



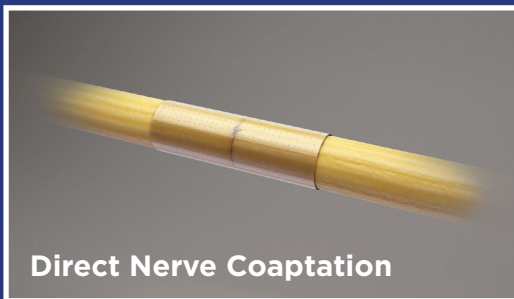
CHECKPOINT
NEUROSHIELD™

CHITOSAN MEMBRANE

**AN OPTIMIZED
BIOMATERIAL FOR
NERVE REPAIR**

CLINICAL APPLICATIONS

Checkpoint NeuroShield's transparency provides surgeons clear visualization of the nerve.

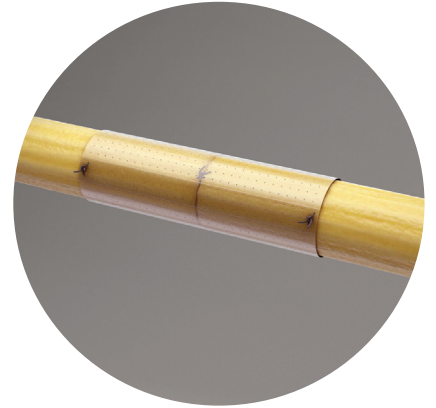


CHECKPOINT NEUROSHIELD™

CHECKPOINT NEUROSHIELD™ is a chitosan polysaccharide membrane indicated for the repair of peripheral nerve injuries by providing a protective barrier during tissue healing.

Why Chitosan?

Chitosan, a derivative of chitin, is a natural, biodegradable polymer and is one of the most abundant organic resources on earth. Clinical and preclinical studies have shown that chitosan displays biocompatibility, biodegradability, low toxicity, and cellular compatibility, all of which are beneficial properties for neural tissue engineering.^{1,2}



Anti-inflammatory^{3,4}



Inhibits Fibroblast Proliferation⁵



Supports Tissue Healing^{6,7}



Antimicrobial^{8,17,18}



Biodegradable^{7,21}



Fully Resorbs¹⁰

WHY PROCESSING MATTERS

An *in vitro* cell culture of chitosan membranes with a low degree of acetylation indicated selective cell adhesion, promoted Schwann cell activity and proliferation, and prevented excessive fibroblast infiltration.⁶

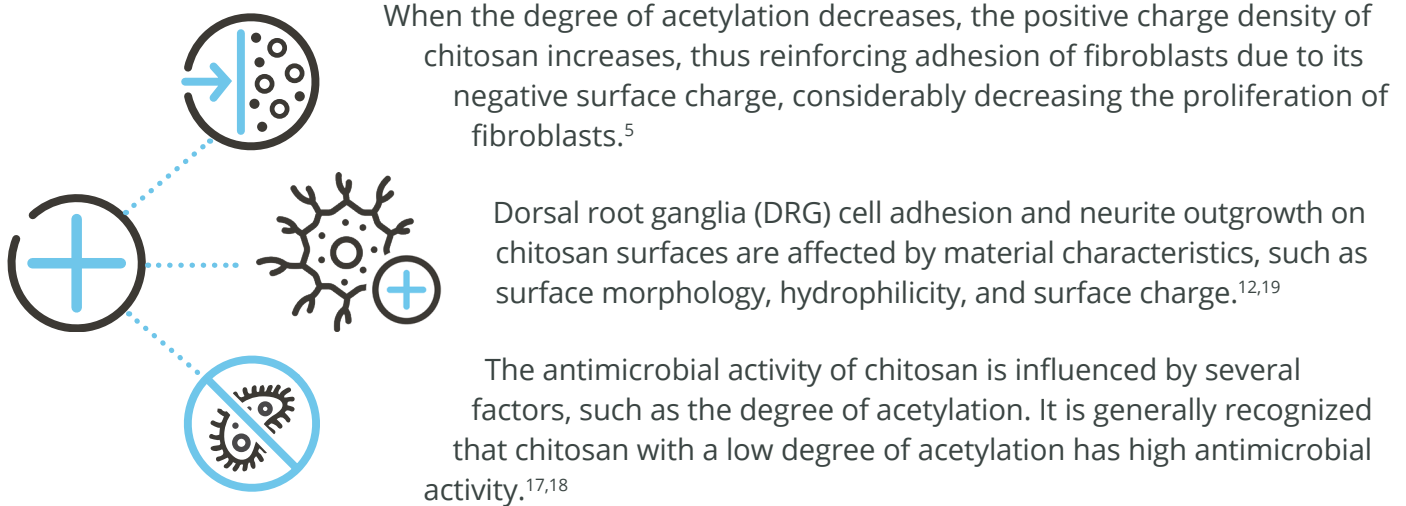
Chitosan is produced commercially by the controlled deacetylation of chitin, the most abundant marine biopolymer in nature and a major component of the shell of shrimps and other crustaceans.⁶ The degree of acetylation is one of the most important chemical characteristics of chitosan processing and has a direct influence on the final product characteristics for tissue engineering applications, such as biodegradation and cellular interactions.^{11,12}

