Analytical HPLC Column Introduction

Grace® Key Column Families

Single-Source Solution for Discovery to Recovery Applications

HPLC is commonly used in a wide range of applications, including drug discovery and purification for the pharmaceutical and biotechnology industries, environmental analysis, forensics, petrochemical analysis, food, cosmetics, and vitamins. The combined premier product lines of Alltech®, Davisil®, Flexit™, Grom™, Jones Chromatography™, Modcol®, and Vydac® create a single-source solution for HPLC columns and accessories from discovery to recovery.

Our column families include reversed-phase, normal-phase, HILIC, ion-exchange, ion-exclusion, size-exclusion, and affinity stationary phases for small- and large-molecule separations, and our column formats maximize their performance. Our product range includes standard and custom columns for analytical separations, preparative phases for scale up, bulk packings that customers can pack in their own columns, and accessories to maintain separation ruggedness and quality.

To help select the appropriate column for your application, we describe key column families and highlight unique phases within these families. Whether the most important factor is analysis speed, column bleed, pH stability, resolution, adjustable selectivity, or analyte molecular weight, Grace offers a column to suit your application.

more info
For information about Grace® analytical hardware formats, see page 31.

more info
For information about prep columns, see pages 148–171.

Column Families Suitable for Small Molecules (<2000 Molecular Weight)

VisionHT™ Ultra High-Pressure Columns

12,000psig pressure-rated columns, with sub 2µm media for high-efficiency, high-speed separations

VisionHT™ columns are optimized for high throughput and ultra high-pressure LC applications. Mechanically stable 1.5µm media and ultra-low volume hardware delivers new separation benefits with excellent stability. A variety of phases available.

Differentiated Phases: C18, C10-B, C18-P, C18-HL, HILIC, Silica

Specifications: Spherical silica, monomerically bonded, proprietary endcapping, 100, 120Å pore size

Formats: Ultra High-Pressure

Alltech® Alltima™ HP Columns

Premium quality, exceptionally stable columns, without phase bleed

Alltech® Alltima™ HP phases are made from high purity silica to eliminate peak tailing. Proprietary bonding eliminates the problem of column bleed for MS and ELSD detection. Full range of phases with pH stability from 1 to 10.

Differentiated Phases: C18 for classic reversed-phase separations, EPS for extended polar selectivity, C18 HiLoad for extra reversed-phase retention, C18 Amide with low bleed, and HILIC.

Specifications: High purity spherical silica, monomerically bonded, endcapped, 100, 120, 190Å pore size

Formats: Microbore, Expedite™, Rocket™, Solvent-Reducer, Analytical, Prep

Alltech® Prevail™ Columns

Reversed-phase columns for use with 100% organic to 100% aqueous mobile phases

Prevail™ phases are designed for wettability with aqueous and organic mobile phases, and are especially useful for broad gradients. Retain highly polar analytes with aqueous mobile phases as well as hydrophobic analytes in organic mobile phases.

Differentiated Phases: Carbohydrate ES, Organic Acid

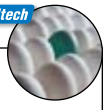
Specifications: Spherical silica, monomerically bonded, endcapped, 110Å pore size

Formats: Microbore, Expedite™, Rocket™, Solvent-Reducer, Analytical, Prep

Analytical HPLC Column Introduction

Column Families Suitable for Small Molecules (<2000 Molecular Weight) (continued)

Alltech® Platinum™ Columns



Alternate retention and selectivity for polar and nonpolar analytes available in sub 2µm particle sizes

Alltech® Platinum™ phases have a controlled polar silica surface which provides enhanced polar selectivity (EPS) in addition to reversed-phase retention. C18 and EPS C18 columns are a complimentary duo to separate polar and nonpolar analytes.

Differentiated Phases: C18, EPS C18

Specifications: Spherical silica, monomerically bonded, proprietary endcapping, 100Å pore size

Formats: Microbore, Expedite™, Rocket™, Solvent-Reducer, Analytical, Prep

GraceSmart™ Columns

Classic reversed-phase and premium performance at an exceptional value

GraceSmart™ HPLC phases use high purity silica. Which translates into symmetrical peaks for acids and bases, and predictable reversed-phase selectivity. Whether routine analysis or new method development, use individually tested GraceSmart™ columns to get premium performance at exceptional value.

Differentiated Phases: C18

Specifications: Spherical silica, monomerically bonded, endcapped, 120Å pore size

Format: Analytical

GraceAlpha™ Columns

A New Silica Generation

New silica from Grace with high porosity surface and dense core ideal for scale-up applications. While high porosity surface increases mass transfer results in increased column efficiencies and loading capacity, dense core and highly spherical shape yields mechanically robust particle.

Differentiated Phases: C18, C8, and Silica

Specifications: High purity spherical silica with high porosity surface and dense core

Formats: Analytical, Prep

Column Families Suitable for Large Molecules (>2000 Molecular Weight)

Vydac® MS Columns

Next generation Vydac® media from the leader in peptide and protein separations

Vydac® MS columns provide unique selectivity and exceptional protein recovery. They require less TFA in the mobile phase for good peak shape, which increases microbore sensitivity of peptides and proteins by reducing "quenching". Vydac® MS columns are also applicable to hydrophobic proteins and peptide mapping.

Differentiated Phases: C18, C8, C4

Specifications: Spherical silica, polymerically and monomerically bonded, endcapped, 300Å pore size

Formats: Capillary, Microbore, Expedite™, Rocket™, Solvent-Reducer, Analytical, Prep

Vydac® ProZap™ Columns

High-speed, high-efficiency columns for fast protein analysis

Short 10 and 20mm ProZap™ columns with 1.5µm particles provide high-speed protein and life science separations. Sharp, efficient peaks maximize method sensitivity.

Differentiated Phases: C18

Specifications: Sub 2µm spherical silica, proprietary bonding and endcapping, 500Å pore size

Format: Expedite™

Vydac® Everest® Columns

For peptide separations, peptide mapping and proteomics applications

High-capacity Everest® C18 columns are recommended as the first choice in peptide separations. Everest® offer high capacity to resolve complex samples such as protein digests.

Differentiated Phases: C18

Specifications: Spherical silica, monomerically bonded, endcapped, 300Å pore size

Formats: Capillary, Microbore, Expedite™, Analytical

HPLC Column Selection

A Comparison of Reversed-Phase Columns

Based on the widely accepted work and data of Drs. Lloyd Snyder and John Dolan[1,2] Grace has developed this column selection tool for choosing reversed phase HPLC columns based on peak capacities and column selectivity of polar and nonpolar compounds. Typically, chromatographers choose HPLC columns by comparing physical characteristics, such as surface area and carbon load. Often, this does not provide enough information about selectivity or capacity for adequate column selection. This chart provides a reliable means of choosing HPLC columns based on acidic, basic, and hydrophobic character.

The Snyder/Dolan column test procedure has been described in a series of publications. Based on retention data for a series of standard mixtures and the same separation conditions (50% acetonitrile/buffer; pH 2.8 and 7.0; 35°C), reversed-phase columns are characterized by five column-selectivity parameters: hydrophobicity (H), steric interaction (S*), hydrogen-bond acidity (A), basicity (B), and relative silanol ionization or cation-exchange capacity (C). Here we have chosen to graphically highlight data for H, (A), and (C), with (C) results at pH 7.0. Hydrophobicity (H) is often the primary analyte interaction with reversed phase columns and indicates overall capacity. Secondary interactions are often polar interactions with basic analytes. The degree of unprotonated base interaction (A) and protonated base interaction (C) with the packing material is measured and represented here.

Directions for Using the Column Chart

The chart lists the columns in descending order of hydrophobic capacity (H). To find similar HPLC columns to test as back-up columns, follow these steps.

1) Find the column you are currently using and note neighboring columns which have similar (H) capacity factors.

2) Compare the values for interaction of polar compounds ((A) and (C)).

If there is more than one choice for a back-up column, then compare your actual sample to the test probes. If your sample is nonpolar, then place more emphasis on hydrophobic values. If your sample is basic (polar), then pay special attention to (A) and (C) and determine if your sample will be protonated ((A)) or unprotonated ((C)) and place greater emphasis on one of these values.

