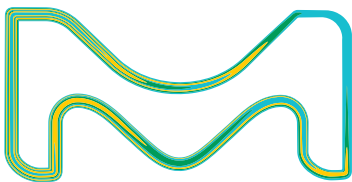


# **BIOshell™ U/HPLC Columns with Fused-Core® Technology**

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



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

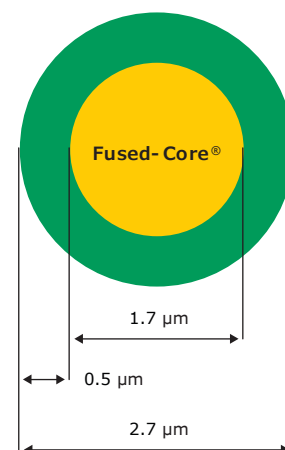
## Guide for Pore Size Selection

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

## BIOshell™ IgG 1000 Å U/HPLC Columns: Maximizing Pore Diameter to Minimize Size Exclusion

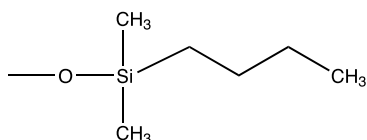
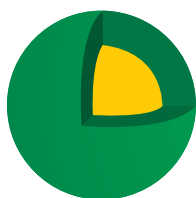
- A 1000 Å pore diameter allows unrestricted access of large biomolecules into the particles.
- Superficially porous particles (SPPs) provide narrower peak widths and improved resolution for characterization of biomolecules in comparison to fully porous particles (FPPs).
- Post-translational modifications (PTMs) of expressed proteins can lead to subtle differences in molecular structure and function of the protein. These minor variants can be resolved with BIOshell™ IgG 1000 Å columns.



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

## BIOshell™ IgG 1000 Å Phase Chemistry Portfolio

### BIOshell™ IgG 1000 Å C4



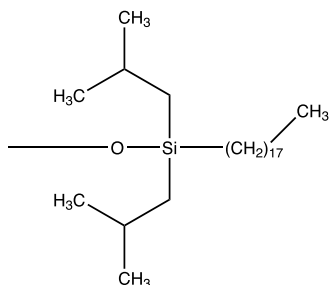
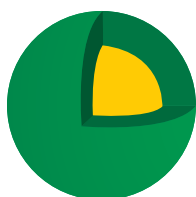
**Ligand:** Dimethylbutylsilane

**USP Designation:** L26

**Available Particle Sizes:** 2.7 µm

**Pore Size:** 1000 Å

### BIOshell™ IgG 1000 Å C18



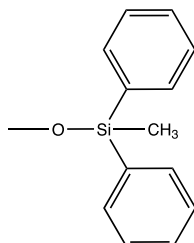
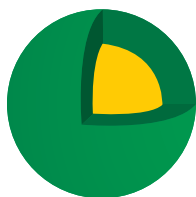
**Ligand:** Diisobutyloctadecylsilane

