GLYCOFLEX®

# CLINICAL & RESEARCH STUDIES

## *Glyco FLEX® and its Active Ingredients*

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Vetri SCIENCE® Laboratories

# ABOUT THIS DOCUMENT

This document represents a compilation of clinical trials, research and studies on Glyco FLEX® 3 and the active ingredients in Glyco FLEX® products. These projects have been conducted over the last seventeen years at leading universities or by independent researchers. All of these studies have been sponsored in some way by VetriScience® Laboratories. The ingredients and products used in these studies have been supplied by VetriScience® and are the same ingredients used in Glyco FLEX® products. The GlycOmega™ (*Perna canaliculus*) used in these studies is exclusive to VetriScience® Laboratories.

Because Glyco FLEX® is an animal health product, we do not purport to cure, mitigate, treat, or prevent any disease. The conclusions reached in these studies are the observations of independent researchers and, as such, should not be misconstrued as a claim made by VetriScience® regarding the benefits of Glyco FLEX®. These studies were conducted to better understand scientifically how the product and ingredients work, not to support any claim.

Please contact your VetriScience® Sales Representative for questions regarding label claims or quality control procedures, to obtain information about Glyco FLEX® products or VetriScience® Laboratories, or to request additional information about these studies.

Studies featured in this publication have been assigned a reference code number. Please specify this number when requesting studies.

# STUDY INDEX

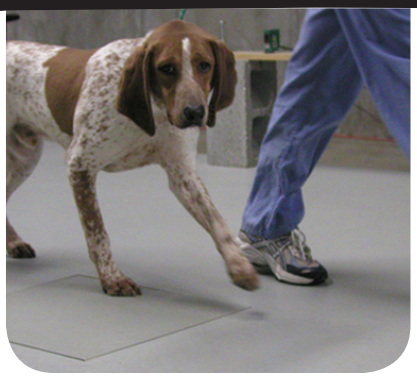
## *Glyco FLEX® 3 Canine Clinical Trials and Studies*



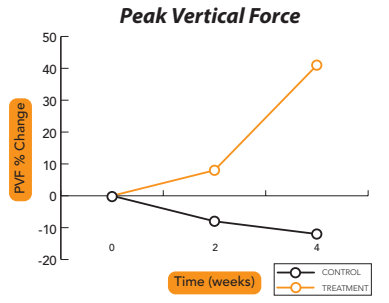
## *Research on Active Ingredients in Glyco FLEX® Products*

# VLS 120

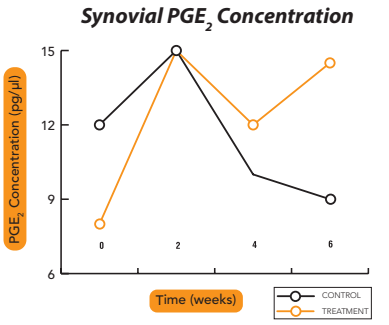
Martinez S, McCormick D, Powers M, Davies N, Yanez J, Hughes K and Lincoln J. The effects of Glyco FLEX® 3 on a stable stifle osteoarthritis model in dogs: a pilot study. Washington State University, 2006. Presented at NAVC 2007.



In a randomized, double-blind, crossover design dog study, a stifle osteoarthritis (OA) model was used to determine if Glyco FLEX® 3 could reduce cartilage breakdown and help normalize joint function. The dogs were randomized into two groups: the treatment dogs (Glyco FLEX® 3) and the control group. After a wash-out period, the two groups were crossed over for treatment and control. Force plate analysis was performed on each of the dogs. Then synovial fluid was collected from the stifle joint and analyzed for markers of joint inflammation and degradation. The responders had significant improvement in lameness after treatment, with a 41% increase in Peak Vertical Force (PVF) and 44% increase in Vertical Impulse (VI) over the pre-treatment value in the dogs. There was a significant decrease in mean synovial PGE2 and soluble collagen (SC) levels in the treatment group as compared to the control group. Other synovial markers in the responders had trends for lower levels, compared to the control group. The results of the study support that Glyco FLEX® 3 may reduce the severity of cartilage breakdown and synovitis, and help normalize joint function in dogs with stifle joints affected by OA.




