# Allowable Adjustments to United States Pharmacopeia (USP) Methods

## LC – Isocratic Elution

| Component | United States Pharmacopeia (USP) |
|---|---|
| **Stationary Phase** | No change of the identity of the substituent permitted.<br>• No replacement of C18 by C8<br>• Other physico chemical characteristics must be similar<br>• Change from totally porous (TPP) to superficially porous particles (SPP) is allowed |
| **Particle Size and Column Length** | Particle size (dp) and/or column length (L) can be adjusted, if the L/dp ratio remains constant or in the range between -25 % and +50 %. When switching to Core-Shell particles, other combinations of L and dp can be used, if the number of theoretical plates (N) is between -25 % and +50 % of the original column. |
| **Column Internal Diameter** | Can be adjusted as wanted.<br>• If a smaller internal diameter (ID) or particle size is used, extra column band broadening may need to be minimized by factors such as instrument connection, detector cell volume, sampling rate and injection volume |
| **Flow Rate** | ± 50 % (after the adjustment due to changes in column ID and particle size)<br>• When particle size or column internal diameter is changed (e.g. from 4.6 mm ID and 5 µm at 1.0 mL/min to 3.0 mm ID and 3 µm), the flow rate is adjusted using the following equation:<br>$F_2 = F_1 \times \frac{dc_2^2 \times dp_1}{dc_1^2 \times dp_2} = 1.0 \times \frac{3.0^2 \times 5}{4.6^2 \times 3} = 0.71\ mL/min$ |
| **Column Temperature** | ± 10 °C (where the operating temperature is specified). |
| **Composition of the Mobile Phase** | ± 30 % (relative) for minor components, but no component is altered by more than 10 % absolute. A minor component comprises less or equal than (100/n) %, n being the total number of components of the mobile phase. |
| **Mobile Phase pH** | ± 0.2 |
| **Concentration of Salts in the Buffer** | ± 10 % |
| **Detector Wavelength** | No adjustment permitted. |
| **Injection Volume** | When the column dimensions are changed, the following equation may be used for adjusting the injection volume:<br>$V_{Inj2} = V_{Inj1} \times \frac{L_2 \times dc_2^2}{L_1 \times dc_1^2}$<br>Even in the absence of any column dimension change, it may be varied if the system suitability criteria remain within their established acceptability limits. |

Source: European Pharmacopeia 11.0, Chapter 2.2.46. Chromatographic separation techniques, p. 86-96 and USP-NF 2022, General Chapter <621> Chromatography.

# Allowable Adjustments to United States Pharmacopeia (USP) Methods

## LC – Gradient Elution

| Component | United States Pharmacopeia (USP) |
|---|---|
| **Stationary Phase** | No change of the identity of the substituent permitted. |
| **Particle Size and Column Length** | Particle size (dp) and/or column length (L) can be adjusted, if the L/dp ratio remains constant or in the range between -25 % and +50 %. When switching to Core-Shell particles, other combinations of L and dp can be used, if the ratio ( $t_R/W_h)^2$ is between -25 % and +50 % of the original column, for each peak used to test the system suitability. |
| **Column Internal Diameter** | Can be adjusted as wanted. |
| **Flow Rate** | Is adjusted if column internal diameter and particle size is changed.<br>• When changing the column from 4.6 mm ID with 5 µm particle size at 2.0 mL/min to 2.1 mm ID with 3 µm particle size, the flow rate is adjusted using the following equation:<br>$F_2 = F_1 \times \frac{dc_2^2 \times dp_1}{dc_1^2 \times dp_2} = 2.0 \times \frac{2.1^2 \times 5}{4.6^2 \times 3} = 0.7\ mL/min$ |
| **Gradient Volume** | When changing the column dimension, each gradient segment volume is adjusted by means of the gradient time using the following equation:<br>$t_{G2} = t_{G1} \times \frac{F_1}{F_2} \times \frac{L_2 \times dc_2^2}{L_1 \times dc_1^2} = 3\ min \times \frac{2.0}{0.7} \times \frac{100 \times 2.1^2}{150 \times 4.6^2} = 3\ min \times 0.4 = 1.2\ min$ |
| **Column Temperature** | ± 5 °C (where the operating temperature is specified). |
| **Composition of the Mobile Phase + Gradient** | Adjustments of the composition of the mobile phase and the gradient are acceptable, if:<br>• The system suitability criteria are fulfilled<br>• The principal peak(s) elute(s) within ± 15 % of the indicated retention time(s). This requirement does not apply when the column dimensions are changed<br>• The first peaks are sufficiently retained and the last peaks are eluted |
| **Mobile Phase pH** | ± 0.2 |
| **Concentration of Salts in the Buffer** | ± 10 % |
| **Dwell Volume** | Gradient time points (t in min) can be adapted to compensate differences in dwell volume between the system used for method development ($D_0$ in mL) and that actually used (D in mL). The adapted time points ($t_c$ in min) at the current flow rate (F in mL/min) can be calculated using the following equation:<br>$t_c = t - \frac{(D - D_0)}{F} = 1\ min - \frac{(1.0\ mL - 0.5\ mL)}{1\ mL/min} = 0.5\ min$ |
| **Detector Wavelength** | No adjustment permitted. |
| **Injection Volume** | When the column dimensions are changed, the following equation may be used for adjusting the injection volume:<br>$V_{Inj2} = V_{Inj1} \times \frac{L_2 \times dc_2^2}{L_1 \times dc_1^2}$<br>• Even in the absence of any column dimension change, injection volume may be varied if the system suitability criteria remain within their established acceptability limits<br>• When the injection volume is decreased, special attention is given to (limit of) detection and repeatability of the peak response(s)<br>• An increase is permitted, if the linearity and resolution of the peak(s) to be determined remain satisfactory |

