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Preparation, Separation,
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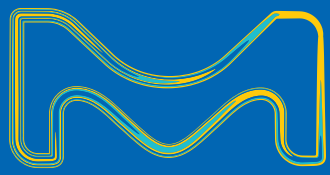


Chromatography Product Selection Guide

Protein A Affinity Chromatography Options

Product	Particle size d50 (µm)	Linear velocity (cm/hr)*	DBC @ 3 min residence time (g/L)	Aggregate removal	Virus removal	Alkaline resistance	Acid resistance
Eshmuno® A resin (Item #1.20089)	46-54	< 500	> 45	++++	**++++**	**++++**	**++++**
ProSep® Ultra Plus resin (Item #1751188)	60	< 1000	> 50	+	**++++**	**N/A**	**++++**
ProSep® vA-High Capacity resin (Item # 1131158)	75-125	< 1000	> 20	+	**++++**	**N/A**	**++++**
ProSep® vA Ultra resin (Item # 1151158)	75-125	< 1000	35	+	**++++**	**N/A**	**++++**

* Linear velocity valid for a 20 cm resin bed height and mobile phase viscosity similar to water.

Plasma Affinity Chromatography Options

Product	Particle size d50 (µm)	Removal at 3 min residence time	IgG Yield	Linear velocity (cm/hr)*	Alkaline resistance	Acid resistance
Eshmuno® P Anti-A and Anti-B resin (Item #1.20094/1.20095)	46-54	Anti-A: 93% Anti-B: 94%	Anti-A: >95% Anti-B: >95%	< 500	++++	++++

* Linear velocity valid for a 20 cm resin bed height and mobile phase viscosity similar to water.

Cation Exchange Chromatography Options

Product	Strong or Weak IEX chemistry	Particle size d50 (µm)	Linear velocity (cm/hr)*	DBC Lysozyme (g/L)	Working conductivity (mS/cm)	Aggregate removal	Charge variant removal	Host cell protein removal
Eshmuno® CP-FT resin (Item #1.20093)	Strong	46-54	≤ 400	N/A	1-9	++++	+	+++
Eshmuno® CPS resin (Item #1.20084)	Strong	46-54	≤ 400	> 100	> 8	+	+	+++
Eshmuno® CPX resin (Item #1.20083)	Strong	46-54	≤ 400	> 100	1-9	+++	++++	++++
Eshmuno® S resin (Item #1.20078)	Strong	75-95	< 1000	> 60	1-9	+	+	+++
Fractogel® EMD COO- (M) resin (Item #1.16886)	Weak	48-60	< 250	30 – 40	1-9	++++	+++	++
Fractogel® EMD SE HiCap (M) resin (Item #1.14894)	Strong	48-60	< 250	80 – 100	1-9	++	++	++++
Fractogel® EMD SO3 resin (Item #1.16882/#1.16890)	Strong	48-60, (M) type 24-40, (S) type	< 250, (M) type ≤ 100, (S) type	80 – 100	1-9	++	+++	++++

* Linear velocity valid for a 20 cm resin bed height and mobile phase viscosity similar to water.

Anion Exchange Chromatography Options

Product	Strong or Weak IEX chemistry	Particle size d50 (µm)	Linear velocity (cm/hr)*	DBC BSA (g/L)	Working conductivity (mS/cm)	Product Flowthrough Mode	Product Bind and Elute Mode
Eshmuno® Q resin (Item #1.20079)	Strong	75-95	< 1000	> 100	1-9	++++	+++
Fractogel® EMD DEAE (M) resin (Item #1.16883)	Weak	48-60	< 250	30 – 40	1-9	+	++++
Fractogel® EMD DMAE (M) resin (Item #1.16884)	Weak	48-60	< 250	30 - 40	1-9	+	++++
Fractogel® EMD TMAE resin (Item #1.16881/1.16887)	Strong	48-60, (M) type 24-40, (S) type	< 250, (M) type ≤ 100, (S) type	80 – 100	1-9	+	++++
Fractogel® EMD TMAE Hicap (M) resin (Item #1.10316)	Strong	48-60	< 250	> 100	1-9	++++	+++
Fractogel® EMD TMAE Medcap (M) resin (Item #1.16885)	Strong	48-60	< 250	> 100	1-9	+	+++
Natrix® Q Chromatography membrane (Item #NXF-01/10/20/50)	Strong	N/A (membrane)	5-25 membrane volumes per min	> 200	1-15	++++	+++

