

BIOshell™ U/HPLC Columns with Fused-Core® Technology

**Faster Separation of Proteins,
Peptides, and Glycans**

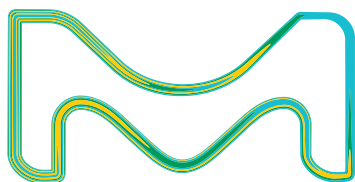


Table of Content

BIOshell™ Portfolio Overview.....	3
BIOshell™ IgG 1000 Å.....	4
BIOshell™ A400 Protein.....	7
BIOshell™ A160 Peptide.....	9
BIOshell™ Glycan.....	12
BIOshell™ Guard Columns.....	14
BIOshell™ Column Part Numbers.....	15

BIOshell™ Glycan, Peptide, Protein, and IgG U/HPLC Columns

As the pharmaceutical and biotechnology industries continuously evolve into the development of “large molecule” biotherapeutics to treat a myriad of diseases, both fast and high-resolution separations are required in order to resolve the numerous structural variants that exist in these complex samples.

The BIOshell™ line of superficially porous particle (SPP) packed columns has been developed to aid research into understanding the subtleties of the molecule that is being developed. Highlighted Applications for these columns include:

- Top-down analysis of intact proteins, monoclonal antibodies (mAbs), antibody-drug conjugates (ADCs), and other large biomolecules.
- Bottom-up analysis (peptide mapping) of proteins for primary structure confirmation
- Middle-up analysis of mAb fragments (light and heavy chains)
- High resolution separation of released N- and O-linked glycans.

The BIOshell™ line of columns is comprised of the following

IgG	Protein	Peptide	Glycan
<ul style="list-style-type: none"> • Largest pore diameter in the portfolio allowing for unrestricted access of proteins and other large molecules. • Compatible for UHPLC, HPLC, and mass spectrometry (MS). • C4, C18, and Diphenyl phase chemistries provide different selectivities. 	<ul style="list-style-type: none"> • Fast separations of biomolecules due to a more shallow shell. • Temperature stable up to 90 °C enabling high efficiency separations perfect for UHPLC, HPLC, and LC-MS assays. • C4 and C18 chemistries provide different selectivities for hydrophobic and hydrophilic proteins. 	<ul style="list-style-type: none"> • Wide range of particle sizes for both high efficiency separations and high throughput. • Peak capacities of columns capable of resolving complex peptide mixtures. • Extensive portfolio of column chemistries. 	<ul style="list-style-type: none"> • Improved retention of polar compounds and zwitterions as compared to bare silica. • Resolution of peaks unaffected by slight changes in buffer concentration. • Capable of resolving complex mixtures of glycans (isobaric glycans with different linkages).

Guide for Pore Size Selection

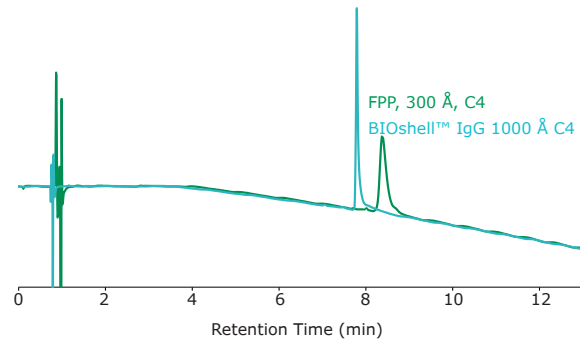
Molecule Size	Pore Size (Å)	Application	Particle Sizes (µm)
Small (< 20 kDa*)	90	Glycan	2.7
Medium (100 Da < MW < 15 kDa)	160	Peptide	2, 2.7, 5
Large (2 kDa < MW < 500 kDa)	400	Protein	3.4
Large (> 50 kDa)	1000	Protein	2.7

*for glycans, glycopeptides, and glycoproteins

Lower Pore Diameters Result in Broader Peaks and Decreased Sensitivity

column:	BIOshell™ IgG 1000 Å C4, 10 cm x 2.1 mm I.D., 2.7 µm µm; FPP 300 Å C4, 10 cm x 2.1 mm I.D., 1.7 µm
mobile phase:	[A] water (0.1% (v/v) difluoroacetic acid); [B] acetonitrile (0.1% (v/v) difluoroacetic acid)
gradient:	Hold at 22% B for 2 min; 22% B to 52% B in 15 min
flow rate:	0.3 mL/min
column temp.:	75 °C
detector:	UV, 215 nm
injection:	5 µL
sample:	IgG4, 100 µg/mL, water

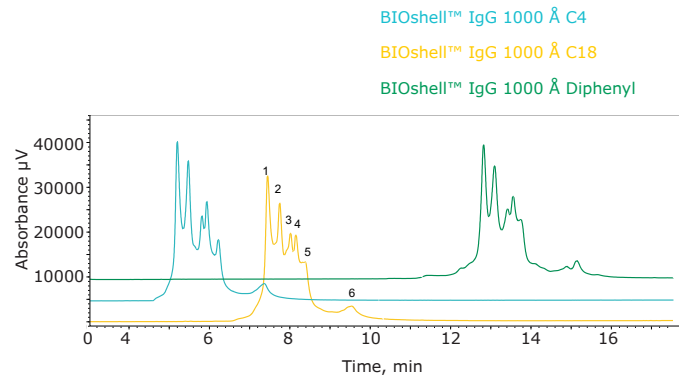
The large pores of the BIOshell™ IgG 1000 Å C4 column allows improved access to the stationary phase resulting in narrower peaks.