Source: European Pharmacopeia 11.0, Chapter 2.2.46. Chromatographic separation techniques, p. 86 - 96 and USP-NF 2022, General Chapter <621> Chromatography.

# HPLC Column Selection by USP Listing

| USP Column Classification | | Recommended Phenomenex Column | Particle Shape |
|---|---|---|---|
| **L1** | Octadecyl silane chemically bonded to porous or non-porous silica or ceramic microparticles, 1.5 to 10 µm in diameter, or a monolithic rod. | Kinetex™ C18<br>Kinetex EVO C18<br>Kinetex Polar C18<br>Kinetex PS C18<br>Kinetex XB-C18<br>Luna™ C18(2)<br>Luna Omega C18<br>Luna Omega PS C18<br>Luna Omega Polar C18<br>Gemini™ NX-C18<br>Gemini C18<br>Synergi™ Hydro-RP<br>Synergi Fusion-RP<br>Biozen™ Peptide PS-C18<br>Onyx™ C18<br>Jupiter™ C18<br>Clarity™ Oligo-RP<br>Clarity Oligo-MS<br>Clarity Oligo-XT<br>Aeris™ WIDEPORE XB-C18<br>Biozen Peptide XB-C18 | Core-Shell<br>Core-Shell<br>Core-Shell<br>Core-Shell<br>Core-Shell<br>Spherical<br>Spherical<br>Spherical<br>Spherical<br>Spherical<br>Spherical<br>Spherical<br>Spherical<br>Spherical<br>Monolith<br>Spherical<br>Spherical<br>Core-Shell<br>Core-Shell<br>Core-Shell<br>Core-Shell |
| **L2** | Octadecyl silane chemically bonded to silica gel of a controlled surface porosity that has been bonded to a solid spherical core, 30 to 50 µm in diameter. | | |
| **L3** | Porous silica particles, 1.5 to 10 µm in diameter, or a monolithic silica rod. | Kinetex HILIC<br>Luna Silica(2)<br>Onyx Silica | Core-Shell<br>Spherical<br>Monolith |
| **L4** | Silica gel of controlled surface porosity bonded to a solid spherical core, 30 to 50 µm in diameter. | | |
| **L5** | Alumina of controlled surface porosity bonded to a solid spherical core, 30 to 50 µm in diameter. | | |
| **L6** | Strong cation-exchange packing: sulfonated fluorocarbon polymer coated on a solid spherical core, 30 to 50 µm in diameter. | | |
| **L7** | Octyl silane chemically bonded to totally or superficially porous silica particles, 1.5 to 10 µm in diameter, or a monolithic silica rod. | Kinetex C8<br>Luna C8(2)<br>Onyx C8<br>Biozen Intact XB-C8 | Core-Shell<br>Spherical<br>Monolith<br>Core-Shell |
| **L8** | An essentially monomolecular layer of aminopropyl-silane chemically bonded to totally porous silica gel support, 1.5 to 10 µm in diameter, or a monolithic silica rod. | Luna $NH_2$<br>Luna Omega SUGAR | Spherical<br>Spherical |
| **L9** | Irregular or spherical, totally porous silica gel having a chemically bonded, strongly acidic cation-exchange coating, 3 to 10 µm in diameter. | Luna SCX | Spherical |
| **L10** | Nitrile groups chemically bonded to porous silica particles or superficially porous particles, 1.5 to 10 µm in diameter, or a monolithic silica rod. | Luna CN | Spherical |
| **L11** | Phenyl groups chemically bonded to porous silica particles or superficially porous particles, 1.5 to 10 µm in diameter, or a monolithic silica rod. | Kinetex Biphenyl<br>Kinetex Phenyl-Hexyl<br>Synergi Polar-RP<br>Luna Phenyl-Hexyl<br>Gemini C6-Phenyl<br>Prodigy PH-3 | Core-Shell<br>Core-Shell<br>Spherical<br>Spherical<br>Spherical<br>Spherical |
| **L12** | Strong anion-exchange packing made by chemically bonding a quaternary amine to a solid silica spherical core, 30 to 50 µm in diameter. | | |
| **L13** | Trimethylsilane chemically bonded to porous silica particles, 3 to 10 µm in diameter. | Develosil® TMS-UG (C1) 130 Å | Spherical |
| **L14** | Silica gel having a chemically bonded, strongly basic quaternary ammonium anion-exchange coating, 5 to 10 µm in diameter. | PhenoSphere™ SAX | Spherical |
| **L15** | Hexyl silane chemically bonded to totally porous silica particles, 3 to 10 µm in diameter. | PhenoSphere C6 | Spherical |
| **L16** | Dimethyl silane chemically bonded to porous silica particles, 5 to 10 µm in diameter. | | |
| **L17** | Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the hydrogen form, 6 to 12 µm in diameter. | Rezex™ RHM-Monosaccharide<br>Rezex ROA-Organic Acid | Spherical<br>Spherical |
| **L18** | Amino and cyano groups chemically bonded to porous silica particles, 3 to 10 µm in diameter. | | |
| **L19** | Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the calcium form, 5 to 15 µm in diameter. | Rezex RCM-Monosaccharide<br>Rezex RCU-Sugar Alcohols | Spherical<br>Spherical |
| **L20** | Dihydroxypropane groups chemically bonded to porous silica or hybrid particles, 1.5 to 10 µm in diameter, or a monolithic silica rod. | Luna HILIC<br>BioSep™-SEC-S<br>Biozen dSEC-2 | Spherical<br>Spherical<br>Spherical |
| **L21** | A rigid, spherical styrene-divinylbenzene copolymer, 3 to 30 µm in diameter. | PolymerX™ RP-1<br>Phenogel™ 100 Å | Spherical<br>Spherical |
| **L22** | A cation-exchange resin made of porous polystyrene gel with sulfonic acid groups, 5 to 15 µm in diameter. | Rezex ROA-Organic Acid | Spherical |
| **L23** | An anion-exchange resin made of porous polymethacrylate or polyacrylate gel with quaternary ammonium groups, 7-12 µm in size. | Shodex® IEC QA-825 | Spherical |
| **L24** | Polyvinylalcohol chemically bonded to porous silica particles, 5 µm in diameter. | | |
| **L25** | Packing having the capacity to separate compounds with a MW range from 100 to 5000 daltons (as determined by polyethylene oxide), applied to neutral, anionic, and cationic water-soluble polymers. A polymethacrylate resin base, crosslinked with poly-hydroxylated ether (surface contained some residual carboxyl functional groups) was found suitable. | PolySep™-GFC-P2000<br>Shodex OHpak SB-802.5HQ | Spherical<br>Spherical |