Treatment dogs showed a 41% increase in peak vertical force after 4 weeks of treatment with Glyco FLEX® 3 compared to pretreatment values.




Prostaglandin $PGE_2$ concentrations of control versus treatment group over time.

## SUMMARY

- Glyco FLEX® 3 may reduce the severity of cartilage breakdown and synovitis, and help normalize joint function in osteoarthritic stifle joints.
- The results of this in vivo (VSL 120) study more than correlate/parallel those from other in vitro (VSL 130 and VSL 260) studies.

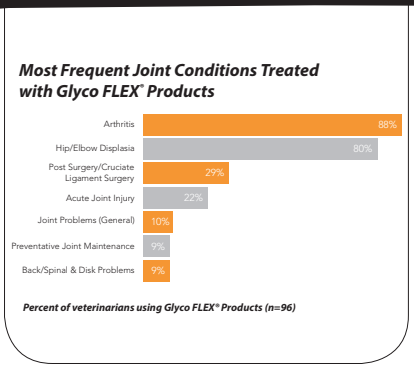
# VLS 110

Hill W. Canine safety study on Glyco FLEX® 3: Physiological, allergenic, immunologic effects in dogs receiving oral Glyco FLEX® 3 for 8 weeks. Nutrition Service Associates by the Merrick Nutrition Center in Hereford, Texas, 2004.

Glyco FLEX® 3 was shown safe in dogs administered at a high dosage for 56 days. The results of the urinalysis, buccal mucosal bleeding test, blood chemistry panel, immunoglobulin levels and complete blood count were all within normal ranges. Results from this study show that Glyco FLEX® 3 had no adverse biochemical, hematologic, hemostatic, physiological, immunological, or allergenic effects.

# VLS 100

Clinical field evaluation of use and satisfaction of Glyco FLEX® Products. Conducted by Forward Research, 2002.

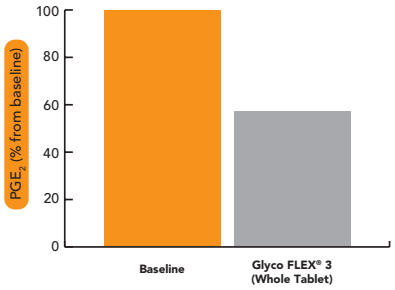



100 veterinarians were surveyed by an outside marketing firm and asked to evaluate the effectiveness and their satisfaction with Glyco FLEX® products used in their practice. Glyco FLEX® was administered most frequently for joint problems associated with arthritis, hip/elbow dysplasia followed by post-surgical use, joint injury, and then general joint problems. Principal signs of improvement included reduced pain, improved range of motion, increased mobility, and improved attitude. Over 85% of veterinarians rated Glyco FLEX® products as good or excellent in reducing joint symptoms. The majority of veterinarians rated Glyco FLEX® products as good to excellent for the long-term management of degenerative joint disease.

# VLS 130

Yanez J, McCormick D, Hughes K, Remsberg C, Temple C, Ohgami Y, Vega-Villa K, Martinez S and Davies N. Pharmacological evaluation of Glyco FLEX® 3 on canine chondrocytes. Washington State University, 2006. Presented at NAVC 2007 and published in Journal of Medical Science, 2008: 1-14.

***Reduction of $PGE_2$ in Canine Chondrocytes Treated with Glyco FLEX® 3***

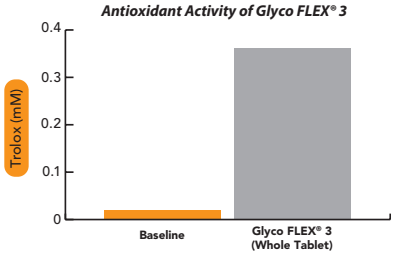



Glyco FLEX® 3 whole tablet shows decreased levels of $PGE_2$ production as compared to baseline.