Effect of Phase Chemistry on Protein Selectivity

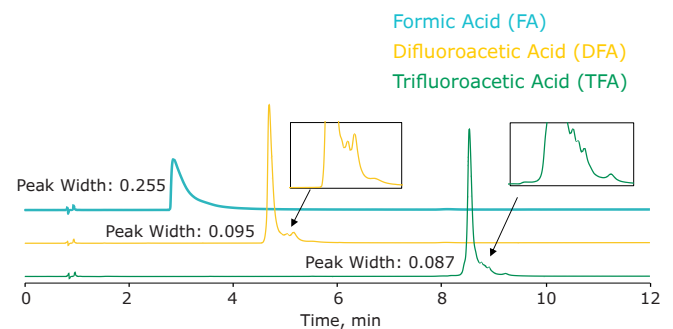
column:	BIOshell™ IgG 1000 Å C4, 15 cm x 2.1 mm I.D., 2.7 µm; BIOshell™ IgG 1000 Å C18, 15 cm x 2.1 mm I.D., 2.7 µm; BIOshell™ IgG 1000 Å Diphenyl, 15 cm x 2.1 mm I.D., 2.7 µm
mobile phase:	[A] 2:10:88 n-propanol/acetonitrile/water (0.1% v/v difluoroacetic acid); [B] 70:20:10 n-propanol/acetonitrile/water (0.1% v/v difluoroacetic acid)
gradient:	16% B to 26% B in 20 min
flow rate:	0.2 mL/min
column temp.:	80 °C
detector:	UV, 280 nm
injection:	2 µL
sample:	Denosumab, 2 mg/mL, water (0.1% v/v trifluoroacetic acid)

Monoclonal antibodies are unique molecules and therefore can interact differently with different phase chemistries. The numbered peaks correspond to IgG2 disulfide bond variants.



Choice of Ion-Pairing Reagent Is Crucial to Enhanced Resolution and Sensitivity

column:	BIOshell™ IgG 1000 Å C4, 15 cm x 2.1 mm I.D., 2.7 µm
mobile phase:	[A] Water (0.1% v/v formic acid, difluoroacetic acid, or trifluoroacetic acid, as indicated) [B] 20:80 Water:Acetonitrile (0.1% v/v formic acid, difluoroacetic acid, or trifluoroacetic acid, as indicated)
gradient:	35% B to 47.5% B in 12 min
flow rate:	0.4 mL/min
column temp.:	80 °C
detector:	UV, 280 nm
injection:	2 µL
sample:	Trastuzumab, varied concentration, 70:30 Water:Acetonitrile

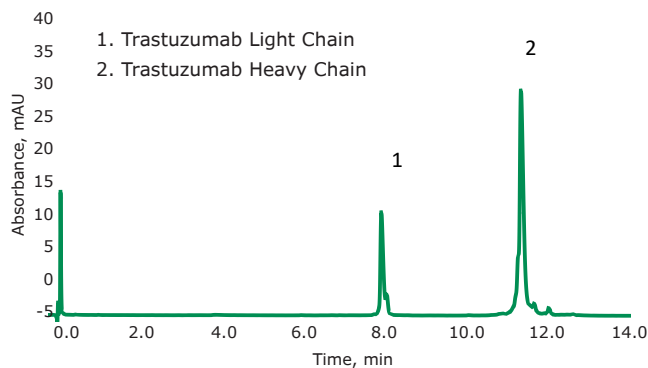


Choosing the right ion-pairing reagent can lead to better resolution of structural variants of mAbs and other proteins as well as better sensitivity.

Optimized Middle-Up Analysis of Reduced IgG1 Using the BIOshell™ IgG 1000 Å Diphenyl Column

column:	BIOshell™ IgG 1000 Å Diphenyl, 15 cm x 2.1 mm I.D., 2.7 μm
mobile phase:	[A] Water (0.1% v/v TFA); [B] Acetonitrile (0.1% v/v TFA)
gradient:	30% B to 40% B in 14.0 min
flow rate:	0.4 mL/min
column temp.:	80 °C
detector:	UV, 280 nm
injection:	2 μL
sample:	Reduced Trastuzumab, 400 μg/mL, water

The BIOshell™ IgG 1000 Å Diphenyl column allows for resolution of minor structural variants of the light and heavy chains of mAbs.

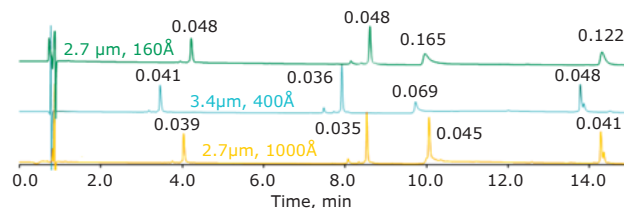


Pore Size Mismatch Can Lead to Significant Losses in Efficiency

column:	BIOshell™ A160 Peptide C18, 15 cm x 2.1 mm I.D., 2.7 μm; BIOshell™ A400 Protein C18, 15 cm x 2.1 mm I.D., 3.4 μm; BIOshell™ IgG 1000 Å C18, 15 cm x 2.1 mm I.D., 2.7 μm;
mobile phase:	[A] Water (0.1% v/v trifluoroacetic acid); [B] 20:80 Water:Acetonitrile (0.085% v/v trifluoroacetic acid)
gradient:	27% B to 60% B in 15 min
flow rate:	0.4 mL/min
column temp.:	60 °C
detector:	UV, 280 nm
injection:	4 μL
sample:	Proteins, varied concentration, water (0.1% v/v trifluoroacetic acid)

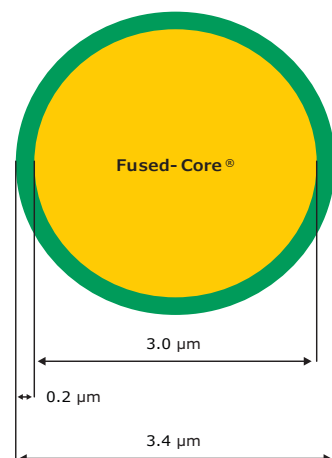
Higher efficiencies and better sensitivity can be realized with proper pore diameter selection. Here, the 1000 Å pore diameter is the only one capable of providing good peak of the mAb (peak 3) analyte.

