



References (2018-Present) on Pain Research

Using ALZET® Osmotic Pumps

Q10951: Y. Jiao, *et al.* Molecular identification of bulbospinal ON neurons by GPER, which drives pain and morphine tolerance. *Journal of Clinical Investigation* 2023;133(1):

Agents: G15 **Vehicle:** CSF, artificial; **Route:** CSF/CNS (cisterna magna); **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 2004; **Duration:** Not Stated;

ALZET Comments: Controls received mp w/ vehicle; animal info (Male and female CPM-treated); G15 is a GPER-selective antagonist; PE-10 catheter used; dependence

Q11282: J. Y. Hong, *et al.* Epidural Injection Method for Long-Term Pain Management in Rats with Spinal Stenosis.

Biomedicines 2023;11(5):

Agents: Not Stated **Vehicle:** Not Stated; **Route:** CSF/CNS (intrathecal); **Species:** Rat; **Strain:** Not Stated; **Pump:** Not Stated; **Duration:** Not Stated;

ALZET Comments: ALZET mention "Previous studies have used implantable mini-osmotic pumps to continuously deliver drugs into the intrathecal space [16]. An osmotic pump (Alzet, Alza, Palo Alto, CA, USA) capable of supplying a certain drug concentration at a constant rate was developed and used in multiple animal species as small as mice. This can be achieved by implantation at multiple anatomical sites for long-term drug delivery, generally over a 2- to 4-week period in the case of rats."

Q10752: S. He, *et al.* A Human TRPV1 Genetic Variant Within the Channel Gating Domain Regulates Pain Sensitivity in Rodents. *Journal of Clinical Investigation* 2023;133(3):

Agents: TAT (45-57); V1-cal **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; Wild-type; **Pump:** 1002; **Duration:** 2 weeks;

ALZET Comments: Dose (1 mg/kg/day); Controls received mp w/ vehicle; animal info (Male mice 10-16 weeks old); peptides; behavioral testing (Measured paw-licking, flinching behavior and paw thickness); good methods (Filled and then primed in 0.9% sterile saline at 37°C for ~24 hours prior to implantation p.27);

Q10525: S. Fujiwara, *et al.* Age-related Changes in Trigeminal Ganglion Macrophages Enhance Orofacial Ectopic Pain After Inferior Alveolar Nerve Injury. *In Vivo* 2023;37(1):132-142

Agents: Liposomal clodronate; Liposome (control) **Vehicle:** Not Stated; **Route:** CSF/CNS; **Species:** Mice; **Strain:** SAMP8/SAMR1; **Pump:** 1004; **Duration:** 5 days;

ALZET Comments: Controls received mp w/ vehicle; animal info (23 week old male mice; Weighed 20-30 g); Brain Coordinates (2,8 mm anterior from posterior fontanelle, 1.2 mm lateral to sagittal suture); polyethylene catheter; dental cement used; aging;

Q11071: D. B. Buchalter, *et al.* Systemic glucose-insulin-potassium reduces skeletal muscle injury, kidney injury, and pain in a murine ischaemia-reperfusion model. *Bone & Joint Research* 2023;12(3):212-218

Agents: Glucose-insulin-potassium **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; **Pump:** Not Stated; **Duration:** 26.5 hours;

ALZET Comments: Dose (16 µl/hr); 0.9% saline used; Controls received mp w/ vehicle; animal info (20 total; Male; 12 weeks old); ischemia-reperfusion injury (skeletal muscle); "Subcutaneous osmotic infusion was chosen over intravenous infusion as it is rapid, inexpensive, and does not require continuous vascular access that tethers the animal to equipment." p. 2

R0449: M. Baudry, *et al.* Calpain-2 Inhibitors as Therapy for Traumatic Brain Injury. *Neurotherapeutics* 2023;20(6):1592-1602