# HPLC Column Selection by USP Listing

| USP Column Classification | | Recommended Phenomenex Column | Particle Shape |
|---|---|---|---|
| **L26** | Butyl silane chemically bonded to totally or superficially porous silica particles, 1.5 to 10 µm in diameter. | Jupiter 300 C4<br>Biozen WidePore C4 | Spherical<br>Core-Shell |
| **L27** | Porous silica particles, 30 to 50 µm in diameter. | Sepra Silica | Irregular |
| **L28** | A multifunctional support, which consists of a high purity, 100 Å, spherical silica substrate that has been bonded with anionic exchanger, amine functionality in addition to a conventional reversed phase C8 functionality. | | |
| **L29** | Gamma alumina, reversed phase, low carbon percentage by weight, alumina-based polybutadiene spherical particles, 5 µm diameter with a pore volume of 80 Å. | | |
| **L30** | Ethyl silane chemically bonded to a totally porous silica particle, 3 to 10 µm in diameter. | | |
| **L31** | A hydroxide-selective, strong anion-exchange resin-quaternary amine bonded on latex particles attached to a core of 8.5 µm macroporous particles having a pore size of 2000 Å and consisting of ethylvinylbenzene cross-linked with 55% divinyl benzene. | | |
| **L32** | A chiral ligand-exchange resin packing-L-proline copper complex covalently bonded to irregularly shaped silica particles, 5 to 10 µm in diameter. | | |
| **L33** | Packing having the capacity to separate dextrans by molecular size over a range of 4,000 to 500,000 daltons. It is spherical, silica-based and processed to provide pH stability. | Yarra SEC-2000 / SEC-3000<br>BioSep-SEC-S2000 / SEC-S3000 | Spherical<br>Spherical |
| **L34** | Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the lead form, 7 to 9 µm in diameter. | Rezex RPM-Monosaccharide | Spherical |
| **L35** | A zirconium-stabilized spherical silica packing with a hydrophilic (diol-type) molecular monolayer bonded phase having a pore size of 150 Å. | (BioSep-SEC-S2000<br>or Yarra SEC-2000<br>may be used) | Spherical<br>Spherical |
| **L36** | 3,5-dinitrobenzoyl derivative of L-phenylglycine covalently bonded to 5 µm aminopropyl silica. | | |
| **L37** | Polymethacrylate gel packing having the capacity to separate proteins by molecular size over a range of 2,000 to 40,000 daltons. | PolySep-GFC-P3000<br>Shodex OHpak SB-803HQ | Spherical<br>Spherical |
| **L38** | Methacrylate-based size-exclusion packing for water-soluble samples. | PolySep-GFC-P series<br>Shodex OHpak SB-800HQ | Spherical<br>Spherical |
| **L39** | Hydrophilic polyhydroxymethacrylate gel of totally porous spherical resin. | PolySep-GFC-P series<br>Shodex OHpak SB-800HQ series<br>Shodex RSpak DM-614 | Spherical<br>Spherical<br>Spherical |
| **L40** | Cellulose tris-3,5-dimethylphenylcarbamate coated porous silica particles, 3 µm to 20 µm in diameter. | Lux Cellulose-1 | Spherical |
| **L41** | Immobilized $\alpha_1$-acid glycoprotein on spherical silica particles, 5 µm in diameter. | | |
| **L42** | Octylsilane and octadecylsilane groups chemically bonded to porous silica particles, 5 µm in diameter. | | |
| **L43** | Pentafluorophenyl groups chemically bonded to silica particles or superficially porous particles, by a propyl spacer, 1.5 to 10 µm in diameter. | Kinetex F5<br>Luna PFP(2) | Core-Shell<br>Spherical |
| **L44** | A multifunctional support, which consists of a high purity, 60 Å, spherical silica substrate that has been bonded with a cationic exchanger, sulfonic acid functionality in addition to a conventional reversed phase C8 functionality. | | |
| **L45** | Beta cyclodextrin, R, S-hydroxypropyl ether derivative, bonded to porous silica particles, 3 to 10 µm in diameter | Shiseido Chiral CD-Ph | Spherical |
| **L46** | Polystyrene/divinylbenzene substrate agglomerated with quaternary amine functionalized latex beads, about 9 to 11 µm in diameter. | | |
| **L47** | High capacity anion-exchange microporous substrate, fully functionalized with a trimethylamine group, 8 µm in diameter. | | |
| **L48** | Sulfonated, cross-linked polystyrene with an outer layer of submicron, porous, anion-exchange microbeads, 5 to 15 µm in diameter. | | |
| **L49** | A reversed phase packing made by coating a thin layer of polybutadiene on to spherical porous zirconia particles, 3 to 10 µm in diameter. | | |
| **L50** | Multifunction resin with reversed phase retention and strong anion-exchange functionalities. The resin consists of ethylvinylbenzene, 55% cross-linked with divinylbenzene copolymer, 3 to 15 µm in diameter, and a surface area of not less than 350 $m^2$/g. Substrate is coated with quaternary ammonium functionalized latex particles consisting of styrene cross-linked with divinylbenzene. | | |
| **L51** | Amylose tris-3,5-dimethylphenylcarbamate-coated, porous, spherical, silica particles, 3 to 10 µm in diameter. | Lux Amylose-1 | Spherical |
| **L52** | A strong cation-exchange resin made of porous silica with sulfopropyl or sulfoethyl groups, 1 to 10 µm in diameter. | | |
| **L53** | Weak cation-exchange resin consisting of ethylvinylbenzene, 55% cross-linked with divinylbenzene copolymer, 3 to 15 µm diameter. Substrate is surface grafted with carboxylic acid and/or phosphoric acid functionalized monomers. Capacity not less than 500 µEq/column. | | |
| **L54** | A size exclusion medium made of covalent bonding of dextran to highly cross-linked porous agarose beads, 5 to 15 µm in diameter. | | |
| **L55** | A strong cation-exchange resin made of porous silica coated with polybutadiene-maleic acid copolymer, about 5 µm in diameter. | | |
| **L56** | Propyl silane chemically bonded to totally or superficially porous silica particles, 3 to 10 µm in diameter. | | |
| **L57** | A chiral-recognition protein, ovomucoid, chemically bonded to silica particles, about 5 µm in diameter, with a pore size of 120 Å. | Ultron ES-OVM | Spherical |
| **L58** | Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the sodium form, about 6 to 30 µm in diameter. | Rezex RNM-Carbohydrate | Spherical |
| **L59** | Size-exclusion separations of proteins (separation by molecular weight) over the range of 5 to 7000 kDa. Spherical (1.5 to 10 µm), silica or hybrid packing with a hydrophilic coating. | Yarra SEC-2000<br>BioSep-SEC-S2000<br>Yarra SEC-3000<br>BioSep-SEC-S3000 | Spherical<br>Spherical<br>Spherical<br>Spherical |
| **L60** | Spherical, porous silica gel, 10 µm or less in diameter, surface has been covalently modified with alkyl amide groups and endcapped. | | |
| **L61** | Hydroxide-selective, strong anion-exchange resin consisting of a highly cross-linked core of 13 µm microporous particles, pore size less than 10 Å, and consisting of ethylvinylbenzene cross-linked with 55% divinylbenzene with a latex coating composed of 85 nm diameter microbeads bonded with alkanol quaternary ammonium ions (6%). | | |