Key to Chart

- Hydrophobic Indicator
- (A) Hydrogen bonding Indicator—pH 2.8 (Protonated under acidic conditions)
- (C) Cation Exchange Indicator—pH 7.0 (Unprotonated under neutral conditions)

Manufacturer	Column	Selectivity Parameters
ZirChrom	ZirChrom®-PBD C18	1.284
YMC	J'Sphere® H80 C18	1.132
Restek	Allure® C18	1.116
Phenomenex	Ultracarb® ODS (30)	1.114
YMC	YMC® Pack Pro C18 RS	1.114
Grace (Alltech)	**Adsorbosphere™ UHS C18**	1.103
Thermo/Hypersil	Hypersil® BetamaxNeutral C18	1.098
Agilent	Zorbax Extend C18	1.098
Agilent	Zorbax C18	1.089
Beckman	Ultrasphere® ODS	1.085
Grace (Alltech)	**Alltima™ HP C18 High Load**	1.080
Agilent	Zorbax Rx-18	1.077
Agilent	Zorbax Eclipse XDB-C18	1.077
Supelco	Ascentis® C18	1.077
Macherey Nagel	Nucleodur® C18 Gravity	1.056
Grace (Grom)	**Grom™ Sapphire 110 C18**	1.055
Restek	Restek® Ultra C18	1.055
Varian	OmniSpher™ 5 C18	1.055
Grace (Vydac)	**Denali® 120 C18**	1.052
Waters	Symmetry® C18	1.052
Akzo Nobel	Kromasil® 100-5C18	1.051
Waters	Nova-Pak® C18	1.049
Thermo/Hypersil	Hypersil® 100 C18	1.048
MacMod/ACT	ACE® 5 C18-HL	1.045
ZirChrom	ZirChrom®-EZ C18	1.040
Grace (Grom)	**Grom™ Sil 120 ODS-5 ST**	1.035
Dionex	Acclaim® 120 C18	1.032
Waters	Sunfire™ C18	1.031
Agilent	Zorbax Eclipse Plus C18	1.030
Merck	Superspher® 100 RP-18e	1.030
Shiseido	CAPCELL™ C18 AG120	1.030
Grace (Grom)	**Grom™ Sil 120 ODS-3 CP**	1.029
Waters	Delta-Pak™ C18 100A	1.028
Macherey Nagel	Nucleodur® Isis	1.023
Phenomenex	Prodigy™ ODS (3)	1.023
Phenomenex	Synergi™ Hydro-RP C18	1.022
Phenomenex	Luna™ C18	1.018
Supelco	Supelcosil™ LC-18	1.018
YMC	YMC® Pro C18	1.015
Phenomenex	Onyx™ Monolithic C18	1.012
Bischoff	ProntoSIL™ SpheriBOND 80-5-ODS2	1.010
Grace (Jones)	**Apex™ II C18**	1.008
Shiseido	CAPCELL™ C18 UG120	1.007
GL Sciences	Inertsil® ODS-2	1.007

Manufacturer	Column	Selectivity Parameters
Merck	LiChrospher® 100 RP-18	1.006
Bischoff	ProntoSIL™ 120-5-C18 H	1.005
Shiseido	CAPCELL™ C18 M G	1.005
Grace (Jones)	**Genesis® 120 C18**	1.005
Bischoff	EU Reference Column C18	1.004
Grace (Alltech)	**Allsphere™ ODS2**	1.004
Merck	Purospher® STAR RP18e	1.003
Merck	Chromolith® RP18e	1.003
Phenomenex	Luna® C18(2)	1.002
Varian	Pursuit® C18	1.001
MacMod/ACT	ACE® 5 C18	1.000
Tosoh	TSKgel® Super-ODS	0.998
Agilent	Zorbax StableBond 80A C18	0.996
Phenomenex	Prodigy™ ODS(2)	0.995
Thermo/Hypersil	Hypersil® BDS C18	0.993
Grace (Alltech)	**Alltima™ C18**	0.993
Grace (Vydac)	**Vydac® Everest® C18**	0.993
Thermo/Hypersil	Hypersil® Beta Basic-18	0.993
GL Sciences	Inertsil® ODS-3	0.990
Grace (Alltech)	**Adsorbosphere™ C18**	0.989
Phenomenex	Synergi™ Max-RP C18	0.989
Shiseido	CAPCELL™ C18 SG120	0.987
Grace (Jones)	**Apex™ I C18**	0.985
Thermo/Hypersil	Hypersil® ODS-2	0.985
Grace (Alltech)	**Alltima™ HP C18**	0.985
Waters	Xterra® MS C18	0.984
Waters	Symmetry® 300 C18	0.984
Supelco	Discovery C18	0.984
Supelco	Supelcosil™ LC-18-DB	0.979
Waters	Spherisorb® S5 ODSB	0.975
Thermo/Hypersil	Hypersil® Bio Basic-18	0.974
Thermo/Hypersil	Hypersil® ODS	0.974
Bischoff	ProntoSIL™ 120-5-C18-AQ	0.974
Grace (Jones)	**Genesis® 300 C18 C18**	0.974
Bischoff	Prontosil™ 200-5-C18 AQ	0.974
Agilent	Zorbax C8	0.974
Tosoh	TSK gel® ODS-80Ts	0.971
Waters	Resolve C18	0.968
Phenomenex	Gemini® C18 110A	0.967
Grace (Alltech)	**Econosil™ C18**	0.966
Phenomenex	Aqua® C18	0.966
YMC	YMC® ODS-AQ C18	0.965
Waters	Spherisorb® ODS-2	0.962
Macherey Nagel	Nucleosil® 100-5-C18 HD C18	0.961

