

# PERINEURONAL NET ANALYSIS

## Product Listing

Cat. No.	Specificity	Clone	Format	Pack	WB	IHC	ELISA
<b>Chondroitin Sulfate Stub Antibodies</b>							
270431-CS	$\Delta$ Di-OS	1B5	Supernatant	1 ml	1:100	1:20	✓
270432-CS	$\Delta$ Di-4S	2B6	Supernatant	1 ml	1:100	1:20	✓
270433-CS	$\Delta$ Di-6S	3B3	Supernatant	1 ml	1:100	1:20	✓
<b>Antibodies to Native Chondroitin Sulfate</b>							
370710-IEC	Chondroitin Sulfate A (C 4 S)	2H6	Purified	200ug	1:10,000	1:100 (P)	1:1,000 - 1:2,000
AMS.A3143	Chondroitin Sulfate A	LY111	Purified	100ug	(Immunodot)	✓	✓
270695 A	Chondroitin Sulfate A+C	CS 56	Raw Ascites Fluid	0.1 ml	Not tested	1:100 1:400 (F)	Not tested
AMS.A2872	Chondroitin Sulfate D (C-2,6-S)	MO-225	Purified	100ug	✓	✓	✓
<b>Other reagents and kits</b>							
AMS.HKD-BC41	Hyaluronic Acid Binding Protein (b-HABP) (versican G1 domain)	N/A	Biotinylated	50ug	✓	✓	✓
280560 N	Proteoglycan Detection Kit	N/A	Based on DMB Dye	1 kit	N/A	N/A	N/A

## Selected Citations

### Chondroitin Sulfate Stub Antibodies

Hu, J., Curinga, G. M., & Smith, G. M. (2015). Chondroitinase Gene Therapy for Spinal Cord Injury. *Extracellular Matrix*, 139-149 (**Clone 3B3**)

Alves, J. N., Muir, E. M., Andrews, M. R., Ward, A., Michelmore, N., Dasgupta, D., ... & Rogers, J. H. (2014). AAV vector-mediated secretion of chondroitinase provides a sensitive tracer for axonal arborisations. *Journal of neuroscience methods*, 227, 107- (**Clone 2B6, also biotin-HABP**)

Christensen, A. C., Lensjø, K. K., Lepperød, M. E., Dragly, S. A., Sutterud, H., Blackstad, J. S., ... & Hafting, T. (2021). Perineuronal nets stabilize the grid cell network. *Nature communications*, 12(1), 1 17. (**Also cites our Ch ABC**)

Cortes, M., Cortes, L. K., & Schwartz, N. B. (2015). Mapping Proteoglycan Functions with Glycosidases. *Glycosaminoglycans: Chemistry and Biology*, 443 455. (**Clones 1B5, 2B6, 3B3 & 10E4**)

Hayes, A. J., Mitchell, R. E., Bashford, A., Reynolds, S., Caterson, B., & Hammond, C. L. (2013). Expression of glycosaminoglycan epitopes during zebrafish skeletogenesis. *Developmental Dynamics*, 242(6), 778 789. (**Clones 1B5, 2B6, 3B3 & 3G10**)

Rosenzweig, E. S., Salegio, E. A., Liang, J. J., Weber, J. L., Weinholtz, C. A., Brock, J. H., ... & Tuszyński, M. H. (2019). Chondroitinase improves anatomical and functional outcomes after primate spinal cord injury. *Nature neuroscience*, 22(8), 1269 1275. (**Clone 2B6**)

Wang, Z., Winsor, K., Nienhaus, C., Hess, E., & Blackmore, M. G. (2017). Combined chondroitinase and KLF7 expression reduce net retraction of sensory and CST axons from sites of spinal injury. *Neurobiology of disease*, 99, 24-35. **(Clone 2B6: Also cites our Chondroitinase ABC and Proteoglycan Detection Kit cat.# 280560-N)**