Agents: NA-101 **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Strain:** C2CKO; WT; **Pump:** Not Stated; **Duration:** 2 weeks; **ALZET Comments:** behavioral testing (Tail suspension test; elevated plus maze); neurodegenerative (traumatic brain injury);



Q10949: M. R. Jain, *et al.* ZYKR1, a novel, potent, and peripherally selective kappa opioid receptor agonist reduces visceral pain and pruritus in animal models. *European Journal of Pharmacology* 2022;924(174961)

Agents: ZYKR1; Fentanyl **Vehicle:** Saline; **Route:** IP; **Species:** Mice; **Strain:** ICR; **Pump:** 1007D; **Duration:** 7 days;

ALZET Comments: Dose: Fentanyl (3.2 mg/kg/day); ZYKR1 (10 mg/kg/day); Controls received mp w/ vehicle; animal info: male ICR mice; behavioral testing: the animals were observed for behavioral visceral episodes (postures) for 30 min in a transparent acrylic chamber; Resultant plasma level (at 0.25 h after IV administration of ZYKR1 (1 mg/kg) in rats, plasma level was found to be 1713.03 ±261.95 ng/ml.); pg. 7; ZYKR1 is a peripherally selective kappa opioid receptor; dependence; "The osmotic pump was used to avoid repeated intravenous administration of drug and also released the drug substance at constant rate for 7 days." p. 3

Q10599: L. Di Cesare Mannelli, *et al.* Neuronal Alarmin IL-1alpha Evokes Astrocyte-Mediated Protective Signals: Effectiveness in Chemotherapy-Induced Neuropathic Pain. *Neurobiology of Disease* 2022;168(105716)

Agents: Interleukin-1a **Vehicle:** Saline; **Route:** CSF/CNS (intrathecal); **Species:** Rat; **Strain:** Not Stated; **Pump:** 1002; **Duration:** 10 days;

ALZET Comments: Dose (0.25 mL/h); Controls received mp w/ vehicle; animal info (Male; Weighed about 200-250 g); behavioral testing (Paw pressure test; Cold plate test); immunology;

Q10563: B. Cao, *et al.* Spinal Cord Retinoic Acid Receptor Signaling Gates Mechanical Hypersensitivity in Neuropathic Pain. *Neuron* 2022;110(24):4108-4124 e6

Agents: Ro41-5253 **Vehicle:** DMSO; **Route:** CSF/CNS (subarachnoid space); **Species:** Mice; **Strain:** P34-P42; **Pump:** 1007D; 1004; **Duration:** 7 days; 4 weeks;

ALZET Comments: Dose (1.25 ug/hr); animal info (); Controls received mp w/ vehicle; catheter; spinal cord injury; behavioral testing (Open field test; Elevated plus maze; Y-maze test; Hargreaves test; Cold plantar assay; Formalin test; Von Frey withdrawal threshold test); pain (neuropathic)

Q9919: H. Yamanaka, *et al.* Aberrant Axo-Axonic Synaptic Reorganization in the Phosphorylated L1-CAM/Calcium Channel Subunit alpha2delta-1-Containing Central Terminals of Injured c-Fibers in the Spinal Cord of a Neuropathic Pain Model. *eNeuro* 2021;8(2):

Agents: Pregabalin **Vehicle:** Saline; **Route:** CSF/CNS (intrathecal); **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** 2001; **Duration:** 14 days;

ALZET Comments: Dose (30 or 300 ug/day); Controls received mp w/ vehicle; animal info (male rats, 200–250 g);

Q9454: K. Sessler, *et al.* Spinal cord fractalkine (CX3CL1) signaling is critical for neuronal sensitization in experimental nonspecific, myofascial low back pain. *Journal of Neurophysiology* 2021;125(5):1598-1611

Agents: Fractalkine; Anti-fractalkine antibody **Vehicle:** CSF, artificial; **Route:** CSF/CNS (spinal cord); **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 2002; **Duration:** 5 days;