*Linear velocity valid for a 20 cm resin bed height and mobile phase viscosity similar to water.

Mixed-Mode Chromatography Options

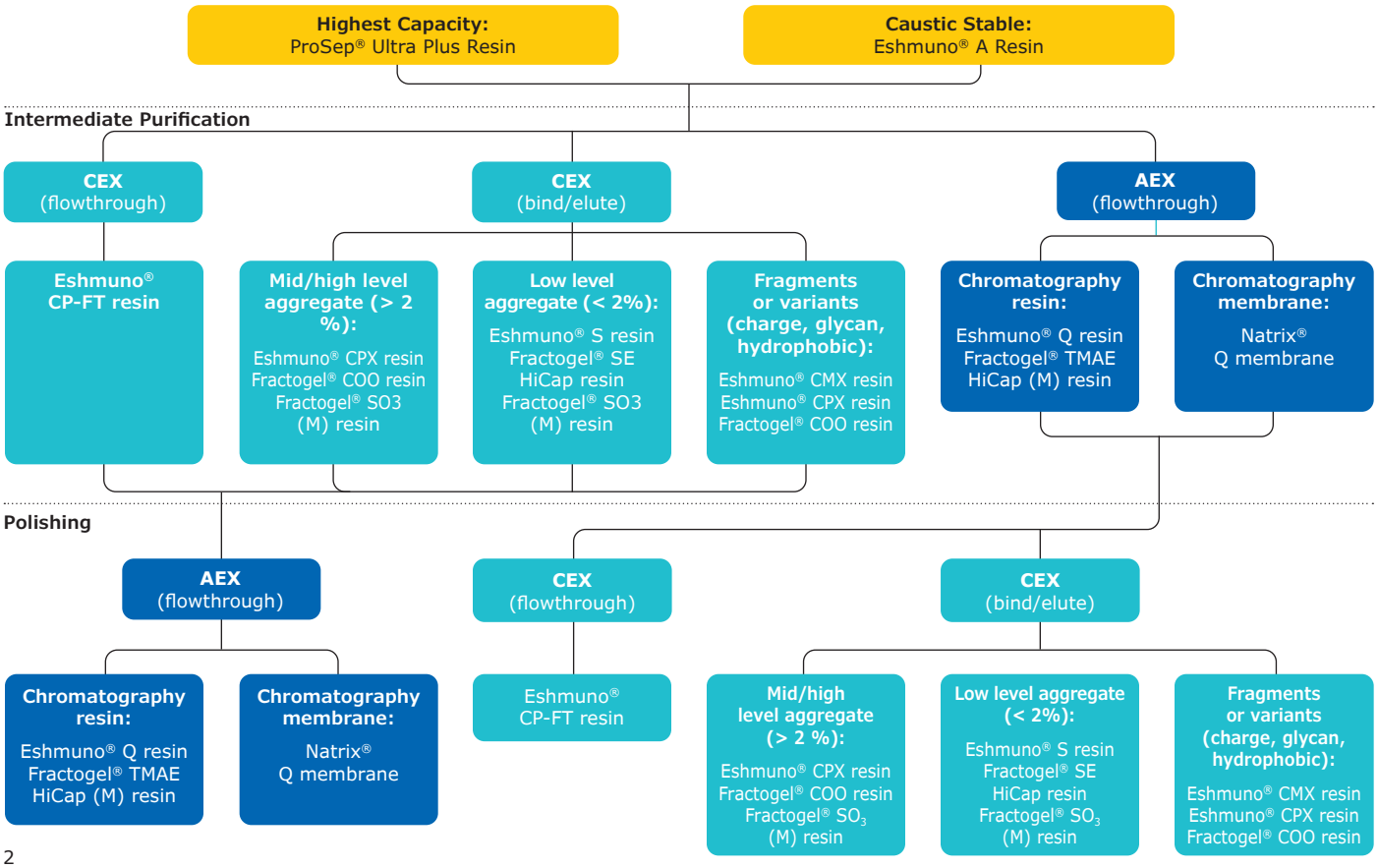
Product	Multimodal chemistry	Particle size d50 (µm)	Linear velocity (cm/hr)*	DBC Lysozyme (g/L)	Aggregate removal	Glycan or hydrophobic variant removal	Host cell protein removal
Eshmuno® CMX resin (Item #1.20650)	Weak cation exchange + moderate hydrophobicity	46-54	≤ 400	≥ 50	+++	++++	++++
Eshmuno® HCX resin (Item #1.20087)	Strong cation exchange + strong hydrophobicity	75-95	< 1000	≥ 50	++	++	+++