Preclinical studies have shown that lower acetylated materials lead to better results in terms of increased cell adhesion and are more supportive for peripheral nerve regeneration, when compared to materials with higher degrees of acetylation.^{1,12}

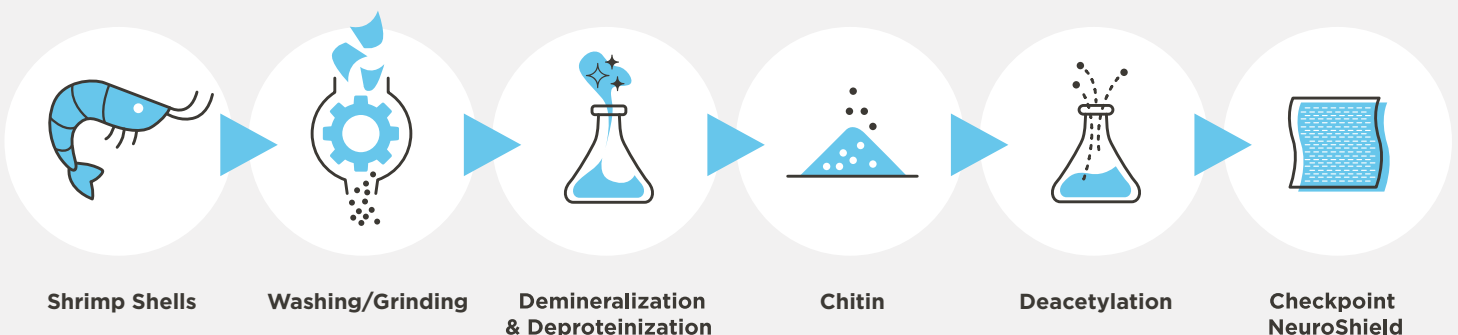
Checkpoint NeuroShield is processed to a degree of acetylation of 5%, which has been shown in a preclinical, *in vivo* animal model to be supportive for peripheral nerve regeneration.¹

THE POWER OF POSITIVE

Chitosan is the only naturally occurring positively charged biopolymer.^{7,16} Positive charge density is a key factor affecting the properties of chitosan for nerve repair, such as cellular adhesion and antimicrobial activity.¹¹



Steps in Checkpoint NeuroShield Processing



This chemical deproteinization step removes the protein component found in shellfish that commonly causes shellfish allergies.¹⁹

