Sample:	crude phosphorothioate deoxyoligonucleotide
Sample load:	1.0 mg

1.0 mg

Sample load:





Figure 39: Purification of oligonucleotide at 80% DBC on TSKgel SuperQ-5PW (20) resin

Figure 41: TSKgel SuperQ-5PW (20) resin: 80% DBC elution peak with fraction purity histogram



Table 12: Oligonucleotide purity and yield from 80% DBC purifications

Resin	Crude oligo purity	Final oligo purity	% Yield
TSKgel SuperQ-5PW (20)	66.5%	96.4%	72.5%
TOYOPEARL GigaCap Q-650S	66.5%	96.9%	81.3%





Figure 42: TOYOPEARL GigaCap Q-650S resin: 80% DBC elution peak with fraction purity histogram



Call customer service: 866-527-3587, technical service: 800-366-4875, option #3



Peptide Purifications

Cation exchange chromatography is commonly used for peptide purification. Table 13 shows the same particle size profile availability of TOYOPEARL and TSKgel resins functionalized with the cation exchange SP ligand. Based on the needs for capacity and resolution, an appropriate SP resin should be selected for a particular peptide application.

Table 13: Peptide purification products

Resin	Bead size (mean µm)	Binding capacity	Resolution	Bead type	Attachment method
TSKgel SP-5PW (20)	20	++	+++++	methacrylic	Traditional
TSKgel SP-5PW (30)	30	++	++++	methacrylic	Traditional
TSKgel SP-3PW (30)	30	++	++++	methacrylic	Traditional
TOYOPEARL SP-650S	35	++++	+++	methacrylic	Traditional
TOYOPEARL SP-650M	65	++++	++	methacrylic	Traditional
TOYOPEARL SP-650C	100	++++	+	methacrylic	Traditional
TOYOPEARL GigaCap S-650S	35	+++++	+++	methacrylic	Туре В
TOYOPEARL GigaCap S-650M	75	+++++	++	methacrylic	Type B

Insulin Purification

TSKgel SP-3PW (30) resin was developed as a higher resolving and higher capacity resin for insulin purification. Table 14 compares the capacity of this new resin to TSKgel SP-5PW (30) resin and SOURCE 30S resin. The improved resolving power of TSKgel SP-3PW (30) resin is demonstrated in Figure 43.

Table 14: Insulin dynamic binding capacity comparison

Resin	TSKgel SP-3PW TSKgel SP-5PW (30) (30)		SOURCE 30S			
Matrix	polymethacrylate	polymethacrylate	polystyrene divinylbenzene			
Particle size	30 µm	:0 μm 30 μm				
Insulin capacity	49 g/L	24 g/L	45 g/L			
Pore size	25 nm	100 nm	NR			
Dynamic binding capacities were determined at 10% breakthrough Column size: 4.6 mm ID × 7.5 cm Mobile phase: gradient elution with 1-propanol by acidic buffer, pH 3.0 containing neutral salt Flow rate: 270 cm/hr (0.75 mL/min) Sample: recombinant insulin (7.2 g/L)						

Figure 43: Selectivity comparison - insulin





PEGylated Proteins

Ion exchange resins are frequently used for the purification of PEGylated proteins. Figure 44 shows the breakthrough curves of five TOYOPEARL cation exchange resins for mono-PEGylated lysozyme. The selectivities of TOYOPEARL GigaCap CM-650M and TOYOPEARL GigaCap S-650M resins for native lysozyme and its mono-PEGylated counterpart are shown in Figure 45.

Figure 44: E	}reakthrough curves of mono-PEGylated lysozyme using
7	OYOPEARL cation exchange resins



Dynamic binding capacities were determined at 10% breakthrough

Figure 45: Selectivity comparison between native protein and mono-PEGylated protein on TOYOPEARL GigaCap resins



Antibody Purification

Klapper *et al.* reported the use of the TOYOPEARL CM-650S for the purification of monoclonal antibodies.¹ Figure 46 shows the elution profile of monoclonal antibody supernatant. Antibody activity is represented in the figure by the black bars.





¹Klapper, D.; Osgood, S.; Esch, R.; Olson, J. Use of new HPLC resins to solve old problems. J. of Liquid Chromatography. 1986, 9, (8), 1613-1633.

Blood Proteins

The separation of human serum on both TOYOPEARL DEAE-650M and TOYOPEARL DEAE-650S is shown in Figure 47. The albumin fractions were collected (between the two vertical lines) and were analyzed via size exclusion chromatography on two TSKgel G3000SW columns in series. As seen in the figure, the albumin fractions contain small amounts of a high formula weight contaminant which is probably α -globulin.² Analytical IEX (not shown) demonstrated that the albumin peaks were fairly homogeneous.





Sample: 1. crude human serum 2. albumin fraction from TOYOPEARL DEAE-650S 3. albumin fraction from TOYOPEARL DEAE-650M

²Kato, Y.; Nakamura, K.; Hashimoto, T. Characterization of TSK-GEL DEAE-Toyopearl 650 Ion Exchanger. J. Chromatogr. 1982, 245, 193-211.



Tryptic Digests

Tryptic fragments from radiolabeled human immunoglobulin light chain can be separated using anion exchange chromatography on TOYOPEARL DEAE-650S.¹ Figure 48 shows the elution profile of a tryptic digest fraction from an SEC column run on TOYOPEARL DEAE-650S. The recovery of the radiolabeled product was greater than 90%.

Figure 48: Separation of tryptic digest peptide mixture



¹Klapper, D.; Osgood, S.; Esch, R.; Olson, J. Use of new HPLC resins to solve old problems. J. of Liquid Chromatography. 1986, 9, (8), 1613-1633.



A selection of screening tools are available for TOYOPEARL and TSKgel IEX resins. See the Process Development Products section of this Product Guide for details.