***Reduction of Nitrate in Canine Chondrocytes Treated with Glyco FLEX® 3***


Glyco FLEX® 3 whole tablet shows decreased levels of Nitrate production as compared to baseline. Nitrate is a measurement of nitric oxide (NO).

***Antioxidant Activity of Glyco FLEX® 3***




Glyco FLEX® 3 whole tablet shows increasing antioxidant activity.

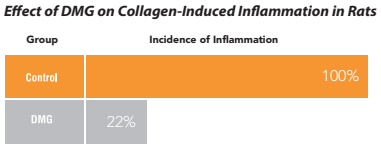
Canine chondrocytes were used in cell culture experiments to assess the effects of the Glyco FLEX® 3 tablets on key markers of inflammation. Glyco FLEX® 3 tablets showed positive reductions in nitric oxide (NO), soluble collagen, tumor necrosis factor-alpha, IL-6, PGE2, and matrix metalloproteinase-3 (MMP-3), which are key markers of inflammation. Glyco FLEX® 3 appears to reduce cartilage breakdown, inhibit cytokine-induced NO and PGE2 production, and reduce proteolytic breakdown. These in vitro results appear to demonstrate some of the key pathways and mechanisms by which Glyco FLEX® 3 functions in the joint. This study also shows that Glyco FLEX® 3 tablets appear to have anti-inflammatory and antioxidant properties.

## SUMMARY

- When used on a canine-specific cartilage cell line, Glyco FLEX® 3 appears to have anti-inflammatory and antioxidant properties.
- Glyco FLEX® 3 appears to reduce cartilage breakdown, inhibit cytokineinduced NO and PGE2 production, and reduce proteolytic breakdown.
- Results from this in vitro (VSL 130) study more than correlate/parallel other in vitro (VSL 260) and in vivo (VSL120) studies.

# VLS 200

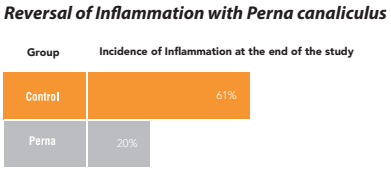
Belkowski S and Lawson J. The effects of DMG on collagen-induced inflammation in rats. Clemson University, 1989.




Dimethylglycine was evaluated for its effects on collagen-induced inflammation in rats. Only 22% of the rats treated with DMG showed any signs of swelling and inflammation compared to 100% of controls. This work resulted in a U.S. Patent #5,026,728 being granted in June of 1991 for the use of DMG to ameliorate inflammation associated with arthritis.

# VLS 240

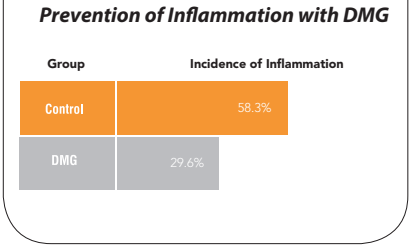
Lawson B, et al. Reversal of inflammation with *Perna canaliculus* in a collagen-induced inflammatory mouse model. Clemson University, 1996. Published in BMC Complementary and Alternative Medicine, 2007, 7:20.




The purpose of this study was to look at the ability of *Perna canaliculus* to reverse inflammation in a collagen-induced inflammatory mouse model. At the beginning of the study all mice had the same degree of inflammation. The Perna mice showed significant reversal of inflammation and swelling at the end of the study. In this model, Perna was found to be effective in reducing inflammation.

# VLS 210

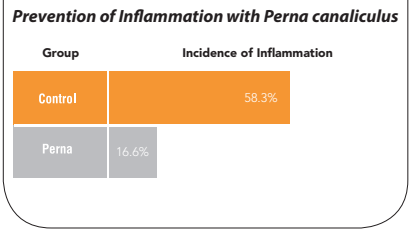
Lawson J, et al. Prevention of inflammation with DMG in a collagen-induced inflammatory rat model. Clemson University, 1990. Published in BMC Complementary and Alternative Medicine, 2007, 7:20.