Grace (Jones)	**Genesis® 120 AQ C18**	0.960
Macherey Nagel	Nucleodur® Pyramid	0.958
Thermo/Hypersil	Hypersil® Elite C18	0.958
Dionex	Acclaim® 300 C18	0.957
Bischoff	ProntoSIL™ 300-5-C18 H	0.956
Waters	Delta-Pak™ C18 300A	0.955
Bischoff	ProntoSIL™ HyperSORB 120 ODS	0.951
Thermo/Hypersil	Hypersil® PAH C18	0.949
Bischoff	ProntoSIL™ 120-5-C18 Aqplus	0.947
Phenomenex	Jupiter® 300 C18	0.945
Varian	Polaris® C18-Ether	0.943
Waters	Atlantis® T3 C18	0.941
Tosoh	TSKgel® 80Ts QA	0.940
Grace (Alltech)	**Alltima™ C18-WP**	0.938
Waters	YMC® Hydrosphere C18	0.937
Grace (Alltech)	**Brava™ BDS C18**	0.938
Bischoff	ProntoSIL™ 60-5 C8 SH	0.929
Varian	Polaris® C18-A	0.928
YMC	J'Sphere® M80 C18	0.926
Agilent	Zorbax Eclipse XDB-C8	0.919
Waters	Atlantis® dC18 b	0.917
Supelco	Ascentis® Express C8	0.915
Thermo	Hypersil® GOLD aQ	0.915
Phenomenex	Selectosil™ C18	0.911
Merck	LiChrosorb® RP-18	0.909
Grace (Vydac)	**Vydac® 218TP C18**	0.909
Waters	Acquity UPLC® BEH Shield RP18 EP	0.907
Macherey Nagel	Nucleosil® C18	0.906
Agilent	Zorbax StableBond 300A C18	0.905
Grace (Alltech)	**Prosphere™ C18 300**	0.903
Grace (Vydac)	**Vydac® 201TP C18**	0.901
Supelco	Ascentis® C-8	0.899
Waters	Nova-Pak® C8	0.899
Waters	Symmetry® C8	0.893
YMC	YMC® Pro C8	0.890
Agilent	Zorbax Eclipse Plus C8	0.889
Phenomenex	Luna™ C8(2)	0.889
Grace (Alltech)	**Prevail™ C18**	0.888
Grace (Alltech)	**Prosphere™ 100 C18**	0.883
Grace (Alltech)	**Alltima™ AQ EP**	0.882
Thermo/Hypersil	Hypersil® GOLD C18	0.881
Phenomenex	Synergi™ Fusion-RP EP	0.879
Phenomenex	Luna™ C8	0.875
Grace (Grom)	**Grom™ Sil 120 Octyl-6 MB C8**	0.872
Grace (Jones)	**Apex™ I C8**	0.869
Shiseido	CAPCELL™ C18 A Q	0.867
Macherey Nagel	Nucelosil® 100-5-C8 HD	0.865
Akzo Nobel	Kromasil® 100-5C8	0.864
Grace (Jones)	**Genesis® 120 EC C8**	0.863
Grace (Alltech)	**Prevail™ Amide EP**	0.862
Macherey Nagel	Nucleosil® ODS	0.860
Restek	Ultra AQ C18	0.857
Waters	Sunfire™ C8	0.856
Waters	Acquity UPLC® BEH C8	0.855
Shiseido	CAPCELL™ PAK C8 UG120	0.854
Waters	Symmetry® Shield C18	0.850
Grace (Alltech)	**Alphabond™ C18**	0.845
Supelco	Ascentis® RP-Amide	0.843
Merck	Purospher® RP-18	0.841
Supelco	Discovery BIO Wide pore C8	0.839
Grace (Grom)	**Grom™ Sapphire 110 C8**	0.835
Thermo/Hypersil	Hypersil® Beta Basic-8	0.834
Grace (Alltech)	**Alltima™ HP C8**	0.834
Thermo/Hypersil	Hypurity® C8	0.833
Supelco	Discovery C8	0.832
GL Sciences	Inertsil® C8-3 C8	0.830
MacMod/ACT	ACE® 5 C8	0.830
Grace (Jones)	**Genesis® 120 C8**	0.829
Thermo	Hypersil® GOLD C8	0.825
Phenomenex	Onyx™ Monolithic C8	0.824
Tosoh	TSKgel® Super-Octyl	0.824
Grace (Alltech)	**Prevail™ Select C18**	0.822
Thermo/Hypersil	Hypersil® Bio Basic-8	0.821
YMC	YMC® Basic C18	0.821
Grace (Alltech)	**Econosphere™ C18**	0.818
Tosoh	TSKgel® Octyl-80Ts	0.814
Whatman	Partisil™ ODS(3)	0.810
Macherey Nagel	Nucleodur® Sphinx RP	0.805
Thermo/Hypersil	Aquasil™ C18	0.805
MacMod/ACT	ACE® AQ EP	0.804
Waters	Xterra® MS C8	0.803
Phenomenex	Luna™ C5	0.800
Waters	MicroBondapak C18	0.798
Agilent	Zorbax StableBond 80A C8	0.795
Agilent	Zorbax Rx-C8	0.792
Grace (Alltech)	**Platinum™ C18**	0.786
Grace	**VisionHT™ C18**	0.786
Phenomenex	Luna™ Phenyl-Hexyl	0.782
Grace (Alltech)	**Alltima™ C18-LL**	0.780
Bischoff	ProntoSIL™ 120-5-C18 ace-EPS	0.772
Grace (Vydac)	**Vydac® 218MS C18**	0.770
Waters	Acquity UPLC® BEH phenyl	0.764
Waters	Spherisorb® C8	0.763
YMC	J'Sphere® L80 C18	0.762
Bischoff	ProntoSIL™ 300-55-C18 ace-EPS	0.762
Dionex	Acclaim® Organic Acid C18	0.761
Waters	Xterra® C18 RP	0.757
Grace (Alltech)	**Alltima™ C8**	0.756
Whatman	Partisil™ C8	0.749
Merck	LiChrospher® 60 RP-Select B C18	0.747
Bischoff	ProntoSIL™ 120-5 C8 SH	0.739
Grace (Alltech)	**Allsphere™ ODS1**	0.733
Waters	Symmetry® Shield C8	0.730
Thermo/Hypersil	Hypurity® C4	0.713
MacMod/ACT	ACE® 5 C4-300	0.710
Varian	Polaris® C8-Ether	0.705
Bischoff	ProntoSIL™ 60-5-Phenyl	0.705
Waters	Nova-Pak® Phenyl	0.704
Macherey Nagel	Nucleosil® 100-5-C18 Nautilus	0.702
Agilent	Zorbax StableBond 300A C8	0.701
Bischoff	ProntoSIL™ SpheriBOND 80-5-ODS1	0.700
Thermo/Hypersil	Fluophase® RP F	0.698
Phenomenex	Jupiter® 300 C4	0.698
Grace (Alltech)	**Prosphere™ 300 C4**	0.689
Bischoff	Prontosil™ 60-5-C4	0.686
Waters	Xterra® Phenyl	0.683
Waters	Spherisorb® ODS-1	0.682
Thermo/Hypersil	Hypersil® Prism C18 RPN	0.678
Thermo/Hypersil	Fluophase® PFP F	0.675
Agilent	Zorbax XDB-Phenyl	0.665
Waters	Symmetry® 300 C4	0.659
Waters	Xterra® C8 RP	0.657
Grace (Alltech)	**Alltima™ HP C18 EPS**	0.655
Supelco	Discovery BIO Wide pore C5	0.654
Agilent	Zorbax Bonus RP EP	0.654
Phenomenex	Synergi™ Polar-RP C18	0.654
MacMod/ACT	ACE® Phenyl	0.647
Grace (Jones)	**Genesis® 120 C4 EC**	0.646
Thermo/Hypersil	Hypersil® Prism C18 RP	0.645
Thermo/Hypersil	BetaMax® Acid EP	0.635
Supelco	Discovery HS F5 F	0.631
Agilent	Zorbax SB-Phenyl	0.623
Grace (Alltech)	**Platinum™ EPS C18**	0.619
Grace	**VisionHT™ C18-P**	0.619
Grace (Alltech)	**Prevail™ C8**	0.617
Grace (Jones)	**Genesis® 300 C4 C4**	0.615
Grace (Jones)	**Genesis® Phenyl**	0.609
Agilent	Zorbax StableBond 80A C3	0.601
MacMod/ACT	ACE® Phenyl-300	0.599
Agilent	Zorbax SB-AQ EP	0.593
ZirChrom	ZirChrom®-PS EP	0.589
Waters	MicroBondapak Phenyl	0.585
Grace (Alltech)	**Platinum™ C8**	0.584
Grace (Alltech)	**Platinum™ EPS C8 300**	0.584
Thermo/Hypersil	BetaBasic® Phenyl	0.582
Macherey Nagel	Nucleosil® C8	0.575
Macherey Nagel	EC Nucleosil® 100-5 Protect 1 EP	0.544
Bischoff	Prontosil™ 120-5-C8 ace-EPS	0.532
Phenomenex	Prodigy™ Phenyl-3	0.529
Agilent	Zorbax StableBond 300A C3	0.526
Grace (Alltech)	**Alltima™ HP C18 Amide**	0.497
Thermo/Hypersil	BetaMax® Base EP	0.470
Grace (Alltech)	**Platinum™ EPS C8**	0.420
Thermo/Hypersil	Hypurity® Advance	0.412

References:

1. "The "Hydrophobic-subtraction" Model of Reversed-phase Column Selectivity", L.R. Snyder, J.W. Dolan and P.W. Carr, *J. Chromatogr. A*, 1060 (2004) 77-116.
2. "A New Look at the Selectivity of Reversed-phase HPLC Columns", L.R. Snyder, J.W. Dolan and P.W. Carr, *Anal. Chem.*, 79 (2007) 3255-3262.