Ordering Information

Anion exchange resins:

Part #	Product description	Container size (mL)	Bead diameter (µm)	lon Exchange Capacity (eq/L)	Typical BSA* capacity (g/L)
	TOYOPEARL and TO	OYOPEARL G	igaCap Anion Ex	change Resins	
23438	TOYOPEARL NH2-750F	100	30 - 60	0.07 - 0.13	>70 Hu. IgG
23439	TOYOPEARL NH2-750F	250	30 - 60	0.07 - 0.13	>70 Hu. IgG
23440	TOYOPEARL NH2-750F	1,000	30 - 60	0.07 - 0.13	>70 Hu. IgG
23441	TOYOPEARL NH2-750F	5,000	30 - 60	0.07 - 0.13	>70 Hu. IgG
23442	TOYOPEARL NH2-750F	50,000	30 - 60	0.07 - 0.13	>70 Hu. IgG
43271	TOYOPEABL OAE-550C	100	50 - 150	0.28 - 0.38	60 - 80
14026	TOYOPEARL QAE-550C	250	50 - 150	0.28 - 0.38	60 - 80
14704	TOYOPEARL QAE-550C	1.000	50 - 150	0.28 - 0.38	60 - 80
14027	TOYOPEARL QAE-550C	5,000	50 - 150	0.28 - 0.38	60 - 80
18365	TOYOPEARL QAE-550C	50,000	50 - 150	0.28 - 0.38	60 - 80
21985	TOYOPEARL Q-600C AR	100	50 - 150	0.14 - 0.23	> 120
21986	TOYOPEARL Q-600C AR	250	50 - 150	0.14 - 0.23	> 120
21987	TOYOPEARL Q-600C AR	1,000	50 - 150	0.14 - 0.23	> 120
21988	TOYOPEARL Q-600C AR	5,000	50 - 150	0.14 - 0.23	> 120
21989	TOYOPEARL Q-600C AR	50,000	50 - 150	0.14 - 0.23	> 120
21854	TOYOPEARL GigaCap Q-650M	100	50 - 100	0.10 - 0.20	<u>≥</u> 162
21855	TOYOPEARL GigaCap Q-650M	250	50 - 100	0.10 - 0.20	<u>≥</u> 162
21856	TOYOPEARL GigaCap Q-650M	1,000	50 - 100	0.10 - 0.20	<u>≥</u> 162
21857	TOYOPEARL GigaCap Q-650M	5,000	50 - 100	0.10 - 0.20	<u>≥</u> 162
21858	TOYOPEARL GigaCap Q-650M	50,000	50 - 100	0.10 - 0.20	≥ 162
10000		25	20 50	0.20, 0.20	105 155
19823	TOYOPEARL SuperQ-650S	25	20 - 50	0.20 - 0.30	105 - 155
17223	TOYOPEARL SuperQ-650S	250	20 - 50	0.20 - 0.30	105 - 155
17224	TOYOPEARL SuperO 650S	T,000	20 - 50	0.20 - 0.30	105 - 155
1/225	TOYOPEARL SuperO 650S	5,000	20 - 50	0.20 - 0.30	105 - 155
19679	TOPOPEARE SuperQ-650S	50,000	20 - 50	0.20 - 0.30	105 - 155
43205	TOYOPEARL SuperQ-650M	100	40 - 90	0.20 - 0.30	105 - 155
17227	TOYOPEARL SuperQ-650M	250	40 - 90	0.20 - 0.30	105 - 155
17228	TOYOPEARL SuperQ-650M	1,000	40 - 90	0.20 - 0.30	105 - 155
17229	TOYOPEARL SuperQ-650M	5,000	40 - 90	0.20 - 0.30	105 - 155
21311	TOYOPEARL SuperQ-650M	50,000	40 - 90	0.20 - 0.30	105 - 155
42075		100	E0 150	0.20, 0.20	105 155
43275		100	50 - 150	0.20 - 0.30	105 - 155
17231	TOVOPEARL SuperO 4500	200	50 - 150	0.20 - 0.30	105 155
17232	TOYOPEARL SuperO 650C	5,000	50 - 150	0.20 - 0.30	105 - 155
17233	TOYOPEARL SuperQ-650C	5,000	50 - 150	0.20 - 0.30	105 - 155