DMG was evaluated for its ability to reduce the onset of inflammation and swelling in a collagen-induced inflammatory rat model. The control rats showed a 58.3% incidence of inflammation; the rats in the DMG group only showed a 29.6% incidence. In this model, DMG was found to be effective in reducing the occurrence of inflammation.

# VLS 220

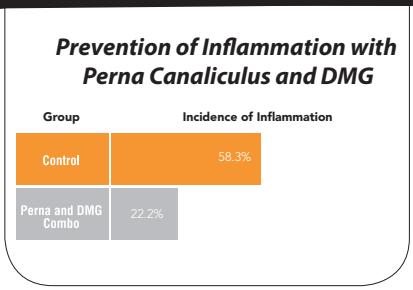
Lawson J, et al. Prevention of inflammation with *Perna canaliculus* in a collagen-induced inflammatory rat model. Clemson University, 1990. Published in BMC Complementary and Alternative Medicine, 2007, 7:20.




*Perna canaliculus* was evaluated for its ability to reduce the onset of inflammation and swelling in a collagen-induced inflammatory rat model. The control rats showed a 58.3% incidence of inflammation; the rats in the Perna group only showed a 16.6% incidence. Of those rats that developed inflammation in the Perna group, the degree of inflammation was 37% less based on paw size compared to the control group. In this model, Perna was found to be effective in reducing the occurrence of inflammation.

# VLS 230

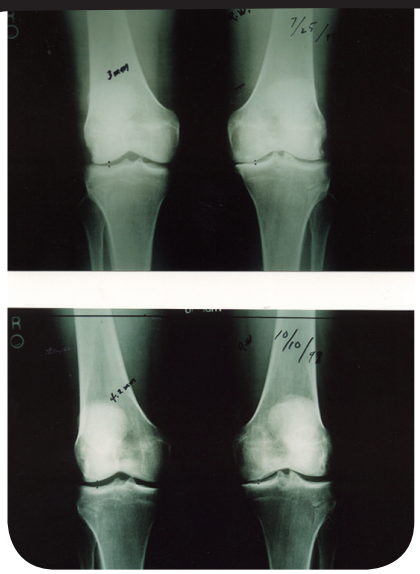
Lawson J, et al. Prevention of inflammation with DMG and *Perna canaliculus* in a collagen-induced inflammatory rat model. Clemson University, 1990. Published in BMC Complementary and Alternative Medicine, 2007, 7:20.




The combination of *Perna canaliculus* and DMG was evaluated for its ability to prevent the onset of inflammation and swelling in a collagen-induced inflammatory rat model. The control rats showed a 58.3% incidence of inflammation; the rats in the DMG and Perna combination group only showed a 22.2% incidence. In this model, the DMG and Perna combination was found to be effective in reducing the incidence of inflammation.

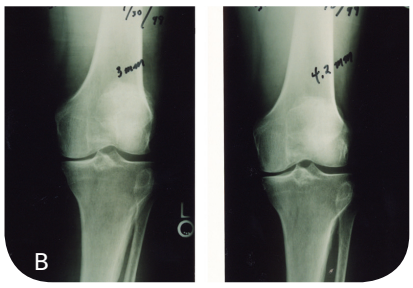
# VLS 250

Hurley L. New research and clinical report on the use of *Perna canaliculus* in the management of arthritis. Townsend Letter for Doctors and Patients. 2000: 99-111.



Standing x-rays. A 53 year old male with Grade III osteoarthritis-genu valgus on right and genu varus on left showing reversal of the progressive joint space narrowing over a period of fifteen months.

120 patients suffering from radiographically confirmed osteoarthritis of the knee were administered whole freeze-dried *Perna canaliculus* for 12 months. 92% of the patients reported overall improvement in areas including: less pain, decreased inflammation, greater range of motion, and improved exercise tolerance. The practitioner's assessment showed that 83% of the patients made either good or excellent progress. A significant number of patients were able to reduce pain medication and use of NSAIDs by 50% or more. Radiographic evaluation revealed that some patients had reversal of the narrowing of the joint space ofthe tibial femoral joint, suggesting an anabolic effect of Perna. In one patient, arthroscopic evaluation revealed the formation of new viable cartilage matrix covering a large osteochonral defect. The results of this study suggest that Perna may support articular cartilage regrowth and appears to be effective forthe management of pain and inflammation in the knee joint.