# HPLC Column Selection by USP Listing

| USP Column Classification | | Recommended Phenomenex Column | Particle Shape |
|---|---|---|---|
| **L62** | C30 silane bonded phase on a fully porous spherical silica or superficially porous particles, 3 to 15 µm in diameter. | Develosil RP-Aqueous<br>Develosil RP-Aqueous-AR | Spherical<br>Spherical |
| **L63** | Glycopeptide teicoplanin linked through multiple covalent bonds to a 100 Å spherical silica. | | |
| **L64** | Strongly basic anion-exchange resin consisting of 8 % crosslinked styrene divinylibenzene copolymer with a quaternary ammonium group in the chloride form, 45 to 180 µm in diameter. | | |
| **L65** | Strongly acidic cation-exchange resin consisting of 2 % sulfonated crosslinked styrene divinylbenzene copolymer with a sulfonic acid group in the hydrogen form, 63 to 250 µm in diameter. | | |
| **L66** | A crown ether coated on a 5 µm particle size silica gel substrate. The active site is (S)-18-crown-6-ether. | | |
| **L67** | Porous vinyl alcohol copolymer with a C18 alkyl group attached to the hydroxyl group of the polymer, 2 to 10 µm in diameter. | Asahipak ODP-50 | Spherical |
| **L68** | Spherical, porous silica, 10 µm or less in diameter, the surface of which has been covalently modified with alkyl amide groups and not endcapped. | | |
| **L69** | Ethylvinylbenzene/divinylbenzene substrate agglomerated with quaternary amine functionalized 130 nm latex beads, about 6.5 µm in diameter. | | |
| **L70** | Cellulose tris (phenyl carbamate) coated on 5 µm silica. | | |
| **L71** | A rigid, spherical polymethacrylate 4 to 6 µm in diameter. | Shodex RSpak DE-413<br>Shodex RSpak DE-613 | Spherical<br>Spherical |
| **L72** | (S)-phenylglycine and 3,5-dinitroaniline urea linkage covalently bonded to silica. | | |
| **L73** | A rigid, spherical polydivinylbenzene particle 5 to 10 µm in diameter. | | |
| **L74** | A strong anion-exchange resin consisting of a highly cross-linked core of 7 µm macroporous particles having a 100 Å average pore size and consisting of ethylvinylbenzene cross-linked with 55 % divinylbenzene and an anion-exchange layer grafted to the surface, which is functionalized with alkyl quaternary ammonium ions. | | |
| **L75** | A chiral-recognition protein, bovine serum albumin (BSA), chemically bonded to silica particles, about 7 µm in diameter, with a pore size of 300 Å. | | |
| **L76** | Silica-based weak cation-exchange material, 5 µm in diameter. Substrate is surface polymerized polybutadiene-maleic acid to provide carboxylic acid functionalities. Capacity not less than 29 µEq/column. | | |
| **L77** | Weak cation-exchange resin consisting of ethylvinylbenzene, 55 % cross-linked with divinylbenzene copolymer, 6 to 9 µm diameter. Substrate is surface grafted with carboxylic acid functionalized groups. Capacity not less than 500 µEq/column (4 mm x 25 cm). | | |
| **L78** | A silane ligand that consists of both reversed phase (an alkyl chain longer than C8) and anion-exchange (primary, secondary, tertiary, or quaternary amino groups) functional groups chemically bonded to porous or non-porous or ceramic micro-particles, 1.0 to 50 µm in diameter or a monolithic rod. | | |
| **L79** | A chiral-recognition protein, human serum albumin (HSA), chemically bonded to silica particles, about 5 µm in diameter. | | |
| **L80** | Cellulose tris(4-methylbenzoate)-coated, porous, spherical, silica particles, 5 to 20 µm in diameter. | Lux Cellulose-3 | Spherical |