Grace® HPLC Packing Material Specifications

Columns for Small Molecules

Brand	Phase	Base Material	Particle Shape	Particle Size	Pore Size	Surface Area	Carbon Load	Phase Type	End-capped?	USP L-code
Adsorbosil®	C18	Silica	Irregular	5, 10µm	60Å	450m²/g	15%	Polymeric	Yes	L1
Alltech	C8	Silica	Irregular	5, 10µm	60Å	450m²/g	10%	Polymeric	Yes	L7
	C2	Silica	Irregular	5, 10µm	60Å	450m²/g	No	Polymeric	No	L16
	CN	Silica	Irregular	5, 10µm	60Å	450m²/g	—	Polymeric	Yes	L10
	NH_2	Silica	Irregular	5, 10µm	60Å	450m²/g	—	Polymeric	No	L8
	Silica	Silica	Irregular	5, 10µm	60Å	450m²/g	—	Polymeric	No	L3
Adsorbosphere™	C18	Silica	Spherical	3, 5, 10µm	80Å	200m²/g	12%	Monomeric	Yes	L1
Alltech	C18 HS	Silica	Spherical	3, 5µm	60Å	350m²/g	20%	Monomeric	Yes	L1
	C18 UHS	Silica	Spherical	5, 10µm	60Å	500m²/g	30%	Monomeric	Yes	L1
	C8	Silica	Spherical	3, 5, 10µm	80Å	200m²/g	8%	Monomeric	Yes	L7
	Phenyl	Silica	Spherical	5µm	80Å	200m²/g	5%	Monomeric	Yes	L11
	Cyano	Silica	Spherical	5µm	80Å	200m²/g	—	Monomeric	Yes	L10
	Cyano-AQ	Silica	Spherical	5µm	120Å	170m²/g	—	Polymeric	No	L10
	Amino (NH_2)	Silica	Spherical	3, 5µm	80Å	200m²/g	—	Polymeric	No	L8
	Silica	Silica	Spherical	5µm	80Å	200m²/g	—	—	No	L3
	SAX	Silica	Spherical	5µm	80Å	200m²/g	—	Monomeric	No	—
	SCX	Silica	Spherical	5µm	80Å	200m²/g	—	Monomeric	Yes	—
Adsorbosphere™ XL	C18	Silica	Spherical	3, 5µm	90Å	200m²/g	11%	Monomeric	Yes	L1
Alltech	C18-B	Silica	Spherical	5µm	90Å	200m²/g	12%	Monomeric	Yes	L1
	C8	Silica	Spherical	3, 5µm	90Å	200m²/g	6%	Monomeric	Yes	L7
	C1 (TMS)	Silica	Spherical	5µm	90Å	200m²/g	—	Monomeric	Yes	L13
	Silica	Silica	Spherical	5µm	90Å	200m²/g	—	—	No	L3
	SAX	Silica	Spherical	5, 10µm	90Å	200m²/g	—	Monomeric	Yes	—
	SCX	Silica	Spherical	5, 10µm	90Å	200m²/g	—	Monomeric	Yes	—
Allsphere™	ODS-1	Silica	Spherical	5µm	80Å	220m²/g	7%	Monomeric	Partial	L1
Alltech	ODS-2	Silica	Spherical	3, 5µm	80Å	220m²/g	12%	Monomeric	Yes	L1
	C8	Silica	Spherical	3, 5µm	80Å	220m²/g	6%	Monomeric	Yes	L7
	C6	Silica	Spherical	5µm	80Å	220m²/g	4%	Monomeric	Yes	L15
	C1 (TMS)	Silica	Spherical	5µm	80Å	220m²/g	3%	Monomeric	No	L13
	Phenyl	Silica	Spherical	5µm	80Å	220m²/g	3%	Monomeric	Yes	L11
	Cyano	Silica	Spherical	5µm	80Å	220m²/g	3.5%	Monomeric	No	L10
	Amino (NH_2)	Silica	Spherical	5µm	80Å	220m²/g	3%	Monomeric	No	L8
	Silica	Silica	Spherical	3, 5µm	80Å	220m²/g	—	—	No	L3
	SAX	Silica	Spherical	5µm	100Å	220m²/g	4%	Monomeric	No	—
	SCX	Silica	Spherical	5µm	100Å	220m²/g	4%	Monomeric	No	—
Alltima™ HP	C18	Silica	Spherical	3, 5µm	190Å	200m²/g	12%	Monomeric	Yes	L1
Alltech	C18 EPS	Silica	Spherical	3, 5µm	190Å	200m²/g	4%	Monomeric	No	L1
	C18 HiLoad	Silica	Spherical	3, 5µm	100Å	450m²/g	24%	Monomeric	Yes	L1
	C18 AQ	Silica	Spherical	3, 5µm	100Å	450m²/g	20%	Monomeric	Yes	L1
	C18 Amide	Silica	Spherical	3, 5µm	190Å	200m²/g	12%	Monomeric	Yes	L1
	C8	Silica	Spherical	3, 5µm	190Å	200m²/g	8%	Monomeric	Yes	L7
	Cyano	Silica	Spherical	3, 5µm	190Å	200m²/g	4%	Monomeric	Yes	L10
	Silica	Silica	Spherical	3, 5µm	100Å	450m²/g	—	—	No	L3
	HILIC	Silica	Spherical	1.5, 3, 5µm	120Å	230m²/g	—	—	No	L3
Alltima™	C18	Silica	Spherical	3, 5, 10µm	100Å	340m²/g	16%	Polymeric	Yes	L1
Alltech	C18 LL	Silica	Spherical	5µm	100Å	340m²/g	9%	Polymeric	Yes	L1
	C8	Silica	Spherical	3, 5, 10µm	100Å	340m²/g	9%	Polymeric	Yes	L7
	Phenyl	Silica	Spherical	3, 5µm	100Å	340m²/g	7.5%	Polymeric	Yes	L11
	Cyano	Silica	Spherical	3, 5µm	100Å	340m²/g	—	Polymeric	Yes	L10
	Amino (NH_2)	Silica	Spherical	3, 5µm	100Å	340m²/g	—	Polymeric	No	L8
	Silica	Silica	Spherical	3, 5, 10µm	100Å	340m²/g	—	—	No	L3
AlphaBond™	C18	Silica	Irregular	5, 10µm	125Å	300m²/g	10%	Monomeric	Yes	L1
Alltech	C8	Silica	Irregular	10µm	125Å	300m²/g	—	Monomeric	Yes	L7
	Phenyl	Silica	Irregular	10µm	125Å	300m²/g	—	Monomeric	Yes	L11
	Cyano	Silica	Irregular	10µm	125Å	300m²/g	—	Monomeric	Yes	L10
	Amino (NH_2)	Silica	Irregular	10µm	125Å	300m²/g	—	Polymeric	No	L8
	Silica	Silica	Irregular	10µm	125Å	300m²/g	—	—	No	L3
Apex™ I	ODS	Silica	Spherical	3, 5, 10µm	100Å	170m²/g	10%	Polymeric	Yes	L1
JONES	C8	Silica	Spherical	3, 5µm	100Å	170m²/g	7%	Monomeric	No	L7
	C8(EC)	Silica	Spherical	3, 5µm	100Å	170m²/g	7%	Monomeric	Yes	L7
	C1	Silica	Spherical	3, 5µm	100Å	170m²/g	2.5%	Monomeric	Yes	L13
	Phe	Silica	Spherical	3, 5µm	100Å	170m²/g	3%	Monomeric	No	L11
	Basic ODS	Silica	Spherical	5µm	100Å	200m²/g	12%	Monomeric	Yes	L1
	PAH	Silica	Spherical	5µm	100Å	170m²/g	—	Monomeric	Yes	
	CN	Silica	Spherical	3, 5µm	100Å	170m²/g	4%	Monomeric	No	L10
	Amino (NH_2)	Silica	Spherical	3, 5µm	100Å	170m²/g	2%	Monomeric	No	L8
	Carbohydrate	Silica	Spherical	5µm	100Å	170m²/g	—	Monomeric	†	
	Silica	Silica	Spherical	3, 5, 10µm	100Å	170m²/g	—	—	No	L3
Apex™ II	ODS	Silica	Spherical	3, 5µm	100Å	170m²/g	10.5%	Monomeric	Yes	L1
JONES	Diol	Silica	Spherical	3, 5µm	100Å	170m²/g	3.5%	Monomeric	No	
	Amino (NH_2)	Silica	Spherical	3, 5µm	100Å	170m²/g	2%	Monomeric	No	L8
	Others—as Apex I	Silica	Spherical	5µm	100Å	170m²/g	—	—	No	—
Apex™ Prepsil	ODS	Silica	Spherical	8, 15µm	130Å	170m²/g	10%	Polymeric	Yes	L1
JONES	C8	Silica	Spherical	8, 15µm	130Å	170m²/g	7%	Monomeric	No	L7
	C8(EC)	Silica	Spherical	8, 15µm	130Å	170m²/g	7%	Monomeric	Yes	L7
	C2	Silica	Spherical	8µm	130Å	170m²/g	2.8%	Monomeric	No	L30
	CN	Silica	Spherical	8µm	130Å	170m²/g	4%	Monomeric	Yes	L10
	Amino (NH_2)	Silica	Spherical	8µm	130Å	170m²/g	2%	Monomeric	Yes	L8
	Silica	Silica	Spherical	8, 15µm	130Å	170m²/g	—	—	No	L3
	Diol	Silica	Spherical	8µm	130Å	170m²/g	3.2%	Monomeric	No	L20

†Proprietary.