1. Ribonuclease A (13.8 kDa)
2. Lysozyme (14.4 kDa)
3. SILu Lite SigmaMAb™ Antibody (~150 kDa)
4. Enolase (46.7 kDa)



BIOshell™ A400 Protein U/HPLC Columns: Minimizing Mass Transfer for Maximum Throughput

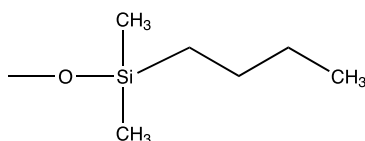
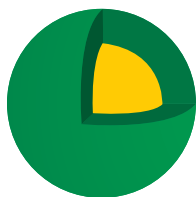
- A 0.2 µm-thick, porous shell with 400 Å pores leads to rapid and efficient separations of proteins.
- Superficially porous particles (SPPs) provide narrower peak widths and improved resolution for characterization of biomolecules in comparison to fully porous particles (FPPs).
- Ability to tolerate high temperature applications (up to 90 °C) in acidic mobile phases.



Applications	Features
<ul style="list-style-type: none"> • mAbs • ADCs • Biosimilars • Proteins • mAb Fragments 	<ul style="list-style-type: none"> • Temperature stable up to 90 °C • Compatible with UHPLC, HPLC, and MS • Resolution of large proteins with superior peak shape and efficiency as compared to separations on FPP-packed columns • Minimal to no LC-MS bleed

BIOshell™ A400 Protein Phase Chemistry Portfolio

BIOshell™ A400 Protein C4



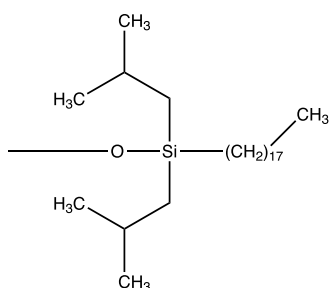
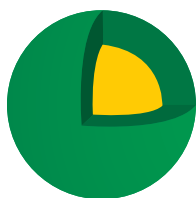
Ligand: Dimethylbutylsilane

USP Designation: L26

Available Particle Sizes: 3.4 µm

Pore Size: 400 Å

BIOshell™ A400 Protein C18



Ligand: Diisobutyloctadecylsilane

USP Designation: L1

Available Particle Sizes: 3.4 µm

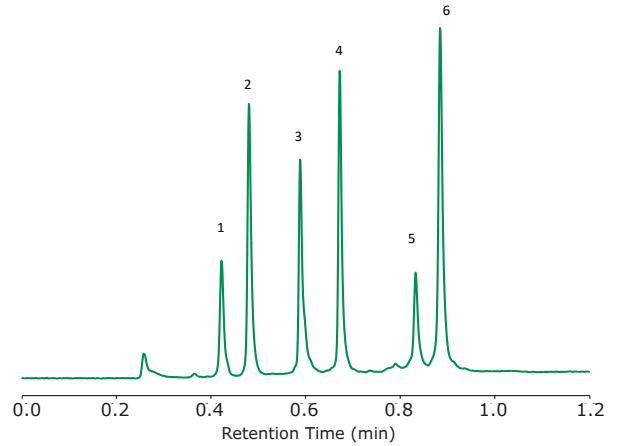
Pore Size: 400 Å

Rapid Protein Separations on BIOshell™ A400

column:	BIOshell™ A400 Protein C4, 5 cm x 2.1 mm I.D., 3.4 µm
mobile phase:	[A] 75:25 (0.1% TFA in water):(0.1% TFA in acetonitrile); [B] 25:75 (0.1% TFA in water):(0.1% TFA in acetonitrile)
gradient:	12 to 100% B in 1 min; held at 100% B for 1 min
flow rate:	0.4 mL/min
column temp.:	90 °C
detector:	UV, 215 nm
injection:	1 µL
sample:	Protein mix, varied concentration, water (0.1% TFA)

Due to the shallow, porous shell, protein separations can be performed in less than one minute with the BIOshell™ A400 column.

Peak Name	kDa (native)
1. lysozyme; chicken	14.3
2. haptoglobin, phenotype 1-1; human	96
3. glutamate dehydrogenase; bovine	332
4. β-galactosidase; <i>E. coli</i>	465
5. lactate dehydrogenase contaminant	
6. lactate dehydrogenase; rabbit	140

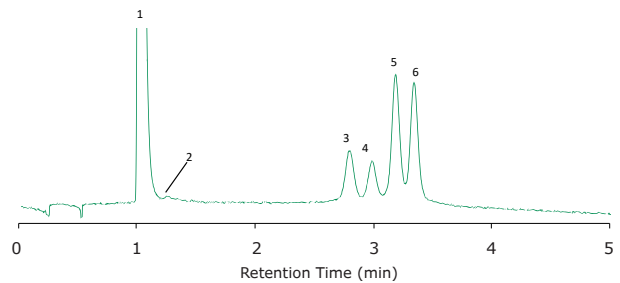


Protein Stability Can be Measured with BIOshell™ A400

column:	BIOshell™ A400 Protein C4, 10 cm x 2.1 mm I.D., 3.4 µm
mobile phase:	[A] 0.1% TFA in water; [B] 0.1% TFA in acetonitrile
gradient:	55 to 70% B in 5 min
flow rate:	0.2 mL/min
column temp.:	60 °C
detector:	UV, 215 nm
injection:	1 µL
sample:	Oxidized filgrastim, 98 µg/mL, 0.1% aqueous hydrogen peroxide

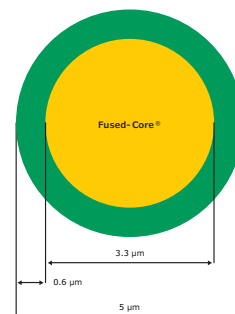
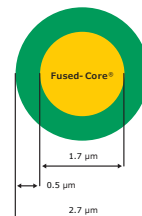
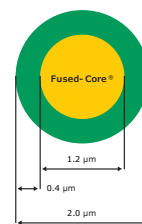
Proteins can be oxidized overtime if not stored properly. Oxidized proteins can lead to lower efficacy or toxicity. The BIOshell™ A400 Protein C4 resolved the oxidation products of Filgrastim in under five minutes..