* Linear velocity valid for a 20 cm resin bed height and mobile phase viscosity similar to water.

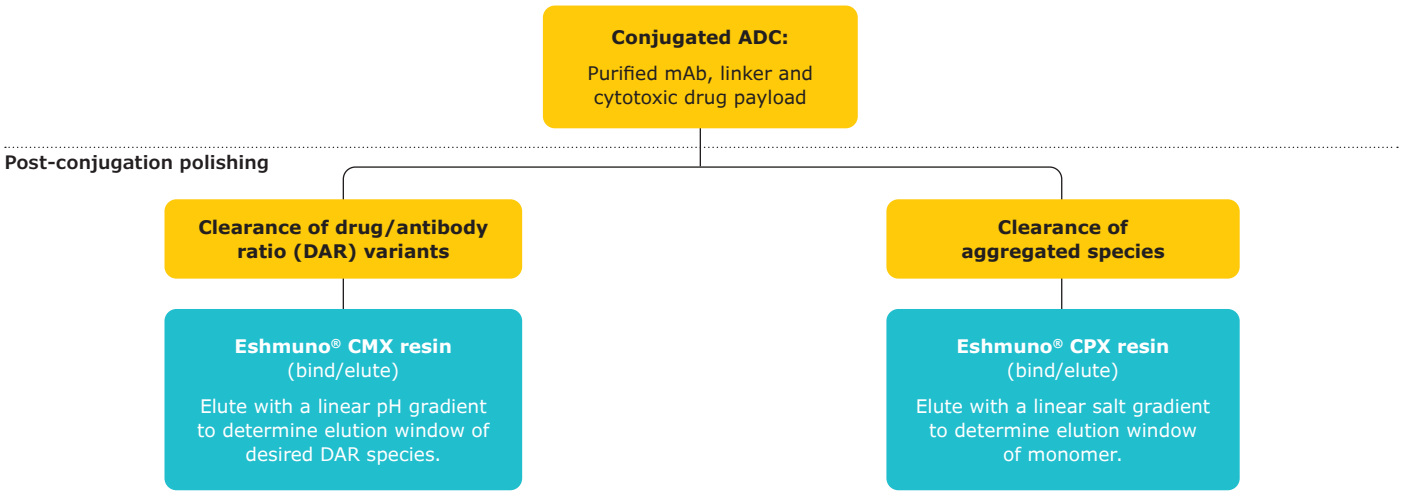
Reversed-Phase Chromatography Options

Resin	Particle size (µm)	Pore size (nm)	Functionality	Particle shape	CIP (0.1M NaOH)
PharmPrep® P Si 100 Resin	10 & 20	10	C8e, C18e	Spherical	10 cycles
LiChroprep® Resin	15–25, 25–40, 40–63	10	RP8, RP18	Irregular	No