Columns for Small Molecules (continued)

Brand	Phase	Base Material	Particle Shape	Particle Size	Pore Size	Surface Area	Carbon Load	Phase Type	End-capped?	USP L-code
Apollo™ Alltech	C18	Silica	Spherical	5µm	100Å	340m²/g	15%	Monomeric	Yes	L1
	C8	Silica	Spherical	5µm	100Å	340m²/g	9%	Monomeric	Yes	L7
	Phenyl	Silica	Spherical	5µm	100Å	340m²/g	8%	Monomeric	Yes	L11
	Silica	Silica	Spherical	5µm	100Å	340m²/g	—	—	No	L3
Brava™ Alltech	C18 BDS	Silica	Spherical	3, 5µm	145Å	185m²/g	8.5%	Monomeric	Yes	L1
	C18 ODS	Silica	Spherical	3, 5µm	130Å	195m²/g	8.5%	Monomeric	Yes	L1
	C8	Silica	Spherical	3, 5µm	130Å	195m²/g	6%	Monomeric	Yes	L7
	C8 BDS	Silica	Spherical	3, 5µm	145Å	185m²/g	5.5%	Monomeric	Yes	L7
	Phenyl	Silica	Spherical	5µm	130Å	195m²/g	—	Monomeric	No	L11
	Cyano	Silica	Spherical	5µm	130Å	195m²/g	—	Monomeric	No	L10
	Cyano BDS	Silica	Spherical	5µm	145Å	185m²/g	—	Monomeric	No	L10
	Amino (NH_2)	Silica	Spherical	5µm	130Å	195m²/g	—	Monomeric	No	L8
	Silica	Silica	Spherical	5µm	130Å	195m²/g	—	—	No	L3
Carbohydrate Alltech	Amino	Silica	Irregular	10µm	80Å	550m²/g	—	Polymeric	No	—
	Cation	Polymer	Spherical	10µm	—	—	—	—	No	—
Denali® VYDAC	238DE C18	Silica	Spherical	3, 5, 10, 15, 20µm	120Å	280-340m²/g	20%	Monomeric	Yes	L1
Econosil™* Alltech	C18	Silica	Irregular	3, 5, 10µm	80Å	200m²/g	10%	Monomeric	Yes	L1
	C8	Silica	Irregular	3, 5, 10µm	80Å	200m²/g	5%	Monomeric	Yes	L7
	CN	Silica	Irregular	5, 10µm	80Å	200m²/g	—	Monomeric	Yes	L10
	NH_2	Silica	Irregular	5, 10µm	80Å	200m²/g	—	Polymeric	No	L8
	Silica	Silica	Irregular	3, 5, 10µm	80Å	200m²/g	—	—	No	L3
Econosphere™* Alltech	C18	Silica	Spherical	3, 5, 10µm	80Å	200m²/g	10%	Monomeric	Yes	L1
	C8	Silica	Spherical	3, 5, 10µm	80Å	200m²/g	5%	Monomeric	Yes	L7
	Cyano	Silica	Spherical	5µm	80Å	200m²/g	—	Monomeric	Yes	L10
	Amino (NH_2)	Silica	Spherical	5µm	80Å	200m²/g	—	Polymeric	No	L8
	Silica	Silica	Spherical	3, 5, 10µm	80Å	200m²/g	—	—	No	L3
Genesis® 120 JONES	C18	Silica	Spherical	3, 4, 7, 15µm	120Å	300m²/g	18%	Monomeric	Yes	L1
	C18 AQ	Silica	Spherical	4, 7µm	120Å	300m²/g	15%	Monomeric	Yes	L1
	C8	Silica	Spherical	3, 4, 7, 15µm	120Å	300m²/g	11%	Monomeric	No	L7
	C8(EC)	Silica	Spherical	3, 4, 7, 15µm	120Å	300m²/g	11%	Monomeric	Yes	L7
	C4	Silica	Spherical	4µm	120Å	300m²/g	6%	Monomeric	Yes	L26
	Phenyl	Silica	Spherical	4µm	120Å	300m²/g	9%	Monomeric	Yes	L11
	CN	Silica	Spherical	3, 4µm	120Å	300m²/g	7%	Monomeric	Yes	L10
	Amino (NH_2)	Silica	Spherical	3, 4µm	120Å	300m²/g	3.5%	Polymeric	No	L8
	Carbohydrate	Silica	Spherical	4µm	120Å	300m²/g	—	Monomeric	No	—
	CN-TCA	Silica	Spherical	4µm	120Å	300m²/g	7%	Monomeric	Yes	—
	Petro-XP	Silica	Spherical	4µm	120Å	300m²/g	—	Monomeric	No	—
	Silica	Silica	Spherical	3, 4, 7, 15µm	120Å	300m²/g	—	—	No	L3
Grace Alpha® GRACE	C18	Silica	Spherical	5, 10, 15, 20µm	120Å	325m²/g	15%	Monomeric	Yes	L1
	C8	Silica	Spherical	5, 10, 15, 20µm	120Å	325m²/g	10%	Monomeric	No	L7
	Silica	Silica	Spherical	5, 10, 15, 20µm	120Å	325m²/g	—	—	No	L3
GraceSmart™ GRACE	C18	Silica	Spherical	3, 5µm	120Å	220m²/g	10%	Monomeric	Yes	L1
Grom™ Sil GROM	ODS-0 AB (acid/base deactivated)	Silica	Spherical	1.5, 3, 5, 10µm	100Å	200m²/g	11%	Monomeric	Yes	L1
	ODS-2 FE (fully endcapped)	Silica	Spherical	1.5, 3, 5, 10µm	80, 100, 300Å	220, 200, 100m²/g	12, 11, 6%	Monomeric	Yes	L1
	ODS-3 CP (encapsulated)	Silica	Spherical	3, 5, 7, 10µm	120, 300Å	320, 170m²/g	15, 6%	Polymeric	No	L1
	ODS-4 HE (hydrophilic endcapping)	Silica	Spherical	3, 4, 5, 7, 10µm	120, 200Å	300, 200m²/g	16, 11%	Monomeric	Yes	L1
	ODS-5 ST (standard)	Silica	Spherical	3, 4, 5, 7, 10µm	60, 120, 200, 300Å	580, 300, 200, 150m²/g	22, 17, 12, 7%	Monomeric	Yes	L1
	ODS-6 NE (non endcapped)	Silica	Irregular	3, 5µm	120Å	300m²/g	17%	Monomeric	No	L1
	ODS-7 pH (pH-stable)	Silica	Irregular	4µm	80Å	510m²/g	22%	Polymeric	No	L1
	Octyl-1 B (base deactivated)	Silica	Spherical	3, 5µm	100Å	200m²/g	6.5%	Monomeric	Yes	L7
	Octyl-2 AB (acid/base deactivated)	Silica	Spherical	3, 5µm	100Å	200m²/g	5%	Monomeric	Yes	L7
	Octyl-3 BA (for bases)	Silica	Spherical	3, 5µm	120Å	300m²/g	9%	Monomeric	Yes	L7
	Octyl-4 FE (fully endcapped)	Silica	Spherical	3, 5, 10µm	80, 100, 300Å	220, 200, 100m²/g	6.6, 6, 3%	Monomeric	Yes	L7
	Octyl-5 CP (encapsulated)	Silica	Spherical	3, 5, 7, 10µm	120, 300Å	320, 170m²/g	10, 5.5%	Polymeric	No	L7
	Octyl-6 MB (monomer binding)	Silica	Spherical	3, 5, 10µm	120, 200, 300Å	300, 200, 150m²/g	10, 7, 4%	Monomeric	Yes	L7
	Hexyl-1 MB (monomeric bonding)	Silica	Spherical	5µm	80, 100Å	220, 200m²/g	4, 4%	Monomeric	Yes	
	Phenyl-1 FE (fully endcapped)	Silica	Spherical	3, 5, 10µm	120, 300Å	300, 150m²/g	9, 5%	Monomeric	Yes	L11
	Phenyl-2 CP (encapsulated)	Silica	Irregular	5µm	120, 300Å	320, 170m²/g	7, 4%	Polymeric	No	L11
	Phenyl-3 PE (partially endcapped)	Silica	Spherical	3, 5, 10µm	80, 100Å	220, 200m²/g	6.6, 6%	Monomeric	Yes	L11
	Butyl-1 ST (standard)	Silica	Spherical	3, 5µm	120, 300Å	300, 150m²/g	7, 2.5%	Monomeric	No	L26
	Butyl-2 FE (fully endcapped)	Silica	Spherical	3, 5µm	300Å	100m²/g	1, 5%	Monomeric	No	L26
	TMS-1 ST (standard)	Silica	Spherical	3, 5µm	120, 300Å	300, 150m²/g	4%	Monomeric	Yes	L13
	TMS-2 CP (encapsulated)	Silica	Spherical	3, 5µm	120, 300Å	320, 170m²/g	3%	Polymeric	No	L13
	Cyan-1 ST (standard)	Silica	Spherical	3, 5µm	120, 300Å	300, 150m²/g	4.8%	Monomeric	Yes	
	Cyan-2 PR (cyanopropyl)	Silica	Spherical	3, 5µm	80, 100Å	220, 200m²/g	3.5%	Monomeric	Yes	
	Cyan-3 CP (encapsulated)	Silica	Spherical	5µm	120Å	320m²/g	4%	Polymeric	No	
	Amino-1 PR (NH-propyl)	Silica	Spherical	3, 5, 10µm	80, 100Å	220, 200m²/g	2%	Monomeric	Yes	L8
	Amino-2 PA (cross linked Poly-NH_2)	Silica	Spherical	5µm	120Å	300m²/g	—	Polymeric	No	L8
	Amino-3 CP (encapsulated NH-residues)	Silica	Irregular	5µm	80Å	420m²/g	—	Monomeric	Yes	L8
	Amino-4 PR (propylamine bonded to silica)	Silica	Irregular	3, 7µm	300Å	100m²/g	—	Monomeric	No	L8
	Diol	Silica	Spherical	5, 10µm	60, 120, 200, 300Å	580, 300, 200, 150m²/g	—	Monomeric	No	L20
	Normal Phase-1 ST (standard silica)	Silica	Spherical	3, 5, 10µm	80, 100, 1000Å	220, 200m²/g	—	—	No	L3
	Normal Phase-2 SP (spherical silica)	Silica	Spherical	3, 5, 10µm	60, 120, 200, 1000Å	580, 300, 200m²/g	—	—	No	L3
	Normal Phase-3 PV (polyvinylalcohol)	Silica	Spherical	5µm	120Å	300m²/g	—	Polymeric	No	L3
	SEC (size exclusion chromatography)	Silica	Spherical	5, 10µm	60, 120, 200, 300Å	580, 300, 200, 150m²/g	—	—	No	
	Strong Anion-1	Silica	Spherical	5, 10µm	80, 100Å	220, 200m²/g	—	—	No	
	Weak Anion-2 (ion exchange)	Silica	Spherical	7µm	300Å	100m²/g	—	—	No	
	Strong Cation-1 (ion exchange)	Silica	Spherical	5, 10µm	80, 100Å	220, 200m²/g	—	—	No	