**USP Designation:** L1

**Available Particle Sizes:** 2.7 µm

**Pore Size:** 1000 Å

### BIOshell™ IgG 1000 Å Diphenyl



**Ligand:** Diphenylmethylsilane

**USP Designation:** L11

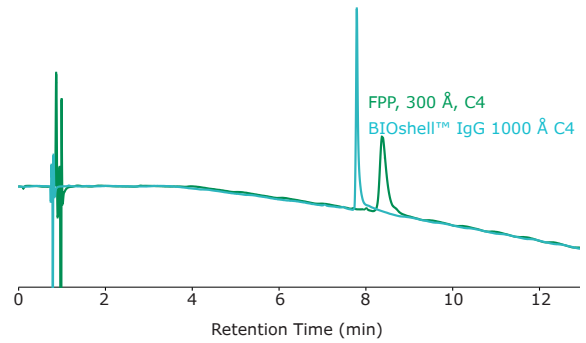
**Available Particle Sizes:** 2.7 µm

**Pore Size:** 1000 Å

### Lower Pore Diameters Result in Broader Peaks and Decreased Sensitivity

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

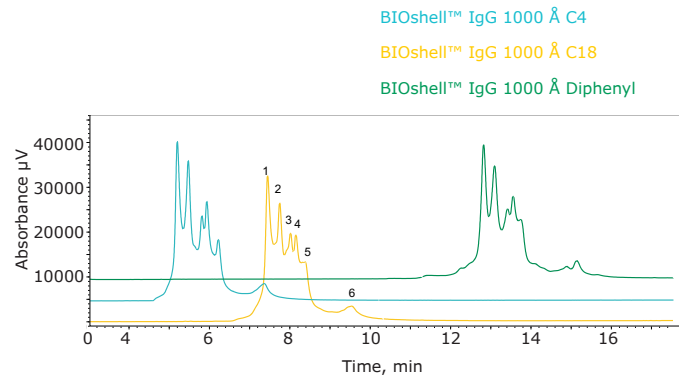
The large pores of the BIOshell™ IgG 1000 Å C4 column allows improved access to the stationary phase resulting in narrower peaks.



### Effect of Phase Chemistry on Protein Selectivity

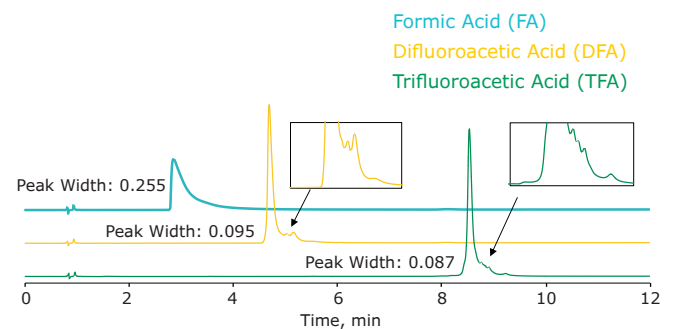
<b>column:</b>	BIOshell™ IgG 1000 Å C4, 15 cm x 2.1 mm I.D., 2.7 μm; BIOshell™ IgG 1000 Å C18, 15 cm x 2.1 mm I.D., 2.7 μm; BIOshell™ IgG 1000 Å Diphenyl, 15 cm x 2.1 mm I.D., 2.7 μm
<b>mobile phase:</b>	[A] 2:10:88 n-propanol/acetonitrile/water (0.1% v/v difluoroacetic acid); [B] 70:20:10 n-propanol/acetonitrile/water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

<b>column:</b>	BIOshell™ IgG 1000 Å C4, 15 cm x 2.1 mm I.D., 2.7 μm
<b>mobile phase:</b>	[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)
<b>gradient:</b>	35% B to 47.5% B in 12 min
<b>flow rate:</b>	0.4 mL/min
<b>column temp.:</b>	80 °C
<b>detector:</b>	UV, 280 nm
<b>injection:</b>	2 μL
<b>sample:</b>	Trastuzumab, varied concentration, 70:30 Water:Acetonitrile

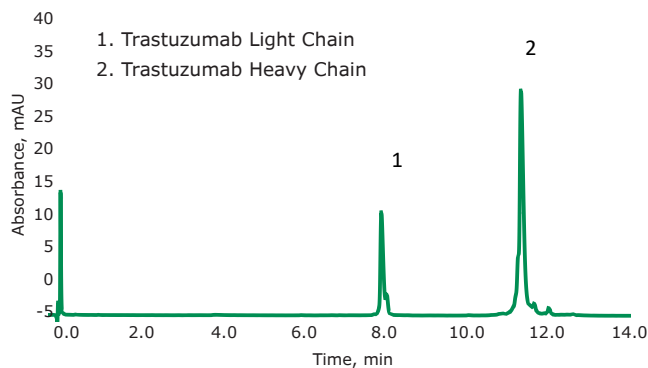


Choosing the right ion-pairing reagent can lead to better resolution of structural variants of mAbs and other proteins as well as better sensitivity.