19804 TOYOPEARL DEAE-650S 25 20-50 0.08 - 0.12 25 - 35 07472 TOYOPEARL DEAE-650S 1.000 20 - 50 0.08 - 0.12 25 - 35 07973 TOYOPEARL DEAE-650S 5.000 20 - 50 0.08 - 0.12 25 - 35 07973 TOYOPEARL DEAE-650S 5.000 20 - 50 0.08 - 0.12 25 - 35 07473 TOYOPEARL DEAE-650M 100 40 - 90 0.08 - 0.12 25 - 35 07473 TOYOPEARL DEAE-650M 1.000 40 - 90 0.08 - 0.12 25 - 35 07474 TOYOPEARL DEAE-650M 5.000 40 - 90 0.08 - 0.12 25 - 35 0788 TOYOPEARL DEAE-650M 5.000 40 - 90 0.08 - 0.12 25 - 35 07989 TOYOPEARL DEAE-650C 1.000 50 - 150 0.05 - 0.11 25 - 35 07989 TOYOPEARL DEAE-650C 5.000 50 - 100 0.15 - 0.25 > 156 22865 TOYOPEARL DEAE-650C 5.000 50 - 100 0.15 - 0.25 > 156 22865 TOYOPEARL GigaCap	Part #	Product description	Container size (mL)	Bead diameter (µm)	lon Exchange Capacity (eq/L)	Typical BSA* capacity (g/L)
07472 TOYOPEARL DEAE-660S 1,000 20 - 50 0.08 - 0.12 25 - 35 14692 TOYOPEARL DEAE-660S 5,000 20 - 50 0.08 - 0.12 25 - 35 21483 TOYOPEARL DEAE-650S 5,000 20 - 50 0.08 - 0.12 25 - 35 14321 TOYOPEARL DEAE-650M 100 40 - 90 0.08 - 0.12 25 - 35 1433 TOYOPEARL DEAE-650M 5,000 40 - 90 0.08 - 0.12 25 - 35 14633 TOYOPEARL DEAE-650M 5,000 40 - 90 0.08 - 0.12 25 - 35 17934 TOYOPEARL DEAE-650M 5,000 40 - 90 0.08 - 0.12 25 - 35 17935 TOYOPEARL DEAE-650M 5,000 40 - 90 0.08 - 0.11 25 - 35 17935 TOYOPEARL DEAE-650C 5,000 50 - 150 0.05 - 0.11 25 - 35 17935 TOYOPEARL DEAE-650C 5,000 50 - 100 0.15 - 0.25 > 156 12835 TOYOPEARL DEAE-650C 5,000 50 - 100 0.15 - 0.25 > 156 12845 TOYOPEARL Gig	19804	TOYOPEARL DEAE-650S	25	20 - 50	0.08 - 0.12	25 - 35
14682 TOYOPEARL DEAE-650S 1,000 20 - 50 0.08 - 0.12 25 - 35 21483 TOYOPEARL DEAE-650S 50,000 20 - 50 0.08 - 0.12 25 - 35 3201 TOYOPEARL DEAE-650M 100 40 - 90 0.08 - 0.12 25 - 35 14301 TOYOPEARL DEAE-650M 250 40 - 90 0.08 - 0.12 25 - 35 14633 TOYOPEARL DEAE-650M 5,000 40 - 90 0.08 - 0.12 25 - 35 14633 TOYOPEARL DEAE-650M 5,000 40 - 90 0.08 - 0.12 25 - 35 17807 TOYOPEARL DEAE-650M 5,000 40 - 90 0.08 - 0.12 25 - 35 17808 TOYOPEARL DEAE-650C 1,000 50 - 150 0.05 - 0.11 25 - 35 17808 TOYOPEARL DEAE-650C 5,000 50 - 100 0.15 - 0.25 > 156 22865 TOYOPEARL GigaCap DEAE-650M 1,000 50 - 100 0.15 - 0.25 > 156 22865 TOYOPEARL GigaCap DEAE-650M 5,000 0.15 - 0.25 > 156 22865 TOYOPEARL GigaCap DEAE-65	07472	TOYOPEARL DEAE-650S	250	20 - 50	0.08 - 0.12	25 - 35
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14693 10/07PEARL DEAE-650M 1,000 40 - 90 0.08 - 0.12 22 - 35 07974 TOYOPEARL DEAE-650M 5,000 40 - 90 0.08 - 0.12 22 - 35 18367 TOYOPEARL DEAE-650M 50,000 40 - 90 0.08 - 0.12 22 - 35 19367 TOYOPEARL DEAE-650C 250 50 - 150 0.05 - 0.11 25 - 35 19388 TOYOPEARL DEAE-650C 5,000 50 - 150 0.05 - 0.11 25 - 35 22865 TOYOPEARL DEAE-650C 50,000 50 - 150 0.05 - 0.11 25 - 35 22865 TOYOPEARL GigaCap DEAE-650M 100 50 - 100 0.15 - 0.25 > 156 22866 TOYOPEARL GigaCap DEAE-650M 1,000 50 - 100 0.15 - 0.25 > 156 22867 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22868 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22884 TOYOPEARL GigaCap 0.650S 250 0.14 - 0.24 >170 22885 TO	0/4/3	TOYOPEARL DEAE-650M	250	40 - 90	0.08 - 0.12	25 - 35
07974 TOYOPEARL DEAE-650M 5,0,00 40 - 90 0.08 - 0.12 25 - 35 18367 TOYOPEARL DEAE-650M 50,000 40 - 90 0.08 - 0.12 25 - 35 07988 TOYOPEARL DEAE-650C 250 50 - 150 0.05 - 0.11 25 - 35 14694 TOYOPEARL DEAE-650C 5,000 50 - 150 0.05 - 0.11 25 - 35 22853 TOYOPEARL DEAE-650C 50,000 50 - 150 0.05 - 0.11 25 - 35 22865 TOYOPEARL DEAE-650C 50,000 50 - 150 0.05 - 0.11 25 - 35 22866 TOYOPEARL GigaCap DEAE-650M 100 50 - 100 0.15 - 0.25 > 156 22867 TOYOPEARL GigaCap DEAE-650M 5,000 50 - 100 0.15 - 0.25 > 156 22868 TOYOPEARL GigaCap DEAE-650M 5,000 50 - 100 0.15 - 0.25 > 156 22881 TOYOPEARL GigaCap D-650S 25 20 - 50 0.14 - 0.24 > 170 22882 TOYOPEARL GigaCap 0.650S 250 0.12 - 0.18 52 - 88 15040 25 <td>14693</td> <td>TOYOPEARL DEAE-650M</td> <td>1,000</td> <td>40 - 90</td> <td>0.08 - 0.12</td> <td>25 - 35</td>	14693	TOYOPEARL DEAE-650M	1,000	40 - 90	0.08 - 0.12	25 - 35
18867 TOYOPEARL DEAE-650M 50,000 40 - 90 0.08 - 0.12 25 - 35 07988 TOYOPEARL DEAE-650C 250 50 - 150 0.05 - 0.11 25 - 35 07989 TOYOPEARL DEAE-650C 5,000 50 - 150 0.05 - 0.11 25 - 35 22853 TOYOPEARL DEAE-650C 50,000 50 - 150 0.05 - 0.11 25 - 35 22865 TOYOPEARL DEAE-650C 50,000 50 - 150 0.05 - 0.11 25 - 35 22865 TOYOPEARL DEAE-650M 100 50 - 100 0.15 - 0.25 > 156 22866 TOYOPEARL GigaCap DEAE-650M 1,000 50 - 100 0.15 - 0.25 > 156 22867 TOYOPEARL GigaCap DEAE-650M 5,000 50 - 100 0.15 - 0.25 > 156 22868 TOYOPEARL GigaCap DEAE-650M 5,000 50 - 100 0.15 - 0.25 > 156 22881 TOYOPEARL GigaCap 0.650S 25 20 - 50 0.14 - 0.24 > 170 22882 TOYOPEARL GigaCap 0.650S 5,000 20 - 50 0.14 - 0.24 > 170 22883<	07974	TOYOPEARL DEAE-650M	5,000	40 - 90	0.08 - 0.12	25 - 35