*Available only online.

Columns for Small Molecules (continued)

Brand	Phase	Base Material	Particle Shape	Particle Size	Pore Size	Surface Area	Carbon Load	Phase Type	End-capped?	USP L-code
Grom™ Sil (cont.)	Weak Cation-2 (ion exchange)	Silica	Spherical	7µm	300Å	100m²/g	—	—	No	
GROM	HIC (hydrophobic interaction chrom.)	Silica	Spherical	7µm	300Å	100m²/g	—	—	No	
Grom™ Sapphire	C18	Silica	Spherical	3, 5, 10µm	65, 110Å	500, 270m²/g	23, 16%	Monomeric	Yes	L1
GROM	C8	Silica	Spherical	3, 5, 10µm	65, 110Å	500, 270m²/g	15, 10%	Monomeric	Yes	L7
	C4	Silica	Spherical	3, 5, 10µm	65, 110Å	500, 270m²/g	10.5, 7%	Monomeric	Yes	L26
	Silica	Silica	Spherical	3, 5, 10µm	65, 110Å	500, 270m²/g	—	—	No	L3
Mixed Mode	C18/Cation	Silica	Spherical	5, 7µm	100Å	350m²/g	—	Polymeric	No	—
Alltech	C8/Anion	Silica	Spherical	7µm	100Å	350m²/g	—	Polymeric	No	—
	C8/Cation	Silica	Spherical	5µm	100Å	350m²/g	—	Polymeric	No	—
Platinum™	C18	Silica	Spherical	1.5, 3, 5µm	100Å	200m²/g	6%	Monomeric	Yes	L1
Alltech	C18 EPS	Silica	Spherical	1.5, 3, 5µm	100Å	200m²/g	5%	Monomeric	No	L1
	C8	Silica	Spherical	1.5, 3, 5µm	100Å	200m²/g	4%	Monomeric	Yes	L7
	C8 EPS	Silica	Spherical	3, 5µm	100Å	200m²/g	2.5%	Monomeric	No	L7
	Phenyl	Silica	Spherical	3, 5µm	100Å	200m²/g	—	Monomeric	Yes	L11
	Cyano	Silica	Spherical	3, 5µm	100Å	200m²/g	—	Monomeric	No	L10
	Amino (NH_2)	Silica	Spherical	3, 5µm	100Å	200m²/g	—	Monomeric	No	L8
	Silica	Silica	Spherical	3, 5µm	100Å	200m²/g	—	—	No	L3
	SAX	Silica	Spherical	3, 5µm	100Å	200m²/g	—	Monomeric	No	—
Prevail™	C18 Select	Silica	Spherical	3, 5µm	110Å	350m²/g	17%	Monomeric	Yes	L1
Alltech	C18	Silica	Spherical	3, 5µm	110Å	350m²/g	15%	Monomeric	Yes	L1
	C8	Silica	Spherical	3, 5µm	110Å	350m²/g	8%	Monomeric	Yes	L7
	Phenyl	Silica	Spherical	3, 5µm	110Å	350m²/g	7%	Monomeric	Yes	L11
	Cyano	Silica	Spherical	3, 5µm	110Å	350m²/g	—	Monomeric	Yes	L10
	Amino (NH_2)	Silica	Spherical	3, 5µm	110Å	350m²/g	—	Monomeric	No	L8
	Silica	Silica	Spherical	3, 5µm	110Å	350m²/g	—	—	No	L3
	Organic Acid	Silica	Spherical	3, 5µm	110Å	350m²/g	—	Monomeric	Yes	—
	Carbohydrate ES	Polymer	Spherical	5µm	—	—	—	—	No	—
Vydac® SP	101SP Sil	Silica	Spheroidal	5, 10µm	100Å	250–350m²/g	—	unbonded	No	L3
VYDAC	201SP C18	Silica	Spheroidal	3, 5, 10, 15µm	90Å	250–350m²/g	13%	Monomeric	Yes	L1
	208SP C8	Silica	Spheroidal	5, 10, 15µm	90Å	250–350m²/g	9%	Monomeric	Yes	L7
VisionHT™	C18	Silica	Spherical	1.5µm	100Å	200m²/g	6%	Monomeric	Yes	L1
GRACE	C-18-B	Silica	Spherical	1.5µm	120Å	220m²/g	5.5%	Monomeric	†	L1
	C18-P	Silica	Spherical	1.5µm	100Å	200m²/g	5%	Monomeric	No	L1
	C18-HL	Silica	Spherical	1.5µm	120Å	220m²/g	11%	Polymeric	†	L1
	HILIC, Silica	Silica	Spherical	1.5µm	120Å	220m²/g	—	—	No	L3