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

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

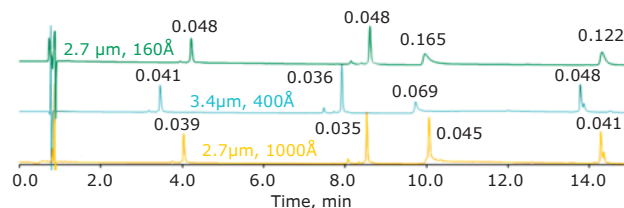


### Pore Size Mismatch Can Lead to Significant Losses in Efficiency

<b>column:</b>	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;
<b>mobile phase:</b>	[A] Water (0.1% v/v trifluoroacetic acid); [B] 20:80 Water:Acetonitrile (0.085% v/v trifluoroacetic acid)
<b>gradient:</b>	27% B to 60% B in 15 min
<b>flow rate:</b>	0.4 mL/min
<b>column temp.:</b>	60 °C
<b>detector:</b>	UV, 280 nm
<b>injection:</b>	4 µL
<b>sample:</b>	Proteins, varied concentration, water (0.1% v/v trifluoroacetic acid)

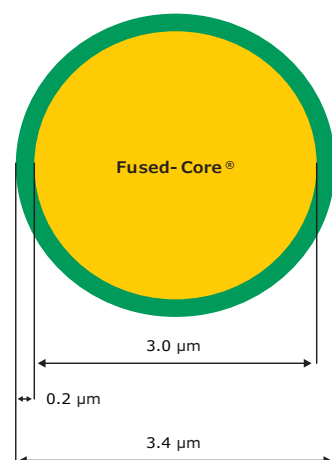
Higher efficiencies and better sensitivity can be realized with proper pore diameter selection. Here, the 1000 Å pore diameter is the only one capable of providing good peak of the mAb (peak 3) analyte.

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

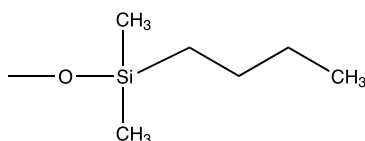
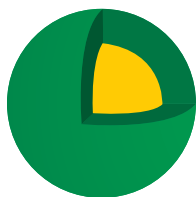
- A 0.2 µm-thick, porous shell with 400 Å pores leads to rapid and efficient separations of proteins.
- Superficially porous particles (SPPs) provide narrower peak widths and improved resolution for characterization of biomolecules in comparison to fully porous particles (FPPs).
- Ability to tolerate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



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

## BIOshell™ A400 Protein Phase Chemistry Portfolio

### BIOshell™ A400 Protein C4



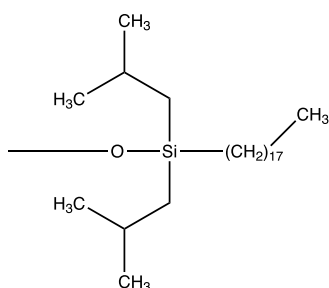
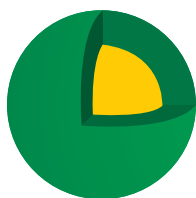
**Ligand:** Dimethylbutylsilane

**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

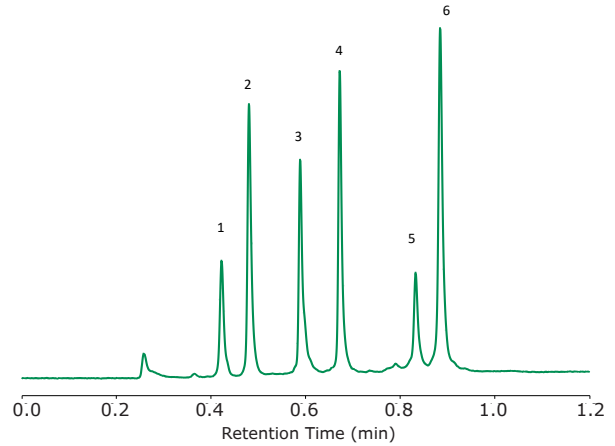
**Pore Size:** 400 Å

### Rapid Protein Separations on BIOshell™ A400

<b>column:</b>	BIOshell™ A400 Protein C4, 5 cm x 2.1 mm I.D., 3.4 µm
<b>mobile phase:</b>	[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)
<b>gradient:</b>	12 to 100% B in 1 min; held at 100% B for 1 min
<b>flow rate:</b>	0.4 mL/min
<b>column temp.:</b>	90 °C
<b>detector:</b>	UV, 215 nm
<b>injection:</b>	1 µL
<b>sample:</b>	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