- | | |
|-----------------------|-----------------------|
| 1. Hydrogen Peroxide | 4. Oxidized Product 3 |
| 2. Oxidized Product 1 | 5. Oxidized Product 4 |
| 3. Oxidized Product 2 | 6. Native Filgrastim |



BIOshell™ A160 Peptide U/HPLC Columns: High Resolution Peptide Separations

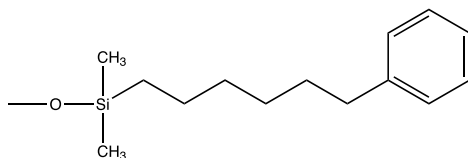
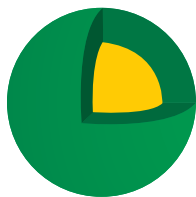
- BIOshell™ A160 Peptide U/HPLC columns offer a broad portfolio of particle sizes and phase chemistries to create a superior solution for fast and efficient separations of peptides up to 20 kDa.
- Higher resolutions and higher peak capacities of peptides at ~ 50% backpressure of sub-2 µm fully porous particles (FPP)-packed columns.
- Lower backpressure allows for columns to be used in series to maximize resolution and peak capacity of complex proteomic samples or tryptic digests.
- Compatible with all UHPLC and LC-MS instrumentation.



Applications	Features
<ul style="list-style-type: none"> • Tryptic Digests • Post-Translational Modifications (PTMs) • Polypeptides 	<ul style="list-style-type: none"> • Temperature stable up to 90 °C • pH stable from 1 – 8 • Fast separations • Enhanced resolution • High peak capacity

BIOshell™ A160 Peptide Phase Chemistry Portfolio

BIOshell™ A160 Peptide Phenyl-Hexyl



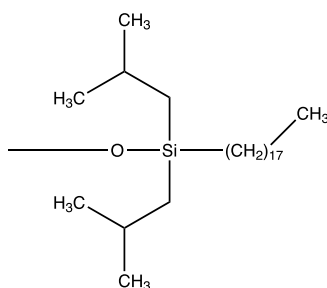
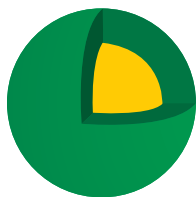
Ligand: Dimethylphenyl-hexylsilane

USP Designation: L11

Available Particle Sizes: 2.7 µm

Pore Size: 160 Å

BIOshell™ A160 Peptide C18



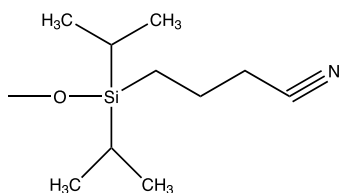
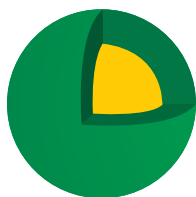
Ligand: Diisobutyloctadecylsilane

USP Designation: L1

Available Particle Sizes: 2.0, 2.7, 5.0 µm

Pore Size: 160 Å

BIOshell™ A160 Peptide Cyano



Ligand: Diisopropylcyanopropylsilane

USP Designation: L10

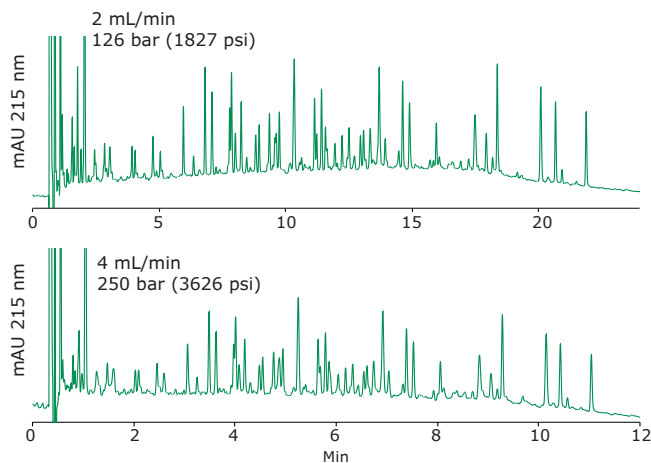
Available Particle Sizes: 2.7, 5.0 µm

Pore Size: 160 Å

Rapid Tryptic Digest Analysis Using BIOshell™ A160 Peptide C18

column:	BIOshell™ A160 Peptide C18, 15 cm x 4.6 mm I.D., 5.0 µm
mobile phase:	[A] Water (0.1% TFA); [B] Acetonitrile (0.1% TFA)
gradient:	As indicated
flow rate:	As indicated
column temp.:	60 °C
detector:	UV, 215 nm
injection:	15 µL
sample:	Tryptic digest, 1 mg/mL, water (0.1% TFA)

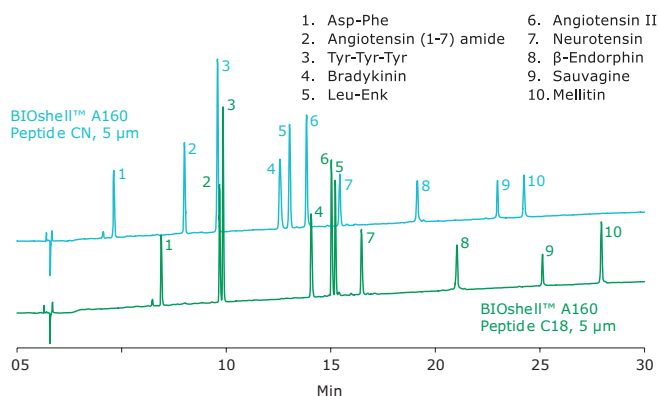
BIOshell™ A160 Peptide columns can more than double sample throughput by allowing the analyst to operate at higher flow rates without a concomitant drop in efficiency.