07988 TOYOPEARL DEAE-650C 250 50 - 150 0.05 - 0.11 25 - 35 14694 TOYOPEARL DEAE-650C 1,000 50 - 150 0.05 - 0.11 25 - 35 22853 TOYOPEARL DEAE-650C 50,000 50 - 150 0.05 - 0.11 25 - 35 22865 TOYOPEARL DEAE-650C 50,000 50 - 150 0.05 - 0.11 25 - 35 22865 TOYOPEARL GigaCap DEAE-650M 100 50 - 100 0.15 - 0.25 > 156 22866 TOYOPEARL GigaCap DEAE-650M 1.000 50 - 100 0.15 - 0.25 > 156 22867 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22868 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22869 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22881 TOYOPEARL GigaCap 0.460S 25 20 - 50 0.14 - 0.24 > 170 22882 TOYOPEARL GigaCap 0.460S 5,000 20 - 50 0.14 - 0.24 > 170	18367	TOYOPEARL DEAE-650M	50,000	40 - 90	0.08 - 0.12	25 - 35
14694 TOYOPEARL DEAE-650C 1,000 50 - 150 0.05 - 0.11 25 - 35 07999 TOYOPEARL DEAE-650C 5,000 50 - 150 0.05 - 0.11 25 - 35 22855 TOYOPEARL DEAE-650C 50,000 50 - 150 0.05 - 0.11 25 - 35 22865 TOYOPEARL GigaCap DEAE-650M 100 50 - 100 0.15 - 0.25 > 156 22866 TOYOPEARL GigaCap DEAE-650M 1,000 50 - 100 0.15 - 0.25 > 156 22867 TOYOPEARL GigaCap DEAE-650M 5,000 50 - 100 0.15 - 0.25 > 156 22868 TOYOPEARL GigaCap DEAE-650M 5,000 50 - 100 0.15 - 0.25 > 156 22869 TOYOPEARL GigaCap DEAE-650M 50,000 20 - 50 0.14 - 0.24 > 170 22881 TOYOPEARL GigaCap 0.650S 250 20 - 50 0.14 - 0.24 > 170 22883 TOYOPEARL GigaCap 0.650S 5,000 20 - 50 0.14 - 0.24 > 170 22884 TOYOPEARL GigaCap 0.650S 5,000 20 - 50 0.12 - 0.18 52 - 88 <tr< td=""><td>07988</td><td>TOYOPEARL DEAE-650C</td><td>250</td><td>50 - 150</td><td>0.05 - 0.11</td><td>25 - 35</td></tr<>	07988	TOYOPEARL DEAE-650C	250	50 - 150	0.05 - 0.11	25 - 35
07989 TOYOPEARL DEAE-650C 5,000 50 - 150 0.05 - 0.11 25 - 35 22853 TOYOPEARL DEAE-650C 50,000 50 - 150 0.05 - 0.11 25 - 35 22865 TOYOPEARL GigaCap DEAE-650M 100 50 - 100 0.15 - 0.25 > 156 22866 TOYOPEARL GigaCap DEAE-650M 100 50 - 100 0.15 - 0.25 > 156 22867 TOYOPEARL GigaCap DEAE-650M 5,000 50 - 100 0.15 - 0.25 > 156 22868 TOYOPEARL GigaCap DEAE-650M 5,000 50 - 100 0.15 - 0.25 > 156 22869 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22881 TOYOPEARL GigaCap DEAE-650M 50,000 20 - 50 0.14 - 0.24 > 170 22882 TOYOPEARL GigaCap 0.650S 250 20 - 50 0.14 - 0.24 > 170 22883 TOYOPEARL GigaCap 0.650S 50,000 20 - 50 0.14 - 0.24 > 170 22884 TOYOPEARL GigaCap 0.650S 50,000 20 - 50 0.14 - 0.24 > 170	14694	TOYOPEARL DEAE-650C	1,000	50 - 150	0.05 - 0.11	25 - 35
22833 TOYOPEARL DEAE-650C 50,000 50 - 150 0.05 - 0.11 25 - 35 22865 TOYOPEARL GigaCap DEAE-650M 100 50 - 100 0.15 - 0.25 > 156 22867 TOYOPEARL GigaCap DEAE-650M 250 50 - 100 0.15 - 0.25 > 156 22868 TOYOPEARL GigaCap DEAE-650M 1,000 50 - 100 0.15 - 0.25 > 156 22869 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22881 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22882 TOYOPEARL GigaCap O-650S 25 20 - 50 0.14 - 0.24 > 170 22883 TOYOPEARL GigaCap O-650S 250 20 - 50 0.14 - 0.24 > 170 22884 TOYOPEARL GigaCap O-650S 5,000 20 - 50 0.14 - 0.24 > 170 22884 TOYOPEARL GigaCap O-650S 5,000 20 - 50 0.14 - 0.24 > 170 22884 TOYOPEARL GigaCap O-650S 5,000 15 - 25 0.12 - 0.18 52 - 88 <t< td=""><td>07989</td><td>TOYOPEARL DEAE-650C</td><td>5,000</td><td>50 - 150</td><td>0.05 - 0.11</td><td>25 - 35</td></t<>	07989	TOYOPEARL DEAE-650C	5,000	50 - 150	0.05 - 0.11	25 - 35
Image Image Image Image Image 22865 TOYOPEARL GigaCap DEAE-650M 100 50 - 100 0.15 - 0.25 > 156 22866 TOYOPEARL GigaCap DEAE-650M 1,000 50 - 100 0.15 - 0.25 > 156 22868 TOYOPEARL GigaCap DEAE-650M 5,000 50 - 100 0.15 - 0.25 > 156 22869 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22869 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22881 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22882 TOYOPEARL GigaCap O-650S 250 20 - 50 0.14 - 0.24 > 170 22883 TOYOPEARL GigaCap O-650S 1,000 20 - 50 0.14 - 0.24 > 170 22884 TOYOPEARL GigaCap O-650S 50,000 20 - 50 0.14 - 0.24 > 170 22885 TOYOPEARL GigaCap O-650S 50,000 15 - 25 0.12 - 0.18 52 - 88 18535 <td< td=""><td>22853</td><td>TOYOPEARL DEAE-650C</td><td>50,000</td><td>50 - 150</td><td>0.05 - 0.11</td><td>25 - 35</td></td<>	22853	TOYOPEARL DEAE-650C	50,000	50 - 150	0.05 - 0.11	25 - 35
22865 TOYOPEARL GigaCap DEAE-650M 100 50 - 100 0.15 - 0.25 > 156 22866 TOYOPEARL GigaCap DEAE-650M 250 50 - 100 0.15 - 0.25 > 156 22867 TOYOPEARL GigaCap DEAE-650M 1,000 50 - 100 0.15 - 0.25 > 156 22868 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22869 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22881 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.14 - 0.24 >170 22882 TOYOPEARL GigaCap O-650S 250 20 - 50 0.14 - 0.24 >170 22883 TOYOPEARL GigaCap O-650S 5,000 20 - 50 0.14 - 0.24 >170 22884 TOYOPEARL GigaCap O-650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap O-650S 50,000 20 - 50 0.14 - 0.24 >170 22884 TOYOPEARL GigaCap O-650S 50,000 15 - 25 0.12 - 0.18 52 - 88	00005		400	F0 400	0.45 0.05	450