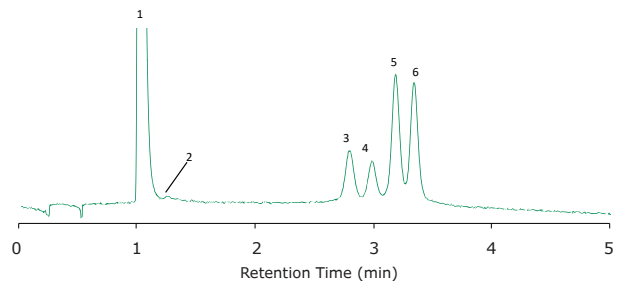


### Protein Stability Can be Measured with BIOshell™ A400

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



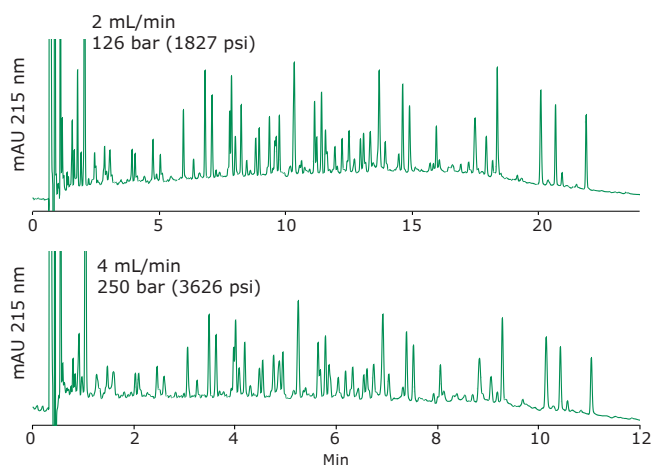




### Rapid Tryptic Digest Analysis Using BIOshell™ A160 Peptide C18

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

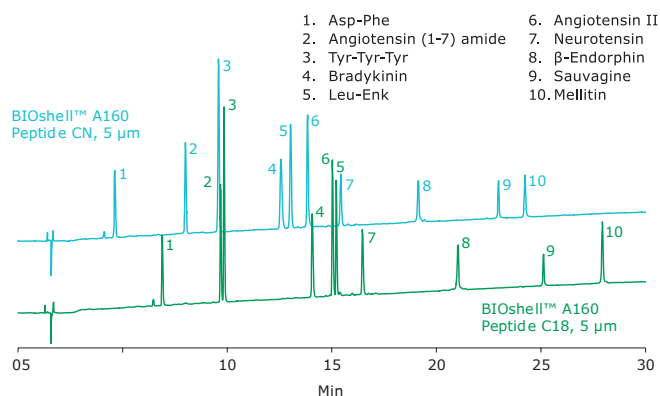
BIOshell™ A160 Peptide columns can more than double sample throughput by allowing the analyst to operate at higher flow rates without a concomitant drop in efficiency.



### Different Phase Chemistries Allows for Alternative Selectivity for Peptides

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

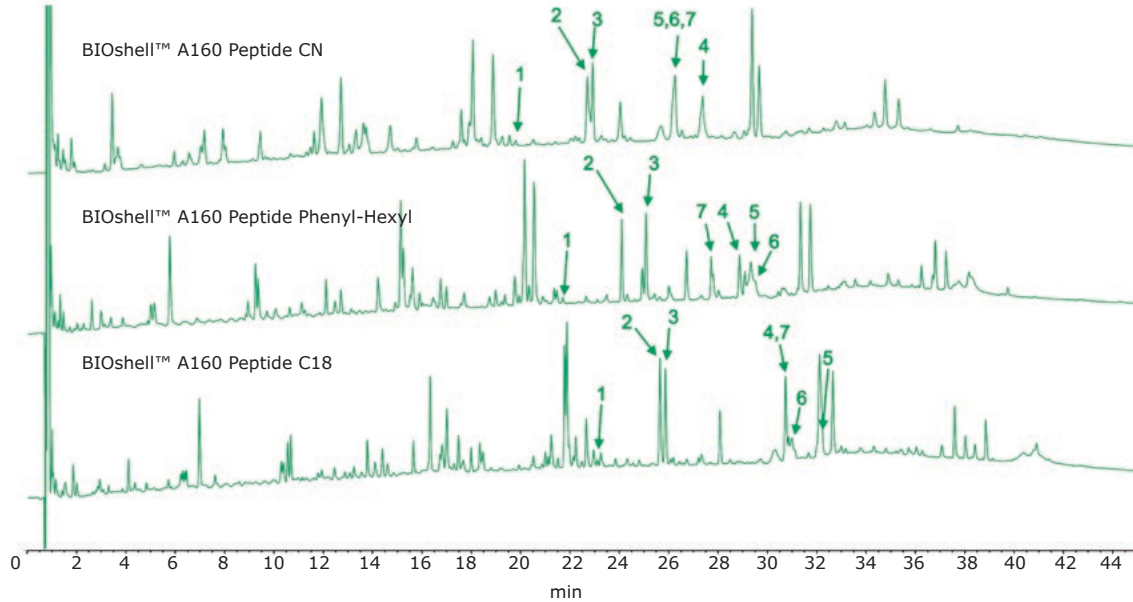
Using phase chemistries that interact with peptides using unique retention mechanisms can lead to different selectivity.