CHECKPOINT NEUROSHIELD: OPTIMIZED FOR NERVE REPAIR

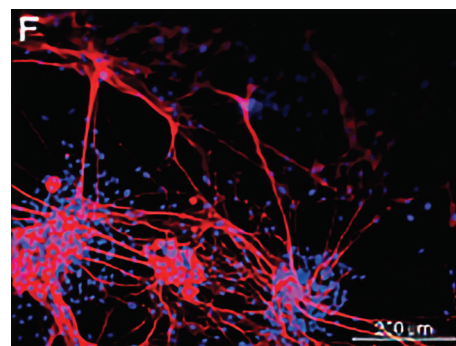
Through its proprietary processing method, resulting in a degree of acetylation of 5%, Checkpoint NeuroShield has been optimized for nerve repair. In an *in vivo* animal model comparing chitosan tubes of varying degrees of acetylation, a DA of 5% was the most supportive for peripheral nerve regeneration, allowing functional and morphological nerve regeneration.¹

Preclinical, *in vitro* studies have shown Schwann cell viability, migration, and proliferation on chitosan membranes, particularly those with a low deacetylation.^{6,12,14-15}

In a rat median nerve model, Checkpoint NeuroShield supported nerve fiber regeneration and functional recovery of neuromuscular function 12 weeks after median nerve damage.¹³

Clinical Evidence

In a clinical study, the use of Checkpoint NeuroShield as a neuroprotective barrier resulted in a statistically significant improvement in recovery compared to the control group.²⁰



Immunofluorescence of rat primary dissociated dorsal root ganglia (DRGs) axonal outgrowth when seeded on plain chitosan films.¹⁴

 **SAFE**
No sign of intolerance or allergic reaction²⁰

 **EFFECTIVE**
Effective neuroprotective barrier²⁰

 **EASY TO USE**
Length, difficulty, and complication rate of the “standard” procedure was not compromised²⁰

ORDERING INFORMATION

Product name:

CHECKPOINT NEUROSHIELD™

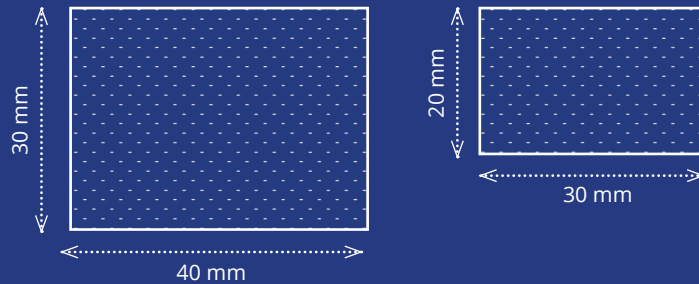
Item numbers:

NS4030 | NS3020

Sizes:

40 x 30 x 0.03 mm

30 x 20 x 0.03 mm



INDICATIONS FOR USE

CHECKPOINT NEUROSHIELD™ is indicated for the repair of peripheral nerve injuries in which there is no gap or where a gap closure can be achieved by flexion of the extremity. Checkpoint NeuroShield nerve membranes are designed exclusively for single use. Allergic reactions to implanted products containing chitosan are not yet known. However, since chitosan is derived from shellfish, individuals with known shellfish allergies should exercise caution in the use of any product containing chitosan. As with all procedures carried out on peripheral nerves, there is a risk of the nerve not regenerating. Please see Instructions for Use for complete product specifications, indications, contraindications, precautions, and warnings.