## ***Antibodies to Native Chondroitin Sulfate***

- Deepa, S. S., Yamada, S., Fukui, S., & Sugahara, K. (2007). Structural determination of novel sulfated octasaccharides isolated from chondroitin sulfate of shark cartilage and their application for characterizing monoclonal antibody epitopes. *Glycobiology*, 17(6), 631-645. **(Clones MO-225, 2H6 & LY111)**
- Foscarin, S., Raha-Chowdhury, R., Fawcett, J. W., & Kwok, J. C. F. (2017). Brain ageing changes proteoglycan sulfation, rendering perineuronal nets more inhibitory. *Aging*, 9(6), 1607. **(Clone LY111)**
- Sugiura, N., Shioiri, T., Chiba, M., Sato, T., Narimatsu, H., Kimata, K., & Watanabe, H. (2012). Construction of a chondroitin sulfate library with defined structures and analysis of molecular interactions. *Journal of Biological Chemistry*, 287(52), 43390-43400. **(Clones MO-225, LY111 & 2H6)**
- Sugahara, K. (2015). Novel Chondroitin Sulfate Oligosaccharide Motifs as Biomarkers: Insights into Their Involvement in Brain Development. In *Biochemical Roles of Eukaryotic Cell Surface Macromolecules* (pp. 165-183). Springer International Publishing. **(Clones CS-56 & MO-225)**
- Miller, G. M., & Hsieh-Wilson, L. C. (2015). Sugar-dependent modulation of neuronal development, regeneration, and plasticity by chondroitin sulfate proteoglycans. *Experimental neurology*, 274, 115-125. **(Clones 2H6 & MO-225)**
- Zhang, X., Bhattacharyya, S., Kusumo, H., Goodlett, C. R., Tobacman, J. K., & Guizzetti, M. (2014). Arylsulfatase B modulates neurite outgrowth via astrocyte chondroitin-4-sulfate: Dysregulation by ethanol. *Glia*, 62(2), 259-271. **(Clone LY111)**

## ***Biotinylated HABP (recombinant VG1 domain)***

- Alves, J. N., Muir, E. M., Andrews, M. R., Ward, A., Michelmore, N., Dasgupta, D., ... & Rogers, J. H. (2014). AAV vector-mediated secretion of chondroitinase provides a sensitive tracer for axonal arborisations. *Journal of neuroscience methods*, 227, 107-120. **(Also cites clone 2B6)**
- Rácz, É., Gaál, B., & Matesz, C. (2016). Heterogeneous expression of extracellular matrix molecules in the red nucleus of the rat. *Neuroscience*, 322, 1-17.
- Gaál, B., Kecskes, S., Matesz, C., Birinyi, A., Hunyadi, A., & Rácz, É. (2015). Molecular composition and expression pattern of the extracellular matrix in a mossy fiber-generating precerebellar nucleus of rat, the prepositus hypoglossi. *Neuroscience letters*, 594, 122-126.
- Godin, A. G., Varela, J. A., Gao, Z., Danné, N., Dupuis, J. P., Lounis, B., ... & Cognet, L. (2017). Single-nanotube tracking reveals the nanoscale organization of the extracellular space in the live brain. *Nature Nanotechnology* 12, 238-243
- Venturino, A., Schulz, R., De Jesús-Cortés, H., Maes, M. E., Nagy, B., Reilly-Andújar, F., ... & Siegert, S. (2021). Microglia enable mature perineuronal nets disassembly upon anesthetic ketamine exposure or 60-Hz light entrainment in the healthy brain. *Cell reports*, 36(1), 109313.

## ***Proteoglycan Detection Kit (280560-N)***

- Wang, Z., Winsor, K., Nienhaus, C., Hess, E., & Blackmore, M. G. (2017). Combined chondroitinase and KLF7 expression reduce net retraction of sensory and CST axons from sites of spinal injury. *Neurobiology of disease*, 99, 24-35. **(Also cites our Clone 2B6 and our Chondroitinase ABC)**
- Zayas-Santiago, A., Cross, S. D., Stanton, J. B., Marmorstein, A. D., & Marmorstein, L. Y. (2017). Mutant Fibulin-3 Causes Proteoglycan Accumulation and Impaired Diffusion Across Bruch's Membrane. *Investigative Ophthalmology & Visual Science*, 58(7), 3046-3054.