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22867 IOYOPEARL GigaCap DEAE-650M 1,000 50 - 100 0.15 - 0.25 > 156 22868 TOYOPEARL GigaCap DEAE-650M 5,000 50 - 100 0.15 - 0.25 > 156 22869 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22881 TOYOPEARL GigaCap DEAE-650M 50,000 250 0.14 - 0.24 >170 22882 TOYOPEARL GigaCap 0.650S 250 20 - 50 0.14 - 0.24 >170 22883 TOYOPEARL GigaCap 0.650S 1,000 20 - 50 0.14 - 0.24 >170 22884 TOYOPEARL GigaCap 0.650S 5,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap 0.650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap 0.650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap 0.650S 50,000 20 - 50 0.12 - 0.18 52 - 88 18383 TSKgel SuperO-5PW (20) 250 15 - 25 0.12 - 0.18 52 - 88	22866	TOYOPEARL GigaCap DEAE-650M	250	50 - 100	0.15 - 0.25	> 156
22888 TOYOPEARL GigaCap DEAE-650M 5,000 50 - 100 0.15 - 0.25 > 156 22889 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22881 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22881 TOYOPEARL GigaCap O-650S 25 20 - 50 0.14 - 0.24 >170 22883 TOYOPEARL GigaCap O-650S 1,000 20 - 50 0.14 - 0.24 >170 22884 TOYOPEARL GigaCap O-650S 5,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap O-650S 5,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap O-650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap O-650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap O-650S 50,000 15 - 25 0.12 - 0.18 52 - 88 18535 TSKgel SuperO-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88	22867	TOYOPEARL GigaCap DEAE-650M	1,000	50 - 100	0.15 - 0.25	> 156
22869 TOYOPEARL GigaCap DEAE-650M 50,000 50 - 100 0.15 - 0.25 > 156 22881 TOYOPEARL GigaCap De650S 25 20 - 50 0.14 - 0.24 >170 22882 TOYOPEARL GigaCap O-650S 250 20 - 50 0.14 - 0.24 >170 22883 TOYOPEARL GigaCap O-650S 1,000 20 - 50 0.14 - 0.24 >170 22884 TOYOPEARL GigaCap O-650S 5,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap O-650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap O-650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap O-650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap O-550W (20) 25 15 - 25 0.12 - 0.18 52 - 88 18535 TSKgel SuperO-5PW (20) 5,000 15 - 25 0.12 - 0.18 52 - 88 18547 TSKgel SuperO-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88 <t< td=""><td>22868</td><td>TOYOPEARL GigaCap DEAE-650M</td><td>5,000</td><td>50 - 100</td><td>0.15 - 0.25</td><td>> 156</td></t<>	22868	TOYOPEARL GigaCap DEAE-650M	5,000	50 - 100	0.15 - 0.25	> 156
22881 TOYOPEARL GigaCap Q-650S 25 20 - 50 0.14 - 0.24 >170 22882 TOYOPEARL GigaCap Q-650S 250 20 - 50 0.14 - 0.24 >170 22883 TOYOPEARL GigaCap Q-650S 1,000 20 - 50 0.14 - 0.24 >170 22884 TOYOPEARL GigaCap Q-650S 5,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap Q-650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap Q-650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap Q-650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap Q-650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap Q-650S 50,000 15 - 25 0.12 - 0.18 52 - 88 18535 TSKgel SuperQ-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88 18547 TSKgel SuperQ-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88 219	22869	TOYOPEARL GigaCap DEAE-650M	50,000	50 - 100	0.15 - 0.25	> 156
22882 TOYOPEARL GigaCap Q-650S 250 20 - 50 0.14 - 0.24 >170 22883 TOYOPEARL GigaCap Q-650S 1,000 20 - 50 0.14 - 0.24 >170 22884 TOYOPEARL GigaCap Q-650S 5,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap Q-650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap Q-650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap Q-650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap Q-650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap Q-650S 50,000 20 - 50 0.12 - 0.18 52 - 88 18535 TSKgel SuperQ-5PW (20) 50,000 15 - 25 0.12 - 0.18 52 - 88 18547 TSKgel SuperQ-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88 18547 TSKgel SuperQ-5PW (20) 25 20 - 40 0.12 - 0.18 52 - 88 19	22881	TOYOPEARL GigaCap Q-650S	25	20 - 50	0.14 - 0.24	>170
22883 TOYOPEARL GigaCap Q-650S 1,000 20 - 50 0.14 - 0.24 >170 22884 TOYOPEARL GigaCap Q-650S 5,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap Q-650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap Q-650S 50,000 20 - 50 0.14 - 0.24 >170 TSKgel SuperQ-5PW (20) 25 15 - 25 0.12 - 0.18 52 - 88 18535 TSKgel SuperQ-5PW (20) 250 15 - 25 0.12 - 0.18 52 - 88 18546 TSKgel SuperQ-5PW (20) 1,000 15 - 25 0.12 - 0.18 52 - 88 18547 TSKgel SuperQ-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88 21919 TSKgel SuperQ-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (30) 25 20 - 40 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (30) 250 20 - 40 0.12 - 0.18 52 - 88 18536 <	22882	TOYOPEARL GigaCap Q-650S	250	20 - 50	0.14 - 0.24	>170