Different Phase Chemistries Allows for Alternative Selectivity for Peptides

columns:	As indicated, 15 cm x 4.6 mm I.D., 5.0 µm
mobile phase:	[A] Water (0.1% TFA); [B] Acetonitrile (0.1% TFA)
gradient:	5% B to 50% B in 30 min
flow rate:	1.0 mL/min
temp:	40°C
detector:	UV, 215 nm
injection vol:	10 µL
sample:	Proteins, 10 µg/mL, water (0.1% TFA)

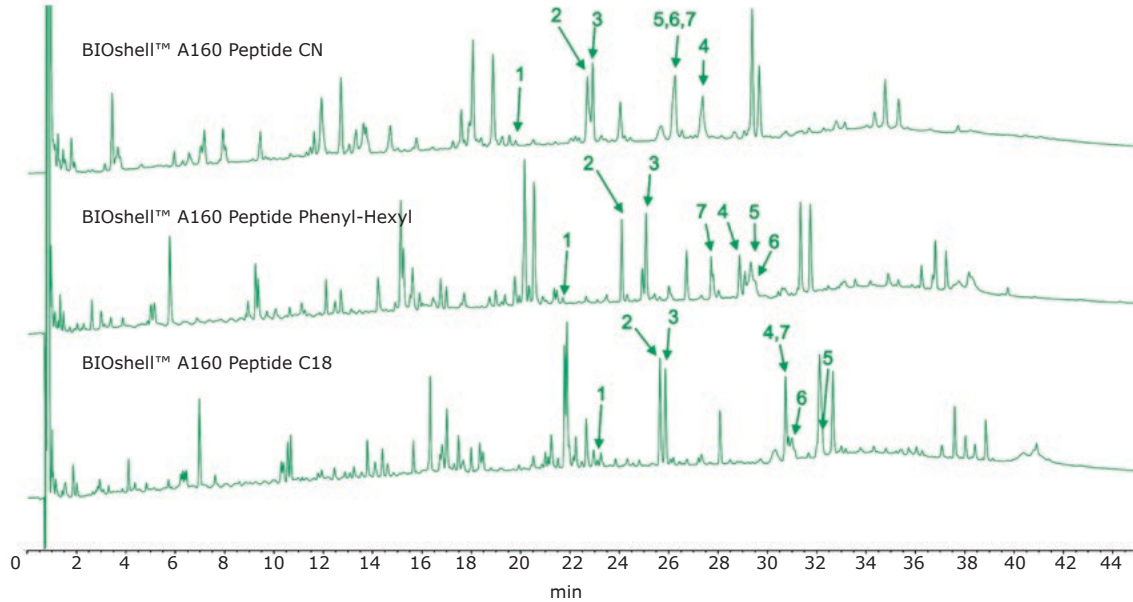
Using phase chemistries that interact with peptides using unique retention mechanisms can lead to different selectivity.



Different Phase Chemistries Allows for Alternative Selectivity for Peptides

Compound (amino acid sequence)

- | | |
|---------------------------|-------------------------------|
| 1. FTISADTSKNTAYLQMNSLR | 5. SGTASVVCLLNIFYPR |
| 2. LSCAASGFNIKDTYIHWVR | 6. SCDKTHTCPPELLGGPSVFLFPPKPK |
| 3. GFYPSDIAVEWESNGQPENNYK | 7. VVSVLTVLHQDWLNGKEYK |
| 4. LLIYSASFLYSGVPSR | |



column:	BIOshell™ A160 Peptide CN, 10 cm x 2.1 mm I.D., 2.7 µm; BIOshell™ A160 Peptide Phenyl-Hexyl, 10 cm x 2.1 mm I.D., 2.7 µm; BIOshell™ A160 Peptide C18, 10 cm x 2.1 mm I.D., 2.7 µm
mobile phase:	[A] 10 mM Difluoroacetic acid in water [B] 10 mM Difluoroacetic acid in acetonitrile
gradient:	2% B to 50% B in 60 min
flow rate:	0.3 mL/min
column temp.:	60 °C
detector:	MSD, ESI-(+3.5 kV)
injection:	5 µL of 0.2 mg/mL digest
sample:	Tryptic peptides, varied concentration, in 50 mM Tris-HCl/1.5 M Guanidine-HCl with 0.25% formic acid

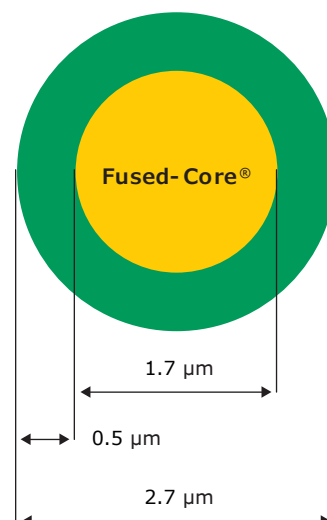
Better sequence coverage, through better resolution of critical pairs, can be achieved by using phase chemistries orthogonal to C18.

BIOshell™ Glycan U/HPLC Columns: High Resolution Glycan Separations

- BIOshell™ Glycan U/HPLC columns consist of a proprietary, pentahydroxy chemistry tethered to a 2.7 µm, 90 Å superficially porous particle (SPP).
- Appropriate for USP L95 methods.
- Main application is for the resolution of oligosaccharides (released and labeled glycans) via hydrophilic interaction liquid chromatography (HILIC).
- Increased retention of acidic and zwitterionic analytes than bare silica columns.
- Each lot of BIOshell™ Glycan particles is tested for quality control by separation of a series of labeled glycans having 2 – 25 glucose units (GU).