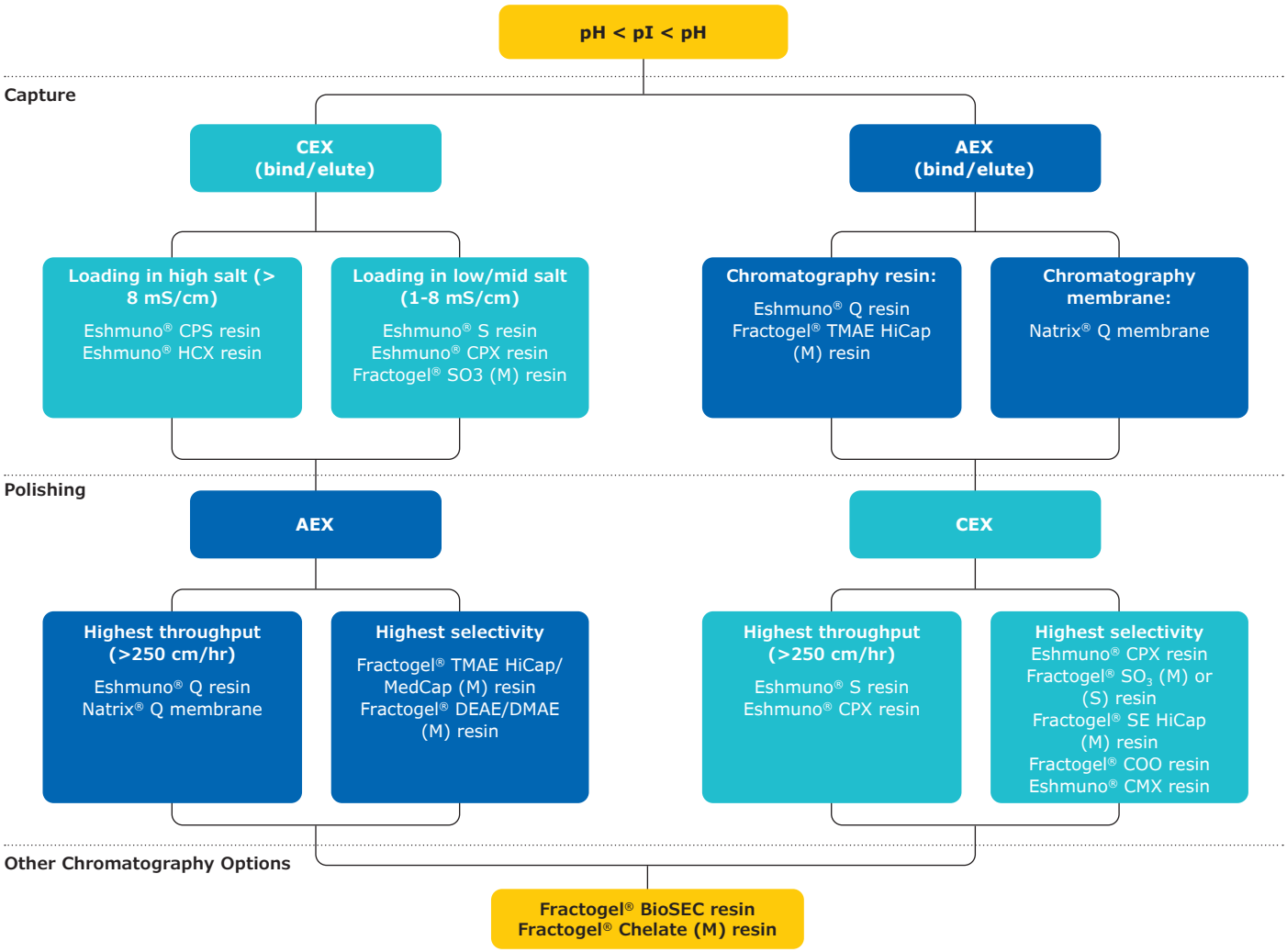
Antibody Purification Strategy



Antibody Drug Conjugate (ADC) Purification Strategy, Post-conjugation



Recombinant Protein and Antibody Fragment Purification Strategy



Plasma Protein Purification Strategy

The complexity of plasma proteins does not allow for templated purification

Molecule	Goal of chrom step	Type of resin	Option
Albumin	Removal of IgG, macroglobulin, trace proteins, albumin aggregates	Weak anion exchange Weak cation exchange Size exclusion	Fractogel® DEAE (M) resin Fractogel® COO (M) resin Fractogel® BioSEC resin
Alpha 1 Proteinase inhibitor (A1PI)	Removal of Albumin, IgG, Transferrin	Weak anion exchange	Fractogel® DEAE (M) resin
C1 inhibitor	Removal of impurities	Weak anion exchange Strong cation exchange	Fractogel® DMAE (M) resin Fractogel® SO_3 (M) resin
Fibrinogen	Removal of solvent/detergent and remaining Thrombin inhibitor	Weak anion exchange	Fractogel® DEAE (M) resin
FVIII	Removal of solvent/detergent agents	Anion exchange	Fractogel® TMAE (M) resin, Fractogel® DEAE (M) resin
	Separate FVIII-vWF from FVIII	Anion exchange	Fractogel® TMAE (M) resin, Fractogel® DEAE (M) resin
		Size exclusion	Fractogel® BioSEC resin
	Remove IgG and Albumin	Strong anion exchange	Eshmuno® Q resin
		Strong cation exchange	Eshmuno® S resin, Eshmuno® CPX resin, Fractogel® SO_3 resin