ALZET Comments: Dose (20 or 200 ng/mL); Controls received mp w/ vehicle; animal info (Adult male rats, 300-460 g)

Q10649: A. Phero, *et al.* A Novel Rat Model of Temporomandibular Disorder With Improved Face and Construct Validities. *Life Sciences* 2021;286(120023)

Agents: OR-486 **Vehicle:** DMSO; **Route:** SC; **Species:** Rat; **Strain:** Not Stated; **Pump:** 2002; **Duration:** 14 days;

ALZET Comments: Dose (15 mg/kg/day); 5:3:2 DMSO:ethano:distilled water; animal info (Male; Weighed 250-350 g); behavioral testing (Rat gnaw meter test); pain (TMJ/TMD)

Q10641: F. Pantouli, *et al.* Comparison of Morphine, Oxycodone and the Biased MOR Agonist SR-17018 For Tolerance and Efficacy in Mouse Models of Pain. *Neuropharmacology* 2021;185(108439)

Agents: Morphine **Vehicle:** Saline; **Route:** Not Stated; **Species:** Mice; **Strain:** C57BL/6J; **Pump:** 2001; **Duration:** 6 days;

ALZET Comments: Controls received mp w/ vehicle; animal info: mice 10–20 weeks of age (23–32 g)dependence; pain



Q10632: S. H. Oh, *et al.* Sec-O-Glucosylhamaudol Mitigates Inflammatory Processes and Autophagy Via p38/JNK MAPK Signaling in a Rat Neuropathic Pain Model. *Korean Journal of Pain* 2021;34(4):405-416

Agents: Sec-O-glucosylhamaudol **Vehicle:** DMSO; **Route:** CSF/CNS (intrathecal); **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** 1002; **Duration:** 2 weeks;

ALZET Comments: Dose (96 ug/day); Controls received mp w/ vehicle; 70% DMSO used; animal info (Male ; Pathogen-free; 100-120 g); behavioral testing (Paw withdrawal threshold using von Frey filament; Naloxone challenge test); spinal cord injury;

Q10256: C. M. Mecca, *et al.* Dynamic Change of Endocannabinoid Signaling in the Medial Prefrontal Cortex Controls the Development of Depression After Neuropathic Pain. *Journal of Neuroscience* 2021;41(35):7492-7508

Agents: Gabapentin **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** Not Stated; **Duration:** Not Stated;

ALZET Comments: "Controls received mp w/ vehicle; animal info: Male and female rats weighing 170-200; behavioral testing: Sensory behavioral tests; von Frey test; Open field test; Sucrose-preference test; Novelty-suppressed feeding; Forced swim test; Gabapentin aka (GBP); Brain coordinates ((from 151 bregma, anteroposterior, +3.2 mm; mediolateral, ±1.0 mm; dorsoventral, -3.5 mm); dental cement used;"

Q10255: S. L. McAllister, *et al.* Aberrant reactive aldehyde detoxification by aldehyde dehydrogenase-2 influences endometriosis development and pain-associated behaviors. *Pain* 2021;162(1):71-83

Agents: Alda-1 **Vehicle:** PEG; DMSO; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6 wild-type; **Pump:** Not Stated; **Duration:** Not Stated;

ALZET Comments: "Dose: (5 mg/kg/day); 50% PEG; 50% DMSO; animal info: virgin female ALDH2*2 knock-in (n 5 107) and (n 5 107) littermate mice, aged 6 to 8 weeks; behavioral testing: abdominal licking, mechanical nociception, thermal nociception, locomotor activity, and exploratory behavior,"

Q10223: Y. Kuthati, *et al.* Tenueligliptin Exerts Antinociceptive Effects in Rat Model of Partial Sciatic Nerve Transection Induced Neuropathic Pain. *Antioxidants (Basel)* 2021;10(9):