| **L81** | A hydroxide-selective, strong anion-exchange resin consisting of a highly cross-linked core of 9 µm porous particles having a pore size of 2000 Å units and consisting of ethylvinylbenzene cross-linked with 55 % divinylbenzene with a latex coating composed of 70 nm diameter microbeads (6 % crosslinked) bonded with alkanol quaternary ammonium ions. | | |
| **L82** | Polyamine chemically bonded to cross-linked polyvinyl alcohol polymer, 4 - 5 µm in diameter | Asahipak $NH_2P$-50 | Spherical |
| **L83** | A hydroxide-selective, strong anion-exchange resin-quaternary amine bonded on latex particles attached to a core of 10.5 µm microporous particles having a pore size of 10 Å and consisting of ethylvinylbenzene cross-linked with 55 % divinylbenzene. | | |
| **L84** | Weak cation-exchange resin consisting of ethylvinylbenzene, 55 % cross-linked with divinylbenzene copolymer, 5 µm diameter. Substrate is surface grafted with carboxylic acid functionalized groups. Capacity not less than 8400 µEq column (5 mm x 25 cm). | | |
| **L85** | A silane ligand that consists of both reversed phase (an alkyl chain longer than C8) and weak cation-exchange (carboxyl groups) functional groups chemically bonded to porous or non-porous particles, 1.0 to 50 µm in diameter. | | |
| **L86** | Fused core particle with a highly polar ligand possessing multiple hydroxyl groups tethered to the silica gel outer layer. | | |
| **L87** | Dodecyl silane chemically bonded to porous or superficially porous silica particles, 1.5 to 10 µm in diameter. | Synergi Max-RP | Spherical |
| **L88** | Glycopeptide vancomycin linked through multiple covalent bonds to 100 Å spherical silica. | | |
| **L89** | Packing having the capacity to separate compounds with a molecular weight range from 100 - 3000 dalton (as determined by polyethylene oxide), applied to neutral and anionic water-soluble polymers. A polymethacrylate resin base, cross-linked with polyhydroxylate ether (surface contains some residual cationic functional groups). | Shodex OHpak SB-802.5 HQ | Spherical |
| **L90** | Amylose tris-[(S)-alpha-methylbenzylcarbamate] coated on porous, spherical silica particles, 3 to 10 µm in diameter. | | |
| **L91** | Strong anion-exchange resin consisting of monodisperse porous polystyrene/divinylbenzene beads coupled with quaternary amine. Bead size is 3 to 10 µm. | | |
| **L92** | A strong anion-exchange resin consisting of a highly cross-linked core of 5-9 µm macroporous particles having a 100 Å average pore size and consisting of ethylvinylbenzene cross-linked with 55 % divinylbenzene and an anion-exchange layer grafted to the surface, which is functionalized with alkanol quaternary ammonium ions. | | |
| **L93** | Cellulose tris (3,5-dimethylphenylcarbamate) reversed phase chiral stationary phase coated on 3 or 5 µm silica gel particles. | Lux Cellulose-1 | Spherical |
| **L94** | A strong anion-exchange resin consisting of highly cross-linked 15 µm microporous particles functionalized with very low cross-linked latex (0.5 %) to provide alkanol quaternary ammonium ion-exchange sites. | | |
| **L95** | Highly polar alkyl ligand comprising five hydroxyl groups that are chemically bonded to totally porous or superficially porous silica, or a monolithic silica rod. | | |
| **L96** | Alkyl chain, reversed phase bonded to totally or superficially porous silica designed to retain hydrophilic and other polar compounds when using highly aqueous mobile phases, including 100 % aqueous, 1.5 µm to 10 µm in diameter. | Kinetex Polar C18<br>Luna Omega Polar C18<br>Synergi Hydro-RP<br>Synergi Fusion-RP | Core-Shell<br>Core-Shell<br>Spherical<br>Spherical<br>Core-Shell<br>Spherical<br>Spherical |