## 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       |                               |



<b>column:</b>	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
<b>mobile phase:</b>	[A] 10 mM Difluoroacetic acid in water [B] 10 mM Difluoroacetic acid in acetonitrile
<b>gradient:</b>	2% B to 50% B in 60 min
<b>flow rate:</b>	0.3 mL/min
<b>column temp.:</b>	60 °C
<b>detector:</b>	MSD, ESI-(+3.5 kV)
<b>injection:</b>	5 µL of 0.2 mg/mL digest
<b>sample:</b>	Tryptic peptides, varied concentration, in 50 mM Tris-HCl/1.5 M Guanidine-HCl with 0.25% formic acid

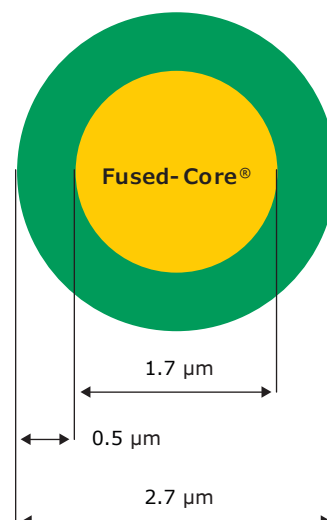
Better sequence coverage, through better resolution of critical pairs, can be achieved by using phase chemistries orthogonal to C18.

## 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 <sup>2</sup> /g
pH Range	2-9
Max Temperature at Low pH	65 °C
Max Temperature at High pH	40 °C
Endcapped	No



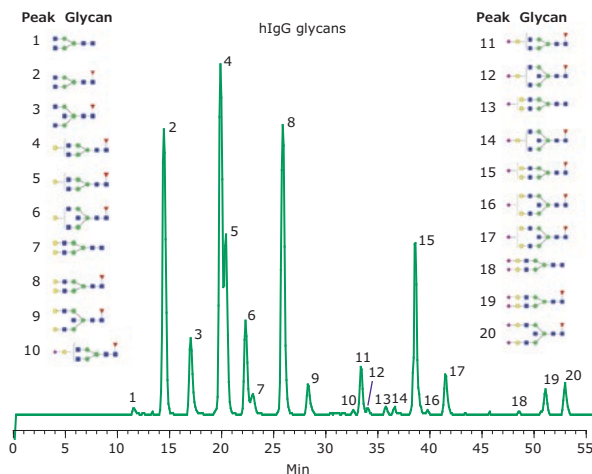
### Did you know?

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

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

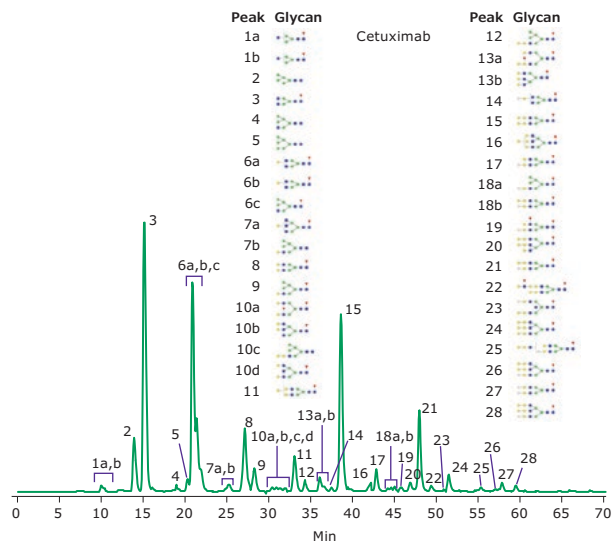
Excellent resolution and peak shape of released glycans.