22884 TOYOPEARL GigaCap Q-650S 5,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap Q-650S 50,000 20 - 50 0.14 - 0.24 >170 22885 TOYOPEARL GigaCap Q-650S 50,000 20 - 50 0.14 - 0.24 >170 43383 TSKgel SuperQ-5PW (20) 25 15 - 25 0.12 - 0.18 52 - 88 18535 TSKgel SuperQ-5PW (20) 1,000 15 - 25 0.12 - 0.18 52 - 88 18546 TSKgel SuperQ-5PW (20) 5,000 15 - 25 0.12 - 0.18 52 - 88 18547 TSKgel SuperQ-5PW (20) 5,000 15 - 25 0.12 - 0.18 52 - 88 21919 TSKgel SuperQ-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (20) 250,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (30) 25 20 - 40 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (30) 250 20 - 40 0.12 - 0.18 52 - 88 18548	22883	TOYOPEARL GigaCap Q-650S	1,000	20 - 50	0.14 - 0.24	>170
22885 TOYOPEARL GigaCap Q-650S 50,000 20 - 50 0.14 - 0.24 >170 Stypel Anion Exchange Resins 43383 TSKgel SuperQ-5PW (20) 25 15 - 25 0.12 - 0.18 52 - 88 18535 TSKgel SuperQ-5PW (20) 250 15 - 25 0.12 - 0.18 52 - 88 18546 TSKgel SuperQ-5PW (20) 1,000 15 - 25 0.12 - 0.18 52 - 88 18547 TSKgel SuperQ-5PW (20) 5,000 15 - 25 0.12 - 0.18 52 - 88 18547 TSKgel SuperQ-5PW (20) 5,000 15 - 25 0.12 - 0.18 52 - 88 21919 TSKgel SuperQ-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (20) 50,000 15 - 25 0.12 - 0.18 52 - 88 18536 TSKgel SuperQ-5PW (30) 250 20 - 40 0.12 - 0.18 52 - 88 18548 TSKgel SuperQ-5PW (30) 1,000 20 - 40 0.12 - 0.18 52 - 88 18548 TSKgel SuperQ-5PW (30) 5,000 20 - 40	22884	TOYOPEARL GigaCap Q-650S	5,000	20 - 50	0.14 - 0.24	>170
TSKgel Anion Exchange Resins 43383 TSKgel SuperQ-5PW (20) 25 15 - 25 0.12 - 0.18 52 - 88 18535 TSKgel SuperQ-5PW (20) 250 15 - 25 0.12 - 0.18 52 - 88 18546 TSKgel SuperQ-5PW (20) 1,000 15 - 25 0.12 - 0.18 52 - 88 18547 TSKgel SuperQ-5PW (20) 5,000 15 - 25 0.12 - 0.18 52 - 88 21919 TSKgel SuperQ-5PW (20) 5,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (20) 50,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (30) 25 20 - 40 0.12 - 0.18 52 - 88 18536 TSKgel SuperQ-5PW (30) 250 20 - 40 0.12 - 0.18 52 - 88 18548 TSKgel SuperQ-5PW (30) 1,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel DEAE-5PW (20) 5,000 20 - 40 0.12	22885	TOYOPEARL GigaCap Q-650S	50,000	20 - 50	0.14 - 0.24	>170
43383 TSKgel SuperQ-5PW (20) 25 15 - 25 0.12 - 0.18 52 - 88 18535 TSKgel SuperQ-5PW (20) 1,000 15 - 25 0.12 - 0.18 52 - 88 18546 TSKgel SuperQ-5PW (20) 1,000 15 - 25 0.12 - 0.18 52 - 88 18547 TSKgel SuperQ-5PW (20) 5,000 15 - 25 0.12 - 0.18 52 - 88 21919 TSKgel SuperQ-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (20) 50,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (20) 50,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (30) 250 20 - 40 0.12 - 0.18 52 - 88 18536 TSKgel SuperQ-5PW (30) 1,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel SuperQ-5PW (30) 5,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel DEAE-5PW (20) 25 15 - 25 0.05 - 0.11 <td< td=""><td></td><td>TSK</td><td>Kgel Anion E</td><td>xchange Resins</td><td></td><td></td></td<>		TSK	Kgel Anion E	xchange Resins		
18535 TSKgel SuperQ-5PW (20) 250 15 - 25 0.12 - 0.18 52 - 88 18546 TSKgel SuperQ-5PW (20) 1,000 15 - 25 0.12 - 0.18 52 - 88 18547 TSKgel SuperQ-5PW (20) 5,000 15 - 25 0.12 - 0.18 52 - 88 21919 TSKgel SuperQ-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (20) 50,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (20) 50,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (30) 25 20 - 40 0.12 - 0.18 52 - 88 18536 TSKgel SuperQ-5PW (30) 250 20 - 40 0.12 - 0.18 52 - 88 18548 TSKgel SuperQ-5PW (30) 1,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel DEAE-5PW (20) 5,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel DEAE-5PW (20) 25 15 - 25 0.05 - 0.11 25	43383	TSKgel SuperQ-5PW (20)	25	15 - 25	0.12 - 0.18	52 - 88
18546 TSKgel SuperQ-5PW (20) 1,000 15 - 25 0.12 - 0.18 52 - 88 18547 TSKgel SuperQ-5PW (20) 5,000 15 - 25 0.12 - 0.18 52 - 88 21919 TSKgel SuperQ-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (20) 50,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (20) 50,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (30) 25 20 - 40 0.12 - 0.18 52 - 88 43283 TSKgel SuperQ-5PW (30) 250 20 - 40 0.12 - 0.18 52 - 88 18548 TSKgel SuperQ-5PW (30) 1,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel SuperQ-5PW (30) 1,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel DEAE-5PW (20) 25 15 - 25 0.05 - 0.11 25 - 45 14710 TSKgel DEAE-5PW (20) 250 15 - 25 0.05 - 0.11 25 - 45 14711 TSKgel DEAE-5PW (20) 1,000 15 - 25 0.05 - 0.11 25 - 4	18535	TSKgel SuperQ-5PW (20)	250	15 - 25	0.12 - 0.18	52 - 88