Columns for Large Molecules

Brand	Phase	Base Material	Particle Shape	Particle Size	Pore Size	Surface Area	Carbon Load	Phase Type	End-capped?	USP L-code
Genesis® 300	C18	Silica	Spherical	4, 7µm	300Å	120m²/g	10%	Monomeric	Yes	L1
JONES	C4	Silica	Spherical	4, 7µm	300Å	120m²/g	3%	Monomeric	Yes	L26
	CN	Silica	Spherical	4µm	300Å	120m²/g	3.3%	Monomeric	Yes	L11
Macrosphere™ 300	C18	Silica	Spherical	5, 7µm	300Å	100m²/g	10%	Monomeric	Yes	L1
Alltech	C8	Silica	Spherical	5, 7µm	300Å	100m²/g	2.2%	Monomeric	Yes	L7
	C4	Silica	Spherical	5, 7µm	300Å	100m²/g	—	Monomeric	Yes	L26
	SAX	Silica	Spherical	7µm	300Å	100m²/g	—	Monomeric	No	—
	WAX	Silica	Spherical	7µm	300Å	100m²/g	—	Monomeric	No	—
	SCX	Silica	Spherical	7µm	300Å	100m²/g	—	Polymeric	No	—
	WCX	Silica	Spherical	7µm	300Å	100m²/g	—	Polymeric	No	—
Macrosphere™ GPC	GPC 60	Silica	Spherical	7µm	60Å	450m²/g	—	Polymeric	No	L25
Alltech	GPC 100	Silica	Spherical	7µm	100Å	350m²/g	—	Polymeric	No	—
	GPC 150	Silica	Spherical	7µm	150Å	200m²/g	—	Polymeric	No	—
	GPC 300	Silica	Spherical	7µm	300Å	100m²/g	—	Polymeric	No	—
ProSphere™	C18	Silica	Spherical	3, 5, 10µm	300Å	120m²/g	9%	Monomeric	Yes	L1
Alltech	C18-AQ	Silica	Spherical	3, 5µm	100Å	450m²/g	18%	Monomeric	Yes	L1
	C4	Silica	Spherical	3, 5, 10µm	300Å	120m²/g	3%	Monomeric	Yes	L26
	Size-Exclusion 125	Silica	Spherical	4, 5µm	125Å	—	—	—	No	—
	Size-Exclusion 250	Silica	Spherical	4, 5µm	250Å	—	—	—	No	—
	Size-Exclusion 450	Silica	Spherical	8µm	450Å	—	—	—	No	—
	P-HR (reversed phase)	Polymer	Spherical	4µm	140Å	—	—	—	No	—
ProZap™ VYDAC	C18 ProZap™	Silica	Spherical	1.5µm	500Å	59m²/g	3%	Monomeric	Yes	L1
Vydac® ATP VYDAC	214ATP C4	Silica	Spheroidal	5, 10–15µm	300Å	70–110m²/g	3%	Polymeric	Yes	L26
Vydac® TP	101TP Sil	Silica	Spheroidal	5, 10, 10–15, 15–20µm	300Å	70–110m²/g	—	unbonded	No	L3
VYDAC	201TP C18	Silica	Spheroidal	5, 7, 10, 10–15, 15–20µm	300Å	70–90m²/g	8%	Polymeric	No	L1
	202TP C18	Silica	Spheroidal	3, 5, 10µm	300Å	60–90m²/g	9%	Polymeric	No	L1
	208TP C8	Silica	Spheroidal	3, 5, 7, 10, 10–15, 15–20µm	300Å	60–110m²/g	5%	Polymeric	Yes	L7
	214TP C4	Silica	Spheroidal	3, 5, 7, 10, 10–15, 15–20µm	300Å	60–110m²/g	3%	Polymeric	Yes	L26
	218TP C18	Silica	Spheroidal	3, 5, 7, 10, 10–15, 15–20µm	300Å	60–110m²/g	8%	Polymeric	Yes	L1
	219TP Di-Phe	Silica	Spheroidal	3, 5, 7, 10, 10–15, 15–20µm	300Å	60–110m²/g	4%	Polymeric	Yes	
	238TP C18	Silica	Spheroidal	3, 5, 7, 10, 10–15, 15–20µm	300Å	60–110m²/g	4%	Monomeric	Yes	L1
Everest® VYDAC	238EV C18	Silica	Spherical	5, 10, 10–15, 15–20µm	300Å	70–110m²/g	6%	Monomeric	Yes	L1
Vydac® MS	208MS C8	Silica	Spheroidal	5µm	300Å	70m²/g	5%	Polymeric	Yes	L7
VYDAC	214MS C4	Silica	Spheroidal	5µm	300Å	70–110m²/g	3%	Polymeric	Yes	L26
	218MS C18	Silica	Spheroidal	3, 5, 10, 10–15µm	300Å	60–110m²/g	8%	Polymeric	Yes	L1
	238MS C18	Silica	Spheroidal	5µm	300Å	70m²/g	4%	Monomeric	Yes	L1
	219MS Di-Phe	Silica	Spheroidal	5µm	300Å	70m²/g	4%	Polymeric	Yes	

*Product information is available at www.discoverysciences.com. †Proprietary.

Grace® HPLC Hardware Formats

Grace Davison Discovery Sciences provides hardware formats to maximize the performance of the phases in our column families for all applications. Choose a hardware format based on your method requirements for speed, sensitivity, and resolution.

Ultra High-Pressure Hardware

Ideally suited for ultra high-pressure systems, this ultra-low volume hardware is pressure rated to 18,000psig, and packed with 1.5µm media to maximize speed and efficiency.

Lengths	Inner Diameters	Pressure Limit	Wetted Surfaces
20, 30, 50, 100mm	1.0, 2.0mm	18,000psig	316 Stainless Steel

Expedite™ MS Hardware

High-speed, low-volume columns for rapid resolution and high-throughput LC/MS applications.

Lengths	Inner Diameters	Pressure Limit	Wetted Surfaces
10, 20mm	2.1, 4.6mm	10,000psig	316 Stainless Steel

Rocket™ Hardware

High-speed, high-resolution columns for high-throughput analysis. Large 7mm i.d. balances column volume with system volume to deliver excellent peak shapes on conventional HPLC instrumentation. Large i.d. also allows fast mobile-phase flow rates which minimizes peak broadening.

Lengths	Inner Diameters	Pressure Limit	Wetted Surfaces
33, 53mm	7mm	10,000psig	316 Stainless Steel

Solvent-Reducer and Microbore Hardware

Smaller diameter columns reduce solvent consumption and increase sensitivity when compared to standard 4.6mm i.d. columns. Use with standard HPLC instrumentation or with MS and ELS detectors.

Lengths	Inner Diameters	Pressure Limit	Wetted Surfaces
50, 100, 150, 150, 250, 300mm	1.0, 2.1, 3.0mm	10,000psig	316 Stainless Steel

Capillary Hardware

For LC/MS and other high-sensitivity and sample-limited applications.

Lengths	Inner Diameters	Pressure Limit	Wetted Surfaces
50, 100, 150, 250, 300mm	0.075, 0.150, 0.3, 0.5, 0.8mm	5000psig	316 Stainless Steel and fused silica

Analytical Hardware

4.6mm i.d. columns for standard HPLC instrumentation, the most commonly used. Analytical columns have industry standard port configurations. Some column families are also available with port configurations for Waters® endfittings.

Lengths	Inner Diameters	Pressure Limit	Wetted Surfaces
30, 50, 100, 150, 250, 300mm	4.6mm	10,000psig	316 Stainless Steel

Metal-Free Hardware

Mechanically strong, metal-free columns offer biocompatibility, and chemical resistance that ion chromatography and biotechnology applications demand.

Lengths	Inner Diameters	Pressure Limit	Wetted Surfaces
50, 100, 150, 250, 300mm	2.1, 4.6mm	5000psig	PEEK

Capillary Guards

Capillary guards offer zero dead-volume with finger-tight connections to maintain column performance. Use them to protective your capillary investment, as enrichment columns, or as short analytical columns.

Lengths	Inner Diameters	Pressure Limit	Wetted Surfaces
5, 10, 20mm	0.3, 0.5mm	5000psig	316 Stainless Steel and fused silica

All-Guard™ Guard Cartridges

Guard system with reusable holder and disposable guard columns to protect analytical columns.

Lengths	Inner Diameters	Pressure Limit	Wetted Surfaces
7.5mm	2.1, 3.0, 4.6mm	5000psig	316 Stainless Steel

more info

Looking for preparative HPLC hardware?

See page 150.

High Throughput HPLC Introduction

The Benefits of Grace® Small Particles and Formats

Today's laboratories are under greater demand to analyze more samples in less time. To help meet this demand, major product advances have been made to decrease analysis time and increase HPLC throughput. HPLC system advances have greatly reduced the influence of extra column volumes and have extended the range of flow rates and pressure capabilities. In response to this, Grace now offers a wide range of column chemistries and formats appropriate for all types of high throughput systems.

The use of smaller particles offers two main improvements to the chromatographic separation—increased resolution and speed. Resolution is directly proportional to the square root of column efficiency, therefore the higher the efficiency, the narrower the peaks and the greater the resolution between them. Increased speed comes from higher mobile phase flow rates that can be used without loss in efficiency, and higher flow rates mean faster analysis times.