FIX	Purification of FII, FVII, FX	Weak anion exchange	Fractogel® DEAE (M) resin
FXI	Removal of impurities	Strong cation exchange	Eshmuno® CPX resin, Fractogel® SO_3 resin
IgG	Bind/elute capture; Removal of solvent/detergent agents	Anion or cation exchange	Eshmuno® Q resin, Fractogel® DEAE (M) resin, Eshmuno® CPX resin, Fractogel® SO_3 (M) resin, Fractogel® COO (M) resin
	Product flowthrough polishing of IgA, IgM, FXIa, other impurities	Strong anion exchange	Fractogel® TMAE (M) Load pH 5.7 – 6.3, low conductivity
	Anti-A and Anti-B clearance	Anti-A or Anti-B affinity	Eshmuno® P Anti-A/anti-B resin
	Polishing	Size exclusion	Fractogel® BioSEC resin
Thrombin	Removal of FIX, FX, solvent/detergent from inactivated prothrombin	Weak anion exchange IMAC (if HIS-tagged)	Fractogel® DEAE (M) resin Fractogel® Chelate resin
	Removal of trace proteins and/or inactivated prothrombin from thrombin	Strong cation exchange	Eshmuno® CPX resin, Fractogel® SO_3 resin

Virus or Viral Vector Purification Strategy

Mammalian cell lines	*S. cerivisiae*	Insect cells	*E. coli*
Centrifugation, cell lysis and/or clarifications	MF, cell lysis, MF/DF	Cell lysis, clarification	Cell lysis, centrifugation

Impurity profile, purification requirements, and product stability are highly process specific.