BIOshell™ Glycan Specifications

Silica	Type B (High purity silica)
Particle Platform	Superficially porous particles (SPP)
Phase Chemistry	Penta-hydroxy
Particle Size	2.7 µm
Pore Size	90 Å
Carbon Load	3.2%
Surface Area	135 m ² /g
pH Range	2-9
Max Temperature at Low pH	65 °C
Max Temperature at High pH	40 °C
Endcapped	No



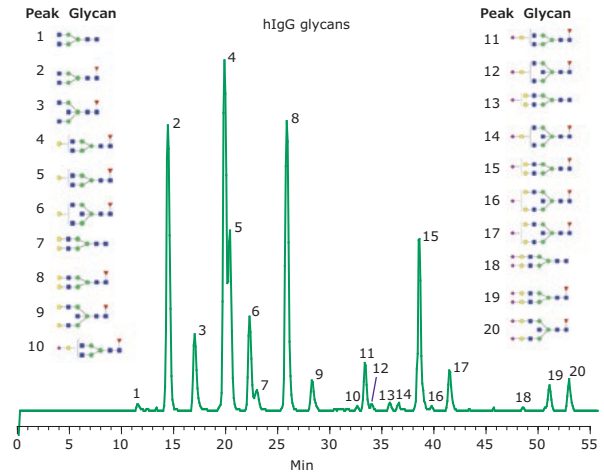
Did you know?

A cyano (CN) and a pentafluorophenyl (F5) column can also be used in HILIC mode. Check out the Ascentis® Express CN and F5 columns for orthogonal selectivities to the BIOshell™ Glycan column.

HPLC Analysis of Procainamide-Labeled Human IgG Glycans on BIOshell™ Glycan using HILIC-FLR

column:	BIOshell™ Glycan, 15 cm x 2.1 mm I.D., 2.7 μm
mobile phase:	[A] 50 mM ammonium formate, pH 4.4 (50 mM ammonium hydroxide, adjusted to pH 4.4 with formic acid); [B] acetonitrile
gradient:	75% B to 59% B in 75 min
flow rate:	0.3 mL/min
temp:	60 °C
detector:	FLR, ex 308 nm, em 359 nm
injection vol:	10 μL
sample:	Released human IgG glycans

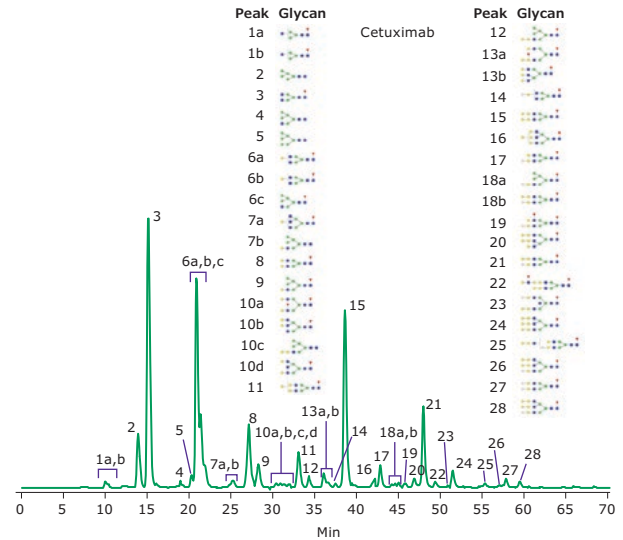
Excellent resolution and peak shape of released glycans.



HPLC Analysis of Procainamide-Labeled Cetuximab Glycans on BIOshell™ Glycan using HILIC-FLR

column:	BIOshell™ Glycan, 15 cm x 2.1 mm I.D., 2.7 μm
mobile phase:	[A] 50 mM ammonium formate, pH 4.4 (50 mM ammonium hydroxide, adjusted to pH 4.4 with formic acid); [B] acetonitrile
gradient:	75% B to 59% B in 75 min
flow rate:	0.3 mL/min
temp:	60 °C
detector:	FLR, ex 308 nm, em 359 nm
injection vol:	10 μL
sample:	Cetuximab

The BIOshell™ Glycan column is able to elucidate the complex glycosylation of this biotherapeutic, allowing a better understanding of the drug's efficacy.



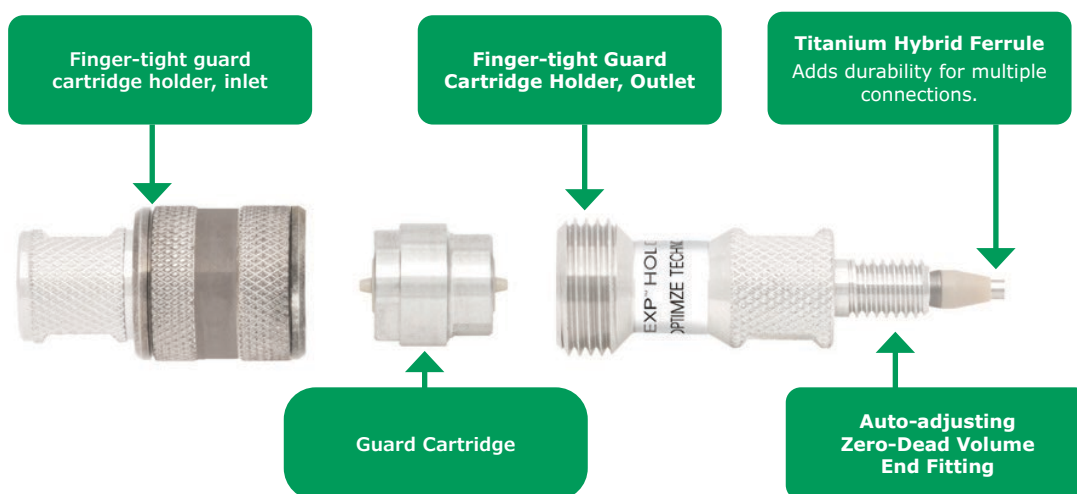
BIOshell™ U/HPLC Guard Columns

- Prevent strongly retained compounds from entering the column and leading to column fouling.
- Ultra-low to no dispersion, easy to install and operate, and can tolerate backpressures up to 1000 bar.
- Finger-tight, direct-connect units that auto-adjust to any column with a 10-32 inlet port.
- The guard cartridge can be removed from and exchanged for a new one without removing guard holder from the flow path.
- Guard columns available for all BIOshell™ analytical geometries (2.1, 3.0, and 4.6 mm I.D.,) and phase chemistries.