Understanding the type of system currently in use for high throughput separations and then matching the right column configuration is critical to achieving the best high throughput separation. Here we outline the three types of systems currently in use today for high throughput and the recommended HPLC column format for use with that system.

tech tip

Converting Methods From Traditional Column Formats to High Throughput Columns

Convert Between Standard HPLC and VisionHT™ Columns	
	Flow Rate
Standard HPLC (4.6mm)	1.0X
VisionHT™ (2.0mm)	2.3X

When adjusting between standard LC conditions to VisionHT™ columns convert flow rates accordingly and then increase flow rate for faster analysis.

Convert Between Standard HPLC Columns and Rocket™ Columns	
	Flow Rate
Standard Analytical (4.6mm)	1.0X
Rocket™ Column (7.0mm)	2.3X

Use this conversion of flow rate to transfer methods between Rocket™ column or VisionHT™ columns. Backpressure on standard LC systems should be considered.

System Type 1
Ultra High-Pressure LC System

(>10,000psig pressure limitation)

Examples: Agilent 1200, Waters® Acquity®, Thermo Accela™, Jasco XLc.

Speed from Ultra High-Pressure Systems:

Representing the latest in LC instrumentation technology, ultra high-pressure systems theoretically have the potential to deliver the fastest separations. They have minimal system volume and offer a pressure limit upwards of 12,000psig. This allows the use of columns with sub 2µm particles and 2–7 times traditional flow rates. Sub 2µm particles extend the working range of acceptable mobile phase linear velocities without sacrificing efficiency. Therefore, you can push flow rates and still get equal or better performance.

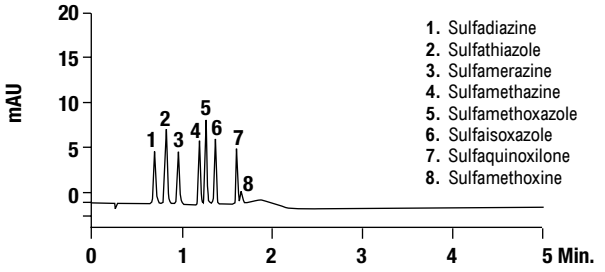
Suggested Column Format:

VisionHT™ columns are designed for microbore and ultra high-pressure LC systems that have small system volumes to limit peak broadening from sample diffusion. VisionHT™ columns are packed with highly efficient 1.5µm phases that yield taller peaks and increase sensitivity. The column hardware incorporates a low dead volume design to minimize sample diffusion, and maintain peak integrity and efficiency. 12,000psig high-pressure stability allows fast flow rates, decreasing run times 10 fold.

System Type 1	
Recommended Column Format:	VisionHT™
Length:	20, 30, 50, 100mm
i.d.:	1.0 and 2.0mm

VisionHT™ Columns for Ultra High-Pressure LC

CHROM 10724



System	Agilent 1200
Mobile Phase:	**A:** 0.1% Formic Acid
	B: Methanol
Detector:	UV at 280nm
Temperature:	Ambient

more info

See pages 34–37 for more information on VisionHT™ columns.

System Type 2
Low Volume, High Throughput (HTP) LC System

(<10,000psig Pressure Limitation)

Examples: Shimadzu Prominence® UFLC, Hitachi Ultra, LC Packings UltiMate®, Surveyor Plus

Speed from Low-Volume HTP LC Systems:

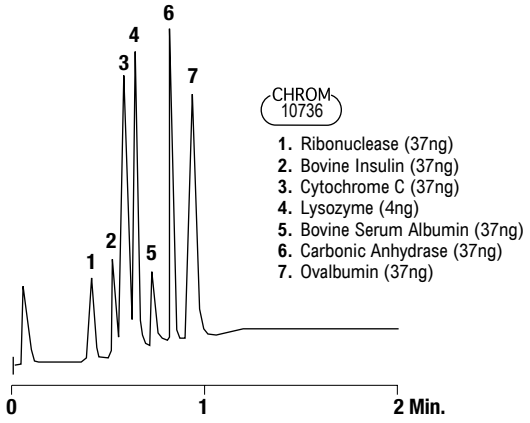
These systems concentrate on reducing the cycle time between injections thus allowing more injections per time frame. Typically they employ high-speed gradient pumps, fast autosamplers and a quick detector sampling rates. They are not pressure rated to the extremes of ultra high-pressure systems, but the low system volume allows for short columns of narrow i.d.

Suggested Column Format:

Expedite™ and VisionHT™ columns are designed for microbore high throughput LC systems that have small system volumes. These formats incorporate a low dead volume design so that sample bands do not diffuse within the column hardware, maintaining peak integrity and efficiency. Expedite™ columns are packed with highly efficient 1.5µm or 3µm in very short column lengths to minimize backpressure and reduce analysis times. Though not as fast as ultra high-pressure LC systems these systems and columns balance both speed and backpressure.

System Type 2	
Recommended Column Formats:	Expedite™ and VisionHT™
Length:	10, 20, 30, 50mm
i.d.:	1, 2, 4.6mm

Expedite™ Columns for Low Volume High Throughput LC



CHROM 10736

1. Ribonuclease (37ng)
2. Bovine Insulin (37ng)
3. Cytochrome C (37ng)
4. Lysozyme (4ng)
5. Bovine Serum Albumin (37ng)
6. Carbonic Anhydrase (37ng)
7. Ovalbumin (37ng)

Column:	ProZap™ C18, 1.5µm, 2.1 x 10mm Expedite™
Mobile Phase:	**A:** 0.1% TFA in Water
	B: 0.085% TFA in Acetonitrile
Flow Rate:	0.8mL/min
Detector:	UV at 280nm
Injection Vol.:	5µL

more info

Expedite™ columns are available in most popular Alltech® brand phases. See page 24–25 for overview of phases and formats offered.

System Type 3
Traditional LC System

(<5000psi Pressure Limitation)

Examples: Agilent 1100, Waters® Alliance®, Thermo Surveyor®, Dionex Ultimate®, Shimadzu Prominence®, Hitachi LaChrom®

Speed from Traditional LC Systems:

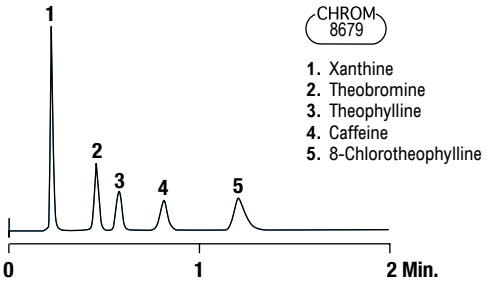
To get speed from a traditional LC system, you need to consider the 5000psig pressure limitation, and the typically "large" 2mL system volume. High throughput columns on this system need to deliver a highly efficient separation typically achieved with a small particle packing (≤3µm), but without the high backpressures. The "large" system volume also needs to be balanced with an equally large column volume or the separation will be plagued with extra-column effects.

Suggested Column Format:

Rocket™ columns provide low backpressure and fast analysis times while preserving column efficiency. They are available with both 1.5µm and 3µm packing materials for use on standard HPLC systems with backpressure limits less than 5000psig. The 7mm i.d. allows faster flow rate that "sweep" the extra system volume faster and reduce peak broadening. This larger diameter also means a larger column volume to system volume ratio to minimize the efficiency loss from extra system volume. This benefit is more pronounced over 2.1 and 1mm i.d. columns that have a smaller ratio than 4.6mm i.d. columns and require much lower flow rates for acceptable backpressures. Low flow rates allow more time for sample diffusion within the standard HPLC's system volume to further degrade the column's efficiency.

System Type 3	
Recommended Column Format:	Rocket™
Length:	33 or 53mm
i.d.:	7mm
Packings:	Any 1.5µm or 3µm media

Rocket™ Columns for High Throughput with Conventional LC



CHROM 8679

1. Xanthine
2. Theobromine
3. Theophylline
4. Caffeine
5. 8-Chlorotheophylline

Column:	Platinum™ C18-EPS 100Å, 3µm, 7 x 33mm Rocket™
Mobile Phase:	0.010M Sodium Acetate, pH 4.0:Methanol (70:30)
Flow Rate:	5.0mL/min
Detector:	UV at 254nm

more info

Rocket™ columns are available in most popular Alltech® brand phases. See page 24–25 for overview of phases and formats offered.