# HPLC Column Selection by USP Listing

| USP Column Classification | | Recommended Phenomenex Column | Particle Shape |
|---|---|---|---|
| **L97** | Weak cation-exchange resin consisting of a highly cross-linked core of 5.5 µm porous particles having a pore size of 2000 Å and consisting of ethylvinylbenzene cross-linked with 55 % divinylbenzene. Substrate is surface grafted with carboxylic acid functionalized groups. Capacity not less than 2400 µEq/column (4 mm x 25 cm). | | |
| **L98** | Weak cation-exchange resin consisting of a highly cross-linked core of 8 µm microporous particles having an average pore size of 10 Å and consisting of ethylvinylbenzene cross-linked with 55 % divinylbenzene. Substrate is surface grafted with carboxylic acid functionalized groups. Capacity not less than 46 µEq/column (4 mm x 5 cm). | | |
| **L99** | Amylose tris-(3,5- dimethylphenylcarbamate), immobilized on porous, spherical, silica particles, 3 to 5 µm in diameter | Lux i-Amylose-1 | Spherical |
| **L100** | A 55 % cross-linked, microporous, hydrophobic resin core (9 µm microporous particles having a pore size of 10 Å) that consists of a bilayer of anion and cation-exchange latex. The first layer is fully sulfonated (140 nm) and the second layer is fully aminated (76 nm). | | |
| **L101** | Cholesteryl groups chemically bonded to porous or non-porous silica or ceramic micro-particles, 1.5 to 10 µm in diameter, or a monolithic rod. | | |
| **L102** | (Naproxen, (S,S)Whelk-O 1) 1-(3,5- dinitrobenzamido)-1,2,3,4- tetrahydrophenanthrene covalently bonded to porous spherical silica particles, 5 to 10 µm in diameter. | | |
| **L103** | A hydroxide-selective, strong anion-exchange resin consisting of a highly cross-linked core of 7.5 µm porous particles having a pore size of 2000 Å and consisting of ethylvinylbenzene cross-linked with 55 % divinylbenzene electrostatically bonded with hyperbranched alkanol quaternary ammonium ions. | | |
| **L104** | Triazole groups chemically bonded to porous silica particles, 1.5 to 10 µm in diameter. | | |
| **L105** | A strong anion-exchange resin consisting of a highly cross-linked 9 µm supermacroporous (2000 Å) particles functionalized with very low cross-linked latex (0.2 %) to provide alkyl quaternary ammonium ion sites. | | |
| **L106** | Weak cation-exchange resin consisting of ethylvinylbenzene, 55 % cross-linked with divinylbenzene copolymer, 5-8 µm diameter, macroporous particles having an average pore size of 100 Å units. Substrate is surface grafted with carboxylic acid and phosphonic acid functional groups. Capacity not less than 2800 µEq/column (4 mm x 25 cm). | | |
| **L107** | Cellulose tris(4-methylbenzoate)-coated porous spherical particles, 3 to 5 µm in diameter, for use with reversed phase mobile phases. | Lux Cellulose-3 | Spherical |
| **L108** | A chiral-recognition protein, cellobiohydrolase (CBH), chemically bonded to silica particles, about 5 µm in diameter. | | |
| **L109** | Spherical particles of porous graphitic carbon, 1.5 to 30 µm in diameter. | | |
| **L110** | A strong anion-exchange resin consisting of a highly cross-linked 13 µm microporous (less than 10 Å) particles coated with very low cross-linked latex (0.5 %) to provide alkanol quaternary ammonium ion-exchange sites. | | |
| **L111** | Polyamine chemically bonded to porous spherical silica particles, 5 µm in diameter. | | |
| **L112** | A hydroxide-selective, strong anion-exchange resin consisting of a highly cross-linked core of 8.5 µm porous particles having a pore size of 2000 Å units and consisting of ethylvinylbenzene cross-linked with 55 % divinyl-benzene with a latex coating composed of 65 nm diameter microbeads (5 % cross-linked) bonded with alkanol quaternary ammonium ions. | | |