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## CITATIONS FOR CHONDROITINASE ABC (AMS.E1028- codes)

### **Neuronal Regeneration Models**

- Abu-Rub, M. T., Newland, B., Naughton, M., Wang, W., McMahon, S., & Pandit, A. (2016). Non-Viral Xylosyltransferase-1 siRNA Delivery as an Effective Alternative to Chondroitinase in an In Vitro Model of Reactive Astrocytes. *Neuroscience* 339, 267-275.
- Christensen, A. C., Lensjø, K. K., Lepperød, M. E., Dragly, S. A., Sutterud, H., Blackstad, J. S., ... & Hafting, T. (2021). Perineuronal nets stabilize the grid cell network. *Nature communications*, 12(1), 1-17. **(Also cites 3B3 stub antibody)**
- Heidemann, M., Streit, J., & Tschertter, A. (2014). Functional regeneration of intraspinal connections in a new in vitro model. *Neuroscience*, 262, 40-52.
- Hu, H. Z., Granger, N., Pai, S. B., Bellamkonda, R. V., & Jeffery, N. D. (2018). Therapeutic efficacy of microtube-embedded chondroitinase ABC in a canine clinical model of spinal cord injury. *Brain*, 141(4), 1017-1027. **See also Moon and Bradbury (doi: [10.1093/brain/awy067](https://doi.org/10.1093/brain/awy067)) for a scientific commentary on this research.**
- Lensjø, K. K., Lepperød, M. E., Dick, G., Hafting, T., & Fyhn, M. (2016). Removal of perineuronal nets unlocks juvenile plasticity through network mechanisms of decreased inhibition and increased gamma activity. *Journal of Neuroscience*, 2504-16.
- Lensjø, K. K., Christensen, A. C., Tennøe, S., Fyhn, M., & Hafting, T. (2017). Differential Expression and Cell-Type Specificity of Perineuronal Nets in Hippocampus, Medial Entorhinal Cortex, and Visual Cortex Examined in the Rat and Mouse. *eNeuro*, 4(3), ENEURO-0379.
- Paveliev, M., Fenrich, K. K., Kislin, M., Kuja-Panula, J., Kuleskiy, E., Varjosalo, M., ... Kuleskaya, N. & Rauvala, H. (2016). HB-GAM (pleiotrophin) reverses inhibition of neural regeneration by the CNS extracellular matrix. *Scientific Reports*, 6, 33916.
- Silver, D. J., Siebzehrubl, F. A., Schildts, M. J., Yachnis, A. T., Smith, G. M., Smith, A. A., ... & Steindler, D. A. (2013). Chondroitin sulfate proteoglycans potently inhibit invasion and serve as a central organizer of the brain tumor microenvironment. *The Journal of Neuroscience*, 33(39), 15603-15617.
- Wang, Z., Winsor, K., Nienhaus, C., Hess, E., & Blackmore, M. G. (2017). Combined chondroitinase and KLF7 expression reduce net retraction of sensory and CST axons from sites of spinal injury. *Neurobiology of disease*, 99, 24-35. **(Also cites 2B6 stub antibody and Proteoglycan Detection Kit cat.# 280560-N)**
- Wu, D., Klaw, M. C., Connors, T., Kholodilov, N., Burke, R. E., & Tom, V. J. (2015). Expressing Constitutively Active Rheb in Adult Neurons after a Complete Spinal Cord Injury Enhances Axonal Regeneration beyond a Chondroitinase-Treated Glial Scar. *The Journal of Neuroscience*, 35(31), 11068-11080.
- Wu, D., Klaw, M. C., Kholodilov, N., Burke, R. E., Detloff, M. R., Côté, M. P., & Tom, V. J. (2016). Expressing constitutively active Rheb in adult dorsal root ganglion neurons enhances the integration of sensory axons that regenerate across a chondroitinase-treated dorsal root entry zone following dorsal root crush. *Frontiers in Molecular Neuroscience*, 9. doi: 10.3389/fnmol.2016.00049
- Xu, C., Klaw, M. C., Lemay, M. A., Baas, P. W., & Tom, V. J. (2015). Pharmacologically inhibiting kinesin-5 activity with monastrol promotes axonal regeneration following spinal cord injury. *Experimental neurology*, 263, 172-176.