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

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

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



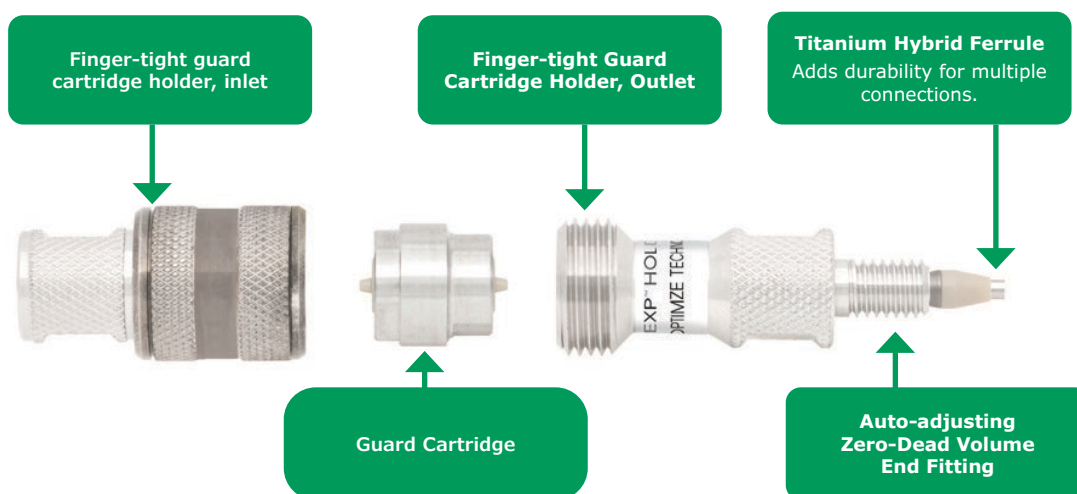
## BIOshell™ U/HPLC Guard Columns

- 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.

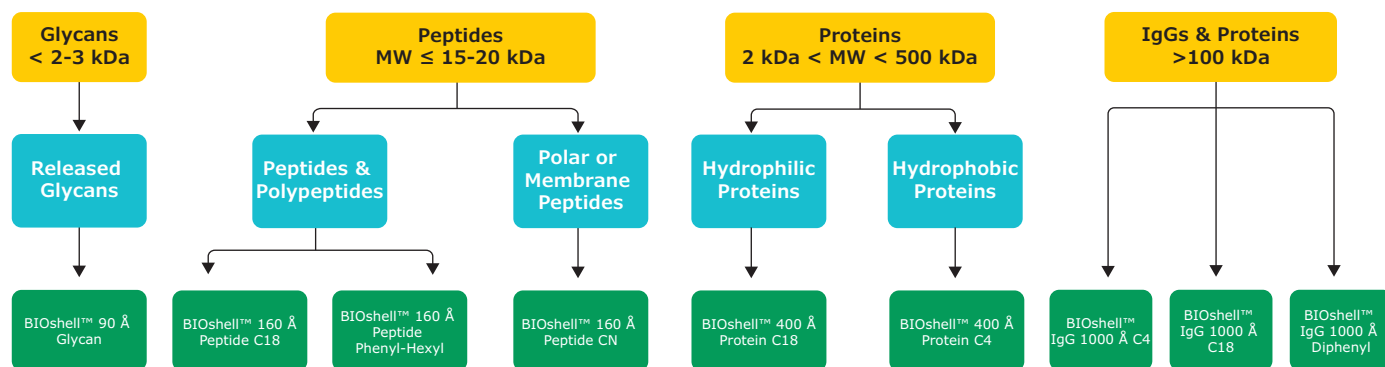
## Did you know?

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 <sub>4</sub>	C <sub>18</sub>	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
<b>Guard Column Holder:</b>	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	**
<b>Guard Column Holder:</b>	66841-U

## BIOshell™ A400 Protein U/HPLC Columns

Dimensions Length (cm) x I.D. (mm)	C <sub>4</sub>	C <sub>18</sub>
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
<b>Guard Column Holder:</b>	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	**	**
<b>Guard Columns, Three Pack</b>						
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					

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