**B)** Standing x-rays. A 51 year old female with Grade III osteoarthritis genu varus showing reversal of the progressive joint space narrowing over a period of seventeen months.

# VLS 260

Yanez J, Ohgami Y, McCormick D, Hughes K, Martinez S and Davies N. Pharmacological evaluation of Glyco FLEX® 3 constituents on canine chondrocytes. Washington State University, 2006. Presented at NAVC 2007 and published in Journal of Medical Science, 2008: 1-14.

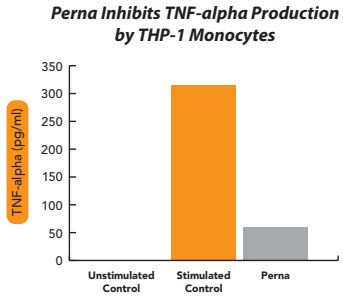
## SUMMARY

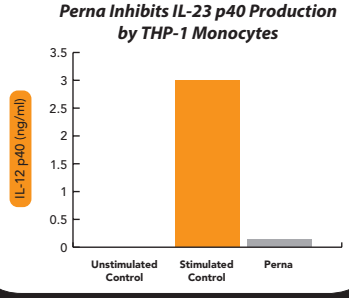
- When used on a canine-specific cartilage cell line, the main active ingredients in Glyco FLEX® 3 appear to have anti-inflammatory and antioxidant properties.
- The main active ingredients in Glyco FLEX® 3 appear to reduce cartilage breakdown, inhibit cytokine-induced NO and PGE2 production, and reduce proteolytic breakdown.
- The results from this in vitro (VSL 260) study more than correlate/parallel results from other in vitro (VSL 130) and in vivo (VSL 120) studies.

Canine chondrocytes were used in cell culture experiments to assess the effects of the main active constituents in Glyco FLEX® 3 on key markers of inflammation. *Perna canaliculus*, Glucosamine, MSM, DMG, and Grape Seed Extract showed positive reductions in nitric oxide (NO), soluble collagen, tumor necrosis factor-alpha, IL-6, PGE2 and matrix metalloproteinase-3 (MMP-3), which are key markers of inflammation. The main active components of Glyco FLEX® 3 appear to reduce cartilage breakdown, inhibit cytokine-induced NO and PGE2 production, and reduce proteolytic breakdown. These in vitro results may demonstrate some of the key pathways and mechanisms by which the main components of Glyco FLEX® 3 may function in the joint. The study shows that the active components of Glyco FLEX® 3 appear to have anti-inflammatory and antioxidant properties.

# VLS 270

Lawson J, et al. Evaluation of *Perna canaliculus* on the inflammatory markers TNF-alpha and IL-12 p40. Clemson University, 2006. Published in BMC Complementary and Alternative Medicine, 2007, 7:20.

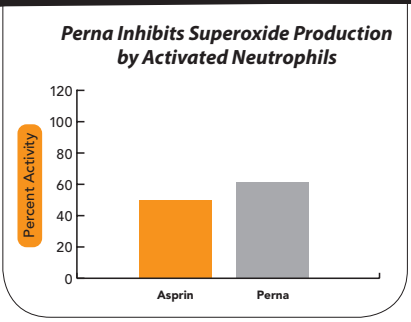



This cell culture study was designed to show the effectiveness of *Perna canaliculus* on certain inflammatory markers. Perna showed a statistically significant response in reducing pro-inflammatory cytokines (TNF-alpha and IL-12 p40). This study shows that Perna appears to reduce key markers of inflammation.

# VLS 280

Davis P, et al. Evaluation of the ability of *Perna canaliculus* to reduce superoxide production in a free radical cell model. Wellington School of Medicine,NZ, 2006. Published in BMC Complementary and Alternative Medicine, 2007, 7:20.