18547 TSKgel SuperQ-5PW (20) 5,000 15 - 25 0.12 - 0.18 52 - 88 21919 TSKgel SuperQ-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (20) 50,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (20) 50,000 15 - 25 0.12 - 0.18 52 - 88 43283 TSKgel SuperQ-5PW (30) 25 20 - 40 0.12 - 0.18 52 - 88 18536 TSKgel SuperQ-5PW (30) 250 20 - 40 0.12 - 0.18 52 - 88 18548 TSKgel SuperQ-5PW (30) 1,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel SuperQ-5PW (30) 1,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel DEAE-5PW (30) 5,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel DEAE-5PW (20) 25 15 - 25 0.05 - 0.11 25 - 45 43381 TSKgel DEAE-5PW (20) 250 15 - 25 0.05 - 0.11 25 - 45 14710 TSKgel DEAE-5PW (20) 250 15 - 25 0.05 - 0.11 25 - 45 <td>18546</td> <td>TSKgel SuperQ-5PW (20)</td> <td>1,000</td> <td>15 - 25</td> <td>0.12 - 0.18</td> <td>52 - 88</td>	18546	TSKgel SuperQ-5PW (20)	1,000	15 - 25	0.12 - 0.18	52 - 88
21919 TSKgel SuperQ-5PW (20) 25,000 15 - 25 0.12 - 0.18 52 - 88 21920 TSKgel SuperQ-5PW (20) 50,000 15 - 25 0.12 - 0.18 52 - 88 43283 TSKgel SuperQ-5PW (30) 25 20 - 40 0.12 - 0.18 52 - 88 18536 TSKgel SuperQ-5PW (30) 250 20 - 40 0.12 - 0.18 52 - 88 18536 TSKgel SuperQ-5PW (30) 250 20 - 40 0.12 - 0.18 52 - 88 18548 TSKgel SuperQ-5PW (30) 1,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel SuperQ-5PW (30) 1,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel SuperQ-5PW (30) 5,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel DEAE-5PW (20) 5,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel DEAE-5PW (20) 25 15 - 25 0.05 - 0.11 25 - 45 14710 TSKgel DEAE-5PW (20) 250 15 - 25 0.05 - 0.11 25 - 45 14711 TSKgel DEAE-5PW (20) 1,000 15 - 25 0.05 - 0.11 25 - 45 <td>18547</td> <td>TSKgel SuperQ-5PW (20)</td> <td>5,000</td> <td>15 - 25</td> <td>0.12 - 0.18</td> <td>52 - 88</td>	18547	TSKgel SuperQ-5PW (20)	5,000	15 - 25	0.12 - 0.18	52 - 88
21920 TSKgel SuperQ-5PW (20) 50,000 15 - 25 0.12 - 0.18 52 - 88 43283 TSKgel SuperQ-5PW (30) 25 20 - 40 0.12 - 0.18 52 - 88 18536 TSKgel SuperQ-5PW (30) 250 20 - 40 0.12 - 0.18 52 - 88 18548 TSKgel SuperQ-5PW (30) 1,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel SuperQ-5PW (30) 1,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel SuperQ-5PW (30) 5,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel SuperQ-5PW (20) 5,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel DEAE-5PW (20) 5,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel DEAE-5PW (20) 25 15 - 25 0.05 - 0.11 25 - 45 14710 TSKgel DEAE-5PW (20) 250 15 - 25 0.05 - 0.11 25 - 45 14711 TSKgel DEAE-5PW (20) 1,000 15 - 25 0.05 - 0.11 25 - 45	21919	TSKgel SuperQ-5PW (20)	25,000	15 - 25	0.12 - 0.18	52 - 88
Image: Mark and	21920	TSKgel SuperQ-5PW (20)	50,000	15 - 25	0.12 - 0.18	52 - 88
43283 TSKgel SuperQ-5PW (30) 25 20 - 40 0.12 - 0.18 52 - 88 18536 TSKgel SuperQ-5PW (30) 250 20 - 40 0.12 - 0.18 52 - 88 18548 TSKgel SuperQ-5PW (30) 1,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel SuperQ-5PW (30) 5,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel SuperQ-5PW (30) 5,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel DuperQ-5PW (20) 5,000 20 - 40 0.12 - 0.18 52 - 88 43381 TSKgel DEAE-5PW (20) 25 15 - 25 0.05 - 0.11 25 - 45 14710 TSKgel DEAE-5PW (20) 250 15 - 25 0.05 - 0.11 25 - 45 14711 TSKgel DEAE-5PW (20) 1,000 15 - 25 0.05 - 0.11 25 - 45	40000		05	00.40	0.10 0.10	50.00
18536 TSKgel SuperQ-5PW (30) 250 20 - 40 0.12 - 0.18 52 - 88 18548 TSKgel SuperQ-5PW (30) 1,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel SuperQ-5PW (30) 5,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel SuperQ-5PW (30) 5,000 20 - 40 0.12 - 0.18 52 - 88 43381 TSKgel DEAE-5PW (20) 25 15 - 25 0.05 - 0.11 25 - 45 14710 TSKgel DEAE-5PW (20) 250 15 - 25 0.05 - 0.11 25 - 45 14711 TSKgel DEAE-5PW (20) 1,000 15 - 25 0.05 - 0.11 25 - 45	43283	TSKgel SuperQ-5PW (30)	25	20 - 40	0.12 - 0.18	52 - 88
18548 ISKgel SuperQ-5PW (30) 1,000 20 - 40 0.12 - 0.18 52 - 88 18549 TSKgel SuperQ-5PW (30) 5,000 20 - 40 0.12 - 0.18 52 - 88 43381 TSKgel DEAE-5PW (20) 25 15 - 25 0.05 - 0.11 25 - 45 14710 TSKgel DEAE-5PW (20) 250 15 - 25 0.05 - 0.11 25 - 45 14711 TSKgel DEAE-5PW (20) 1,000 15 - 25 0.05 - 0.11 25 - 45	18536	TSKgel SuperQ-5PW (30)	250	20 - 40	0.12 - 0.18	52 - 88
18549 1SKgel SuperQ-5PW (30) 5,000 20 - 40 0.12 - 0.18 52 - 88 43381 TSKgel DEAE-5PW (20) 25 15 - 25 0.05 - 0.11 25 - 45 14710 TSKgel DEAE-5PW (20) 250 15 - 25 0.05 - 0.11 25 - 45 14711 TSKgel DEAE-5PW (20) 1,000 15 - 25 0.05 - 0.11 25 - 45	18548	ISKgel SuperQ-5PW (30)	1,000	20 - 40	0.12 - 0.18	52 - 88
43381 TSKgel DEAE-5PW (20) 25 15 - 25 0.05 - 0.11 25 - 45 14710 TSKgel DEAE-5PW (20) 250 15 - 25 0.05 - 0.11 25 - 45 14711 TSKgel DEAE-5PW (20) 1,000 15 - 25 0.05 - 0.11 25 - 45	18549	ISKgel SuperQ-5PW (30)	5,000	20 - 40	0.12 - 0.18	52 - 88
14710 TSKgel DEAE-5PW (20) 250 15 - 25 0.05 - 0.11 25 - 45 14711 TSKgel DEAE-5PW (20) 1,000 15 - 25 0.05 - 0.11 25 - 45	43381	TSKgel DEAE-5PW (20)	25	15 - 25	0.05 - 0.11	25 - 45
14711 TSKgel DEAE-5PW (20) 1,000 15 - 25 0.05 - 0.11 25 - 45	14710	TSKgel DEAE-5PW (20)	250	15 - 25	0.05 - 0.11	25 - 45
	14711	TSKgel DEAE-5PW (20)	1.000	15 - 25	0.05 - 0.11	25 - 45
18436 TSKgel DEAE-5PW (20) 5,000 15 - 25 0.05 - 0.11 25 - 45	18436	TSKgel DEAE-5PW (20)	5,000	15 - 25	0.05 - 0.11	25 - 45