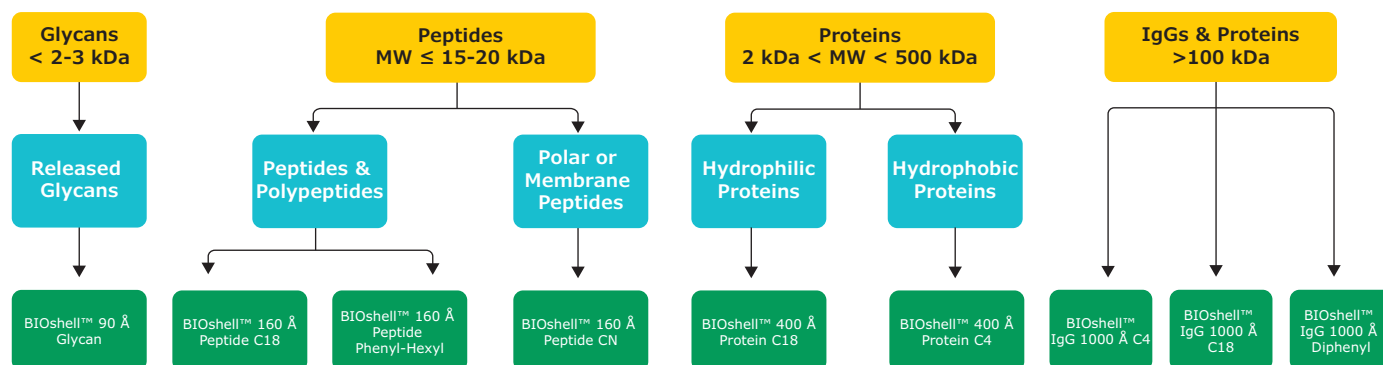
Did you know?

We have HPLC columns for all modes of chromatography for analyzing biomacromolecules.

Please visit [SigmaAldrich.com/bio-hplc](https://www.sigmaaldrich.com/bio-hplc) for a complete overview of the bio-HPLC portfolio and for technical literature pertaining to biomacromolecule separations.



Column Selection Guide for Biomolecule Separations



BIOshell™ IgG 1000 Å U/HPLC Columns

Dimensions Length (cm) x I.D. (mm)	C ₄	C ₁₈	Diphenyl
5 x 0.075	**	**	**
100 x 0.075	**	**	**
150 x 0.075	**	**	**
5 x 0.1	**	**	**
100 x 0.1	**	**	**
150 x 0.1	**	**	**
5 x 0.2	**	**	**
10 x 0.2	**	**	**
150 x 0.2	**	**	**
5 x 0.3	63336-U	581367-U	577436-U
10 x 0.3	**	**	**
15 x 0.3	63335-U	581366-U	577435-U
5 x 0.5	63338-U	581381-U	577438-U
10 x 0.5	**	**	**
15 x 0.5	63337-U	581380-U	577437-U
3 x 1.0	**	**	**
5 x 1.0	63340-U	581383-U	577440-U
7.5 x 1.0	**	**	**
10 x 1.0	**	**	**
15 x 1.0	63339-U	581382-U	577439-U
5 x 1.5	581385-U	**	577451-U
15 x 1.5	581384-U	**	577450-U
2 x 2.1	63281-U	**	**
3 x 2.1	63282-U	**	**
5 x 2.1	63283-U	581362-U	577419-U
7.5 x 2.1	63284-U	**	**
10 x 2.1	63288-U	582701-U	577420-U
15 x 2.1	63289-U	582703-U	577421-U
25 x 2.1	**	582704-U	577422-U
2 x 3.0	63306-U	**	**
3 x 3.0	63307-U	582705-U	577423-U
5 x 3.0	63308-U	582706-U	577424-U
7.5 x 3.0	63311-U	**	**
10 x 3.0	63313-U	582707-U	577425-U
15 x 3.0	63314-U	582708-U	577426-U
25 x 3.0	**	**	**
2 x 4.6	63322-U	**	**
3 x 4.6	63324-U	582709-U	577427-U
5 x 4.6	63325-U	582710-U	577428-U
7.5 x 4.6	63327-U	**	**
10 x 4.6	63328-U	582713-U	577429-U
15 x 4.6	63329-U	581348-U	577430-U
25 x 4.6	**	582715-U	577434-U

Guard Columns, Three Pack

0.5 x 2.1	63291-U	581349-U	577431-U
0.5 x 3.0	63315-U	581360-U	577432-U
0.5 x 4.6	63334-U	581361-U	577433-U
Guard Column Holder:	66841-U		

For geometries marked **, please contact technical service for custom quote options.

Dimensions Length (cm) x I.D. (mm)	BIOshell™ Glycan
5 x 2.1	50991-U
10 x 2.1	50993-U
15 x 2.1	50994-U
5 x 4.6	50997-U
10 x 4.6	50998-U
15 x 4.6	50999-U