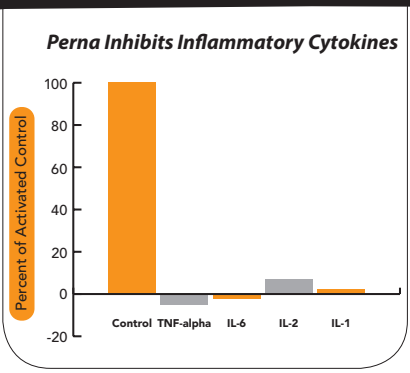

The purpose of this study was to evaluate the ability of ***Perna canaliculus*** to reduce superoxide (a free radical) production in cell culture using activated rat neutrophils. In this model, Perna demonstrated more than 1.2 times the activity of Aspirin in inhibiting superoxide production.

## SUMMARY

» *Perna canaliculus* was shown to be better than aspirin in inhibiting superoxide production from activated neutrophils in a dose dependant manner.

# VLS 290

Mani S and Lawson J. In vitro modulation of inflammatory cytokine and IgG levels of *Perna canaliculus*. BMC Complement Alternative Med., 2006; 6:1.




The purpose of the study was to evaluate how *Perna canaliculus* may reduce inflammation. Perna demonstrated reduction of certain inflammatory pathways including those involving cytokines (TNF-alpha, IL-1, IL-2 and IL-6), cycloxygenase enzyme (COX-2), and IgG (immunoglobulin G), suggesting that Perna may have a role in reducing inflammation.

## SUMMARY

» Perna inhibited IgG production and reduced pro-inflammatory cytokines TNF-alpha, IL-1, IL-2 and IL-6 in cell culture models.

» Perna inhibits the COX-2 enzyme system.

» Results demonstrate possible mechanisms by which Perna can modulate inflammatory mediators.

## SUPPLEMENTAL LITERATURE REFERENCES


***Perna canaliculus***

Bui L and Bierer T. Influence of Green Lipped Mussels (Perna canaliculus) in alleviating signs of arthritis in dogs. Veterinary Therapeutics. 2003; 4: 397-407.
Gibson RG, Gibson SL, Conway V and Chappell D. Perna canaliculus in the treatment of arthritis. Practitioner, 1980; 224: 955-960.
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Miller T and Wu H. In vivo evidence for prostaglandin inhibitory activity in New Zealand Green Lipped Mussel extract. NZ Med. J. 1984; 97: 355-357.
Pollard B, et al. Clinical efficacy and tolerance of an extract of Green Lipped Mussel (Perna canaliculus) in dogs presumptively diagnosed with degenerative joint disease. NZ Vet J. 2006; 54(3): 114-8.
Rainsford K and Whitehouse M. Gastroprotective and anti-inflammatory properties of Green Lipped Mussel (Perna canaliculus) preparation. Arzneim. Fforsch./Drug Res. 1980; 30: 2128- 2133.

**Methylsulfonylmethane (MSM)**

Jacob S and Appleton J. MSM: The Definitive Guide. A comprehensive review of the science and therapeutics of methylsulfonylmethane. Topanga: Freedom Press, 2003.
Kim LS, et al. Efficacy of methylsulfonylmethane (MSM) in osteoarthritis pain of the knee: a pilot study. OsteoArthritis and Cartilage. 2006; 14: 286-294.
Usha P and Naidu M. Randomized, double-blind, parallel, placebo-controlled study of oral glucosamine, methylsulfonylmethane and their combination in osteoarthritis. Clin. Drug Invest. 2004; 24(6): 363.

**Glucosamine**

Muller-Fabender H, et al. Glucosamine sulfate compared to ibuprofen in osteoarthritis of the knee. Osteoarthritis Cartilage. 1994; 2: 61-69.
Setnikar I, Giacchetti C and Zanolo G. Pharmacokinetics of glucosamine in the dog and in man. Arzneimittelforschung. 1986; 36: 729-735.
Setnikar I, Pacini MA and Revel L. Anti-arthritic effects of glucosamine sulfate studied in animal models. Arzneimittelforschung. 1991; 41(5): 542-545.


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