Part #	Product description	Container size (mL)	Bead diameter (µm)	lon Exchange Capacity (eq/L)	Typical BSA* capacity (g/L)
43281	TSKgel DEAE-5PW (30)	25	20 - 40	0.05 - 0.11	20 - 40
14712	TSKgel DEAE-5PW (30)	250	20 - 40	0.05 - 0.11	20 - 40
14713	TSKgel DEAE-5PW (30)	1,000	20 - 40	0.05 - 0.11	20 - 40
18370	TSKgel DEAE-5PW (30)	5,000	20 - 40	0.05 - 0.11	20 - 40

⁺ Typical BSA capacity (g/L) unless otherwise noted

Cation exchange resins:

Part #	Product description	Container size (mL)	Bead diameter (µm)	lon Exchange Capacity (eq/L)	Typical Lysozyme⁺ capacity (g/L)		
TOYOPEARL and TOYOPEARL GigaCap Cation Exchange Resins							
23467	TOYOPEARL Sulfate-650F	100	50 - 100	<u>≥</u> 0.53	≥ 114 Hu.γ-globulin		
23468	TOYOPEARL Sulfate-650F	250	50 - 100	<u>≥</u> 0.53	≥ 114 Hu.γ-globulin		
23469	TOYOPEARL Sulfate-650F	1,000	50 - 100	≥ 0.53	≥ 114 Hu.γ-globulin		
23470	TOYOPEARL Sulfate-650F	5,000	50 - 100	<u>≥</u> 0.53	≥ 114 Hu. γ-globulin		
23471	TOYOPEARL Sulfate-650F	50,000	50 - 100	≥ 0.53	≥ 114 Hu. γ-globulin		
		400	50.400				
21833		100	50 - 100	0.10 - 0.20	136 - 176 Hu. γ-globulin		
21834	TOYOPEARL GigaCap S-650M	250	50 - 100	0.10 - 0.20	136 - 176 Hu. γ-globulin		
21835	TOYOPEARL GigaCap S-650M	1,000	50 - 100	0.10 - 0.20	136 - 176 Hu. γ-globulin		
21836	TOYOPEARL GigaCap S-650M	5,000	50 - 100	0.10 - 0.20	136 - 176 Hu. γ-globulin		
21837	TOYOPEARL GigaCap S-650M	50,000	50 - 100	0.10 - 0.20	136 - 176 Hu. γ-globulin		
22875	TOYOPEARL GigaCap S-650S	25	20 - 50	0.15 - 0.25	>150 Hu. γ-globulin		
22876	TOYOPEARL GigaCap S-650S	250	20 - 50	0.15 - 0.25	>150 Hu. γ-globulin		
22877	TOYOPEARL GigaCap S-650S	1,000	20 - 50	0.15 - 0.25	>150 Hu. γ-globulin		
22878	TOYOPEARL GigaCap S-650S	5,000	20 - 50	0.15 - 0.25	>150 Hu. γ-globulin		
22879	TOYOPEARL GigaCap S-650S	50,000	20 - 50	0.15 - 0.25	>150 Hu. γ-globulin		
21946	TOYOPEABL GigaCap CM-650M	100	50 - 100	0 17 - 0 28	> 110 Hu v⊱globulin		
21940	TOYOPEABL GigaCap CM-650M	250	50 - 100	0.17 - 0.28	> 110 Hu. y-globulin		
21047	TOYOPEARL GigaCap CM-650M	1 000	50 - 100	0.17 - 0.20	> 110 Hu, y-globulin		
21040	TOYOPEABL GigaCap CM-650M	5,000	50 - 100	0.17 - 0.28	> 110 Hu. y-globulin		
21940	TOYOPEABL GigaCap CM-650M	50.000	50 - 100	0.17 - 0.20	> 110 Hu. γ -globulin		
21330		30,000	30 - 100	0.17 - 0.20			
43272	TOYOPEARL SP-550C	100	50 - 150	0.14 - 0.18	80 - 120		
14028	TOYOPEARL SP-550C	250	50 - 150	0.14 - 0.18	80 - 120		
14705	TOYOPEARL SP-550C	1,000	50 - 150	0.14 - 0.18	80 - 120		
14029	TOYOPEARL SP-550C	5,000	50 - 150	0.14 - 0.18	80 - 120		
18366	TOYOPEARL SP-550C	50,000	50 - 150	0.14 - 0.18	80 - 120		
19822	TOYOPEARL SP-650S	25	20 - 50	0.13 - 0.17	40 - 60		
08437	TOYOPEABL SP-650S	250	20 - 50	0.13 - 0.17	40 - 60		
14698	TOYOPEARL SP-650S	1.000	20 - 50	0.13 - 0.17	40 - 60		
08438	TOYOPEARL SP-650S	5,000	20 - 50	0.13 - 0.17	40 - 60		
21477	TOYOPEARL SP-650S	50,000	20 - 50	0.13 - 0.17	40 - 60		



Part #	Product description	Container size (mL)	Bead diameter (µm)	lon Exchange Capacity (eq/L)	Typical Lysozyme⁺ capacity (g/L)
43202	TOYOPEARL SP-650M	100	40 - 90	0.13 - 0.17	40 - 60
07997	TOYOPEARL SP-650M	250	40 - 90	0.13 - 0.17	40 - 60
14699	TOYOPEARL SP-650M	1,000	40 - 90	0.13 - 0.17	40 - 60
07998	TOYOPEARL SP-650M	5,000	40 - 90	0.13 - 0.17	40 - 60
18369	TOYOPEARL SP-650M	50,000	40 - 90	0.13 - 0.17	40 - 60
07004		250	F0 150	0.10 0.10	
14700		250	50 - 150	0.12 - 0.18	35 - 55
14700		T,000	50 - 150	0.12 - 0.18	30 - 00 25 - 55
07995	TOTOFEARL SF-050C	5,000	50 - 150	0.12 - 0.16	30 - 55
19803	TOYOPEARL CM-650S	25	20 - 50	0.08 - 0.12	30 - 50
07474	TOYOPEARL CM-650S	250	20 - 50	0.08 - 0.12	30 - 50
14695	TOYOPEARL CM-650S	1,000	20 - 50	0.08 - 0.12	30 - 50
07971	TOYOPEARL CM-650S	5,000	20 - 50	0.08 - 0.12	30 - 50
43203	TOYOPEARL CM-650M	100	40 - 90	0.08 - 0.12	30 - 50
07475	TOYOPEARL CM-650M	250	40 - 90	0.08 - 0.12	30 - 50
14696	TOYOPEARL CM-650M	1,000	40 - 90	0.08 - 0.12	30 - 50
07972	TOYOPEARL CM-650M	5,000	40 - 90	0.08 - 0.12	30 - 50
19839	TOYOPEARL CM-650M	50,000	40 - 90	0.08 - 0.12	30 - 50
07991	TOYOPEARL CM-650C	250	50 - 150	0.05 - 0.11	25 - 45
14697	TOYOPEARL CM-650C	1,000	50 - 150	0.05 - 0.11	25 - 45
07992	TOYOPEARL CM-650C	5,000	50 - 150	0.05 - 0.11	25 - 45
19329	TOYOPEARL CM-650C	50,000	50 - 150	0.05 - 0.11	25 - 45
21804	TOYOPEARL MegaCap II SP-550EC	100	100 - 300	0.10 - 0.20	100 - 155 insulin
21805	TOYOPEARL MegaCap II SP-550EC	250	100 - 300	0.10 - 0.20	100 - 155 insulin
21806	TOYOPEARL MegaCap II SP-550EC	1,000	100 - 300	0.10 - 0.20	100 - 155 insulin
21807	TOYOPEARL MegaCap II SP-550EC	5,000	100 - 300	0.10 - 0.20	100 - 155 insulin
21808	TOYOPEARL MegaCap II SP-550EC	50,000	100 - 300	0.10 - 0.20	100 - 155 insulin
	TSK	gel Cation E	xchange Resins		
43382	TSKgel SP-5PW (20)	25	15 - 25	0.06 - 0.12	20 - 40
14714	TSKgel SP-5PW (20)	250	15 - 25	0.06 - 0.12	20 - 40
14715	TSKgel SP-5PW (20)	1,000	15 - 25	0.06 - 0.12	20 - 40
18435	TSKgel SP-5PW (20)	5,000	15 - 25	0.06 - 0.12	20 - 40
13383	TSKaal SP-5PW/ (30)	25	20 - 40	0.06 - 0.12	20 - 40
43202	TSKgel SP-5PW (30)	25	20 - 40	0.00 - 0.12	20 - 40
14710		1 000	20 - 40	0.00 - 0.12	20 - 40
19201	TSKapl SP-50 W (30)	F 000	20-40		20 - 40
10384		5,000	20 - 40	0.00 - 0.12	20 - 40
21976	TSKgel SP-3PW (30)	25	20 - 40	0.07 - 0.22	>65 insulin
21977	TSKgel SP-3PW (30)	250	20 - 40	0.07 - 0.22	>65 insulin
21978	TSKgel SP-3PW (30)	1,000	20 - 40	0.07 - 0.22	>65 insulin
21979	TSKgel SP-3PW (30)	5,000	20 - 40	0.07 - 0.22	>65 insulin
21980	TSKgel SP-3PW (30)	50,000	20 - 40	0.07 - 0.22	>65 insulin

* Typical Lysozyme capacity (g/L) unless otherwise noted