| **L113** | A hydroxide-selective, strong anion-exchange resin consisting of a highly cross-linked core of 7.5 µm porous particles having a pore size of 2000 Å and consisting of ethylvinylbenzene cross-linked with 55 % divinylbenzene with a latex coating composed of 65 nm diameter microbeads (5 % crosslinked) bonded with alkanol quaternary ammonium ions. | | |
| **L114** | Sulfobetaine graft-polymerized to totally or superficially porous silica, 1.5 to 10 µm in diameter, or a monolithic rod. Packing having densely bonded zwitterionic groups with 1:1 charge balance. | | |
| **L115** | Ethylvinylbenzene/divinylbenzene substrate (55% cross-linked) agglomerated with quaternary amine functional-ized 275 nm latex microbeads (6% cross-linked), about 8.5 µm in diameter. | | |
| **L116** | Sulfonated ethylvinylbenzene/divinylbenzene substrate agglomerated with hydrophilic quaternary amine func-tionalized glycidyl-derivative methacrylate microbeads, approximately 2 to 50 µm in diameter. | | |
| **L117** | A crown ether coated on a 5 µm particle size silica gel substrate. The active site is (R)-18-crown-6-ether. | | |
| **L118** | Aqueous polymerized C18 groups on silica particles, 1.2 to 5 µm in diameter. | Kinetex PAH | Core-Shell |
| **L119** | Cellulose tris-(3,5-dichlorophenylcarbamate), immobilized on porous, spherical, silica particles, 3 to 5 µm in diameter. | Lux i-Cellulose-5 | Spherical |
| **L120** | A hydroxide-selective, strong anion-exchange resin consisting of a highly cross-linked core of 13 µm micropo-rous particles having a pore size of less than 10 Å units and consisting of ethylvinylbenzene cross-linked with 55 % divinylbenzene with a latex coating composed of 65 nm diameter microbeads (8 % cross-linked) bonded with alkanol quaternary ammonium ions. Capacity not less than 10 µEq/column (4 mm x 5 cm). | | |
| **L121** | A hydroxide-selective, strong anion-exchange resin consisting of a highly cross-linked core of 11 µm porous particles having a pore size of less than 10 Å units and consisting of ethylvinylbenzene cross-linked with 55 % divinylbenzene electrostatically bonded with hyperbranched alkanol quaternary ammonium ions. | | |
| **L122** | Sulfobetaine graft-polymerized to totally or superficially porous hydrophilic polymer particles, 1.0 to 10 µm in diameter, or a monolithic rod. Packing having densely bonded zwitterionic groups with 1:1 charge balance. | | |
| **L123** | Cellulose tris(3-chloro-4-methylphenylcarbamate) coated porous silica particles, 3 to 20 µm in diameter. | Lux Cellulose-2 | Spherical |
| **L124** | Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the silver form, average 9 µm in diameter. | Rezex RSO-Oligosaccharide | Spherical |
| **L125** | Polyvinyl alcohol polymer gel weak cation-exchange packing material, 5 µm porous particles. The surface is polymerized with polybutadiene-maleic acid to provide carboxylic acid functionalities. The Capacity is not less than 1 mEq/column. | Shodex IC YS-50 | Spherical |
| **L126** | Amylose tris (3-chlorophenylcarbamate), immobilized on porous, spherical, silica particles, 1 µm to 20 µm in diameter. | | |
| **L127** | A crown ether chemically bonded to a 5 µm particle size silica gel substrate. The active site is (S)- pseudo-18-crown-6-ether. | Sumichiral OA-8000 | Spherical |
| **L128** | Porous particles of polystyrene divinyl benzene with linear molecular weight operating range from 200 to 2,000,000 g/mol (polystyrene equivalent), 5 µm in diameter. | | |
| **L130** | Cellulose tris(3,5-dimethylphenylcarbamate) coated on 10 Åm silica gel particles. | Lux Cellulose-1 | Spherical |