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## Glycoanalysis

Dagälv, A., Lundequist, A., Filipek-Górniok, B., Dierker, T., Eriksson, I., & Kjellén, L. (2015). Heparan sulfate structure: methods to study N-sulfation and NDST action. *Glycosaminoglycans: Chemistry and Biology*, 189-200.

Dierker, T., Shao, C., Haitina, T., Zaia, J., Hinas, A., & Kjellén, L. (2016). Nematodes join the family of chondroitin sulfate-synthesizing organisms: Identification of an active chondroitin sulfotransferase in *Caenorhabditis elegans*. *Scientific Reports*, 6, 34662.

Fang, J., Song, T., Lindahl, U., & Li, J. P. (2016). Enzyme overexpression—an exercise toward understanding regulation of heparan sulfate biosynthesis. *Scientific Reports*, 6, 31242.

Nelson, A., Berkestedt, I., & Bodelsson, M. (2014). Circulating glycosaminoglycan species in septic shock. *Acta Anaesthesiologica Scandinavica*, 58(1), 36-43.

Roucourt, B., Meeussen, S., Bao, J., Zimmermann, P., & David, G. (2015). Heparanase activates the syndecan-syntenin-ALIX exosome pathway. *Cell research*, 25(4), 412-428.

Scavenius, C., Nikolajsen, C. L., Stenvang, M., Thøgersen, I. B., Wyrożemski, Ł., Wisniewski, H. G., ... & Enghild, J. J. (2016). The compact and biologically relevant structure of inter- $\alpha$ -inhibitor is maintained by the chondroitin sulfate chain and divalent cations. *Journal of Biological Chemistry*, 291(9), 4658-4670.

## BACKGROUND / REVIEWS:

Burnside, E. R., & Bradbury, E. J. (2014) Review: Manipulating the extracellular matrix and its role in brain and spinal cord plasticity and repair. *Neuropathology and applied neurobiology*, 40(1), 26-59.

Caterson, B. (2012) Fell-Muir Lecture: Chondroitin sulphate glycosaminoglycans: fun for some and confusion for others. *International journal of experimental pathology*, 93(1), 1-10.

Fox, K., & Caterson, B. (2002) Freeing the brain from the perineuronal net. *Science*, 298 (5596), 1187-1189.

## HIGHLY CITED PAPERS FEATURING SEIKAGAKU PROTEASE-FREE CHONDROITINASE ABC:

Bradbury, E. J., Moon, L. D., Popat, R. J., King, V. R., Bennett, G. S., Patel, P. N., & McMahon, S. B. (2002) Chondroitinase ABC promotes functional recovery after spinal cord injury. *Nature*, 416(6881), 636-640.

Moon, L.D.F., Asher, R.A., Rhodes, K.E., & Fawcett, J.W. (2001) Regeneration of CNS axons back to their target following treatment of adult rat brain with chondroitinase ABC. *Nature Neuroscience* 4, 465-466.

**(Also cites 2B6 & 3B3 stub antibodies)**

Pizzorusso, T., Medini, P., Berardi, N., Chierzi, S., Fawcett, J. W., & Maffei, L. (2002). Reactivation of ocular dominance plasticity in the adult visual cortex. *Science*, 298(5596), 1248-1251. **(Also cites 2B6 stub antibody)**

Thuret, S., Moon, L.D.F., & Gage, F.H. (2006) Therapeutic interventions after spinal cord injury. *Nature Reviews Neuroscience* 7, 628-643.

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