Guard Columns, Three Pack

0.5 x 2.1	**
0.5 x 4.6	**
Guard Column Holder:	66841-U

BIOshell™ A400 Protein U/HPLC Columns

Dimensions Length (cm) x I.D. (mm)	C ₄	C ₁₈
5 x 0.075	**	**
100 x 0.075	**	**
150 x 0.075	**	**
5 x 0.1	**	**
100 x 0.1	**	**
150 x 0.1	**	**
5 x 0.2	**	**
10 x 0.2	**	**
150 x 0.2	67037-U	**
5 x 0.3	67038-U	67496-U
10 x 0.3	**	**
15 x 0.3	67039-U	**
5 x 0.5	**	**
10 x 0.5	**	**
15 x 0.5	67041-U	**
3 x 1.0	**	**
5 x 1.0	**	**
7.5 x 1.0	**	**
10 x 1.0	**	**
15 x 1.0	67045-U	**
2 x 2.1	**	67457-U
3 x 2.1	**	67458-U
5 x 2.1	66824-U	67459-U
7.5 x 2.1	**	67462-U
10 x 2.1	66825-U	67463-U
15 x 2.1	66826-U	67469-U
25 x 2.1	**	**
2 x 3.0	**	67471-U
3 x 3.0	**	67472-U
5 x 3.0	**	67473-U
7.5 x 3.0	**	67474-U
10 x 3.0	**	67475-U
15 x 3.0	**	67477-U
25 x 3.0	**	**
2 x 4.6	**	67478-U
3 x 4.6	**	67482-U
5 x 4.6	66827-U	67483-U
7.5 x 4.6	**	67485-U
10 x 4.6	66828-U	67487-U
15 x 4.6	66829-U	67488-U
25 x 4.6	**	**

Guard Columns, Three Pack

0.5 x 2.1	66830-U	67505-U
0.5 x 3.0	**	67506-U
0.5 x 4.6	66831-U	67508-U
Guard Column Holder:	66841-U	

BIOshell™ A160 Peptide U/HPLC Columns

	160 Å, 2.0 µm		160 Å, 2.7 µm		160 Å, 5.0 µm	
Dimensions Length (cm) x I.D. (mm)	C18	C18	CN	Phenyl-Hexyl	C18	CN
5 x 0.075	**	**	**	**	**	**
100 x 0.075	**	**	**	**	**	**
150 x 0.075	**	**	**	**	**	**
5 x 0.1	**	**	**	**	**	**
100 x 0.1	**	**	**	**	**	**
150 x 0.1	**	**	**	**	**	**
5 x 0.2	**	**	**	**	**	**
10 x 0.2	**	**	**	**	**	**
150 x 0.2	**	**	**	**	**	**
5 x 0.3	**	**	67159-U	577546-U	**	**
10 x 0.3	**	**	**	**	**	**
15 x 0.3	**	67093-U	67160-U	577545-U	**	**
5 x 0.5	**	**	67161-U	577548-U	**	**
10 x 0.5	**	67096-U	**	**	**	**
15 x 0.5	**	67097-U	67163-U	577547-U	**	**
3 x 1.0	**	**	**	**	**	**
5 x 1.0	**	**	67164-U	577550-U	**	**
7.5 x 1.0	**	**	**	**	**	**
10 x 1.0	**	**	**	**	**	**
15 x 1.0	**	67099-U	67165-U	577549-U	**	**
5 x 1.5	67284-U	66923-U	**	**	**	**
15 x 1.5	67283-U	66922-U	**	**	**	**
2 x 2.1	67234-U	**	**	577523-U	**	**
3 x 2.1	67238-U	66901-U	66965-U	577524-U	67001-U	67061-U
5 x 2.1	67239-U	66902-U	66966-U	577525-U	67002-U	67062-U
7.5 x 2.1	67241-U	66903-U	66967-U	577526-U	67003-U	67063-U
10 x 2.1	67242-U	66904-U	66968-U	577527-U	67004-U	67064-U
15 x 2.1	67243-U	66905-U	66969-U	577528-U	67006-U	67065-U
25 x 2.1	**	**	**	**	**	**
2 x 3.0	67257-U	**	**	577529-U	**	**
3 x 3.0	67263-U	66906-U	66970-U	577530-U	67007-U	67066-U
5 x 3.0	67267-U	66907-U	66971-U	577531-U	67008-U	67067-U
7.5 x 3.0	67274-U	**	**	577532-U	**	**
10 x 3.0	67275-U	66908-U	66972-U	577533-U	67011-U	67068-U
15 x 3.0	67277-U	66909-U	66973-U	577534-U	67012-U	67069-U
25 x 3.0	**	**	**	**	**	**
2 x 4.6	**	**	**	577535-U	**	**
3 x 4.6	**	**	**	577536-U	**	**
5 x 4.6	**	66913-U	66974-U	577537-U	67013-U	67071-U
7.5 x 4.6	**	**	**	577538-U	**	**
10 x 4.6	**	66915-U	66975-U	577539-U	67014-U	67080-U
15 x 4.6	**	**	66976-U	577540-U	67015-U	67081-U
25 x 4.6	**	**	**	577544-U	**	**
Guard Columns, Three Pack						
0.5 x 2.1	67281-U	66918-U	66977-U	577541-U	67016-U	67082-U
0.5 x 3.0	67282-U	66919-U	66978-U	577542-U	67017-U	67083-U
0.5 x 4.6	**	66921-U	66979-U	577543-U	67018-U	67084-U
Guard Column Holder:	66841-U					

To place an order or receive technical assistance

Order/Customer Service: [SigmaAldrich.com/order](https://www.sigmaaldrich.com/order)
 Technical Service: [SigmaAldrich.com/techservice](https://www.sigmaaldrich.com/techservice)
 Safety-related Information: [SigmaAldrich.com/safetycenter](https://www.sigmaaldrich.com/safetycenter)

[SigmaAldrich.com/bioshell](https://www.sigmaaldrich.com/bioshell)

We have built a unique collection of life science brands with unrivalled experience in supporting your scientific advancements.

Millipore® Sigma-Aldrich® Supelco® Milli-Q® SAFC® BioReliance®

© 2023 Merck KGaA, Darmstadt, Germany and/or its affiliates. All Rights Reserved. MilliporeSigma, the vibrant M, BioReliance, Millipore, Milli-Q, SAFC, Sigma-Aldrich, Supelco, BIOshell, SigmaMAB, and SILu are trademarks of Merck KGaA, Darmstadt, Germany or its affiliates. All other trademarks are the property of their respective owners. Detailed information on trademarks is available via publicly accessible resources.

MilliporeSigma
400 Summit Drive
Burlington, MA 01803