REFERENCES

1. Haastert-Talini, K. et al. Chitosan tubes of varying degrees of acetylation for bridging peripheral nerve defects. *Biomaterials* 34 (2013): 9886-9904.
2. Freier, Thomas et al. "Chitin-based tubes for tissue engineering in the nervous system." *Biomaterials* vol. 26,22 (2005): 4624-32.
3. Vasconcelos DP, Fonseca AC, Costa M, et al. Macrophage polarization following chitosan implantation. *Biomaterials*. 2013;34(38):9952-9959.
4. Oliveira, Marta I et al. "Chitosan drives anti-inflammatory macrophage polarisation and pro-inflammatory dendritic cell stimulation." *European cells & materials* vol. 24 136-52; discussion 152-3. 24 Jul. 2012.
5. Chatelet, C et al. "Influence of the degree of acetylation on some biological properties of chitosan films." *Biomaterials* vol. 22,3 (2001): 261-8.
6. Carvalho, Cristiana R et al. "Investigation of cell adhesion in chitosan membranes for peripheral nerve regeneration." *Materials science & engineering. C, Materials for biological applications* vol. 71 (2017): 1122-1134.
7. Matica A. Biodegradability of chitosan-based products. *New Front Chem*. 2017;26:75-86.
8. Ke CL, Deng FS, Chuang CY, et al. Antimicrobial actions and applications of chitosan. *Polymers (Basel)*. 2021 Mar 15;13(6):904.
9. Rathke, TD et al. Review of chitin and chitosan as fiber and film formers. *J Mater Sci: Rec Macromolecular Chem Phys* 1994;C34:375-437.
10. Wang, Y., Zhao, Y., Sun, C. et al. Chitosan Degradation Products Promote Nerve Regeneration by Stimulating Schwann Cell Proliferation via miR-27a/FOXO1 Axis. *Mol Neurobiol* 53, 28-39 (2016).
11. Yilmaz Atay, Hüsnügül. "Antibacterial Activity of Chitosan-Based Systems." *Functional Chitosan: Drug Delivery and Biomedical Applications* 457-489. 6 Mar. 2020.
12. Freier, Thomas et al. "Controlling cell adhesion and degradation of chitosan films by N-acetylation." *Biomaterials* vol. 26,29 (2005): 5872-8.
13. Muratori, Luisa et al. "New basic insights on the potential of a chitosan-based medical device for improving functional recovery after radical prostatectomy." *BJU international* vol. 124,6 (2019): 1063-1076.
14. Wrobel, Sandra et al. In vitro evaluation of cell-seeded chitosan films for peripheral nerve tissue engineering. *Tissue engineering. Part A* vol. 20,17-18 (2014): 2339-49.
15. Yuan, Ying et al. "The interaction of Schwann cells with chitosan membranes and fibers in vitro." *Biomaterials* vol. 25,18 (2004): 4273-8.
16. Pavinatto, Felipe J et al. "Chitosan in nanostructured thin films." *Biomacromolecules* vol. 11,8 (2010): 1897-908.
17. Lillo, Luis et al. "Antibacterial activity of chitooligosaccharides." *Zeitschrift fur Naturforschung. C, Journal of biosciences* vol. 63,9-10 (2008): 644-8.
18. Jeon Y. J., Park P. J., and Kim S. K. (2001), Antimicrobial effect of chitooligosaccharides produced by bioreactor. *Carbohydr. Polym.* 44, 71-76.
19. Younes, Islem, and Marguerite Rinaudo. "Chitin and chitosan preparation from marine sources. Structure, properties and applications." *Marine drugs* vol. 13,3 1133-74. 2 Mar. 2015.
20. Porpiglia, Francesco et al. "Use of chitosan membranes after nerve-sparing radical prostatectomy improves early recovery of sexual potency: results of a comparative study." *BJU international* vol. 123,3 (2019): 465-473.
21. Suyeon Kim. Competitive Biological Activities of Chitosan and Its Derivatives: Antimicrobial, Antioxidant, Anticancer, and Anti-Inflammatory Activities, *International Journal of Polymer Science*, vol. 2018, Article ID 1708172, 13 pages, 2018.

Distributed by:

Checkpoint Surgical, Inc.
6050 Oak Tree Blvd., Suite 360
Independence, Ohio 44131
216.378.9107; 216.378.9116 (Fax)
checkpointsurgical.com

Manufactured by:

Monarch Bioimplants GmbH
Platz 4
CH-6039 Root D4
Switzerland



NERVE CARE. EMPOWERED.