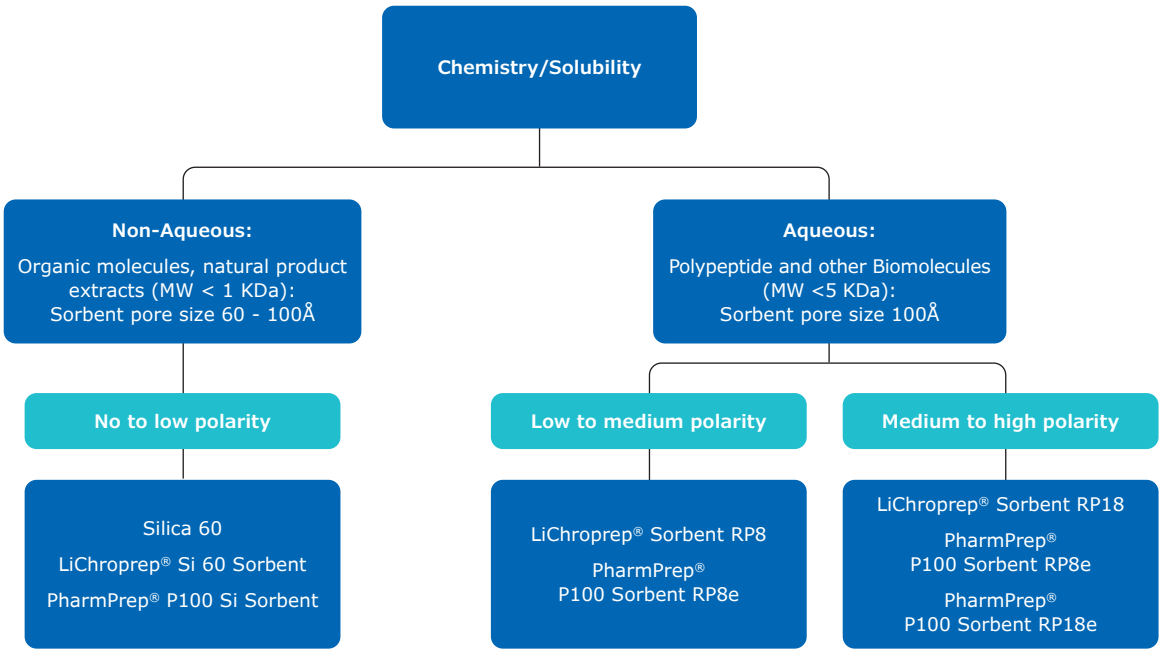
pH < pI < pH

CEX (bind/elute)		AEX (bind/elute)	
Highest throughput (>250 cm/hr) Eshmuno® S resin Eshmuno® CPX resin	**Highest selectivity** Eshmuno® CPX resin Fractogel® SO_3 (M) or (S) resin Fractogel® SE HiCap (M) resin Fractogel® COO resin	**Highest throughput (>250 cm/hr)** Eshmuno® Q resin Natrix® Q membrane	**Highest selectivity** Fractogel® TMAE (M) or (S) Fractogel® TMAE HiCap (M) Fractogel® DEAE/DMAE (M) resin

Plasmid DNA and Conjugated Polysaccharide Vaccine Purification Strategy

Plasmid DNA (pDNA) expressed in *E.Coli*	Conjugated polysaccharides expressed in bacteria
Alkaline cell lysis, clarification As pDNA product and impurities (RNA, endotoxin) are very negatively charged, the strength of interactions with AEX media are weakened by adding salt to the load material.	**Clarification, TFF, precipitation** No process template; highly molecule dependent. Bind/elute AEX chromatography useful to clear DNA and other impurities.
AEX (bind/elute) Fractogel® DEAE (M) / DMAE (M) resin Eshmuno® Q resin Natrix® Q membrane Supplement pDNA lysate with 0.12 - 0.25 M NaCl. Elution with up to 1.5M NaCl (depending on pDNA size).	**AEX (bind/elute)** Fractogel® DEAE (M) /DMAE (M) resin Fractogel® TMAE (M) / TMAE HiCap (M) resin Eshmuno® Q resin Natrix® Q membrane Load pH 8.0 potassium phosphate buffer. Wash 140mM NaCl. Elute 200mM NaCl.

Small Molecule Purification Strategy



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