**Australia**
t: +61 (0)2-9428-6444
auinfo@phenomenex.com

**Austria**
t: +43 (0)1-319-1301
anfrage@phenomenex.com

**Belgium**
t: +32 (0)2 503 4015 (French)
t: +32 (0)2 511 8666 (Dutch)
beinfo@phenomenex.com

**Canada**
t: +1 (800) 543-3681
info@phenomenex.com

**China**
t: +86 400-606-8099
cninfo@phenomenex.com

**Czech Republic**
t: +420 272 017 077
cz-info@phenomenex.com

**Denmark**
t: +45 4824 8048
nordicinfo@phenomenex.com

**Finland**
t: +358 (0)9 4789 0063
nordicinfo@phenomenex.com

**France**
t: +33 (0)1 30 09 21 10
franceinfo@phenomenex.com

**Germany**
t: +49 (0)6021-58830-0
anfrage@phenomenex.com

**Hong Kong**
t: +852 6012 8162
hkinfo@phenomenex.com

**India**
t: +91 (0)40-3012 2400
indiainfo@phenomenex.com

**Indonesia**
t: +62 21 3952 5747
indoinfo@phenomenex.com

**Ireland**
t: +353 (0)1 247 5405
eireinfo@phenomenex.com

**Italy**
t: +39 051 6327511
italiainfo@phenomenex.com

**Japan**
t: +81 (0) 120-149-262
jpinfo@phenomenex.com

**Luxembourg**
t: +31 (0)30-2418700
nlinfo@phenomenex.com

**Mexico**
t: 01-800-844-5226
tecnicomx@phenomenex.com

**The Netherlands**
t: +31 (0)30-2418700
nlinfo@phenomenex.com

**New Zealand**
t: +64 (0)9-4780951
nzinfo@phenomenex.com

**Norway**
t: +47 810 02 005
nordicinfo@phenomenex.com

**Poland**
t: +48 22 51 02 180
pl-info@phenomenex.com

**Portugal**
t: +351 221 450 488
ptinfo@phenomenex.com

**Singapore**
t: 800-852-3944
sginfo@phenomenex.com

**Slovakia**
t: +420 272 017 077
sk-info@phenomenex.com

**Spain**
t: +34 91-413-8613
espinfo@phenomenex.com

**Sweden**
t: +46 (0)8 611 6950
nordicinfo@phenomenex.com

**Switzerland**
t: +41 (0)61 692 20 20
swissinfo@phenomenex.com

**Taiwan**
t: +886 (0) 0801-49-1246
twinfo@phenomenex.com

**Thailand**
t: +66 (0) 2 566 0287
thaiinfo@phenomenex.com

**United Kingdom**
t: +44 (0)1625-501367
ukinfo@phenomenex.com

**USA**
t: +1 (310) 212-0555
www.phenomenex.com/chat

**All other countries/regions**
**Corporate Office USA**
t: +1 (310) 212-0555
www.phenomenex.com/chat

**www.phenomenex.com**

Phenomenex products are available worldwide. For the distributor in your country/region, contact Phenomenex USA, International Department at international@phenomenex.com



FL5220323_W