Agents: Tenueligliptin **Vehicle:** DMSO; **Route:** CSF/CNS (intrathecal); **Species:** Rat; **Strain:** Wistar; **Pump:** 2001; **Duration:** 7 days;

ALZET Comments: Dose: (5 ug/1 uL/h); Controls received mp w/ vehicle; animal info: Male rats; behavioral testing; Behavior Test for Tactile Allodynia; Behavior Test for Thermal Hyperalgesia; Tenueligliptin aka (TEN) is a dipeptidyl peptidase-4 inhibitor

Q10952: R. Koyama, *et al.* Pannexin 1-Mediated ATP Signaling in the Trigeminal Spinal Subnucleus Caudalis Is Involved in Tongue Cancer Pain. *International Journal of Molecular Sciences* 2021;22(21):

Agents: 10Panx; Brilliant blue G, dye; BzATP **Vehicle:** PBS; **Route:** CSF/CNS (cisterna magna); **Species:** Rat; **Strain:** Fisher; **Pump:** 1002; **Duration:** Not Stated;

ALZET Comments: Dose: (PBS/10Panx 20 nmol/0.5 ml/h; BBG 7pmol/0.5 ml/h; BzATP 20 pmol/0.5 ml/h); Controls received mp w/ vehicle; animal info: male (weighing 200–250 g); 10Panx is an inhibitory peptide for pannexin 1; BzATP is a specific agonist of P2X7Rs; cancer (Squamous cell carcinoma; Tongue cancer pain (PANX1)

T0015: R. Koyama. The role of pannexin 1-mediated ATP signaling in the trigeminal spinal subnucleus caudalis in tongue cancer pain. *Proceedings of the National Academy of Sciences* 2021;

Agents: 10Panx; Brilliant blue G; BzATP **Vehicle:** PBS; **Route:** CSF/CNS (cisterna magna); **Species:** Rat; **Strain:** Fischer; **Pump:** 2002; **Duration:** 14 days;

ALZET Comments: Dose: PBS and 10Panx (20 nmol/0.5 µL/h), Brilliant Blue G (7 pmol/0.5 µL/h), or BzATP (20 pmol/0.5 µL/h); Controls received mp w/ vehicle; animal info: male (weighing 200–250 g) post op. care: (e.g., buprenorphine, meloxicam, ketoprofen, carprofen, or tramadol); peptides; BBG is an antagonist of P2X7Rs; BzATP is a specific agonist of P2X7Rs; 10Panx is an inhibitory peptide for PANX1 channels; PANX1 is a therapeutic target for the development of appropriate drugs to prevent tongue cancer pain



Q10193: N. A. Huck, *et al.* Temporal Contribution of Myeloid-Lineage TLR4 to the Transition to Chronic Pain: A Focus on Sex Differences. *Journal of Neuroscience* 2021;41(19):4349-4365

Agents: RS504393 **Vehicle:** DMSO; **Route:** SC; **Species:** Mice; **Strain:** Wild-type C57BL/6J; **Pump:** 1002; **Duration:** 2 weeks; **ALZET Comments:** Dose: (5mg/kg/day) animal info: Male 25g and female 20g adult mice 10-12 weeks old, mice, Cx3CR1-Cre behavioral testing (see pg. 2) RS504393 is a selective CCR2 antagonist

Q10378: O. Echeverria-Rodriguez, *et al.* Participation of angiotensin-(1-7) in exercise-induced analgesia in rats with neuropathic pain. *Peptides* 2021;146(170670)

Agents: Angiotensin 1-7; A779 **Vehicle:** Water, deionized; **Route:** SC; **Species:** Rat; **Strain:** Not Stated; **Pump:** Not Stated; **Duration:** 14 days;

ALZET Comments: Dose (Ang 1-7 0.1 and 1 mg/kg; A779 24 ug/kg/h); animal info (Male; Weigh 120-150 g); behavioral testing (Swimming); peptides; spinal cord injury;

Q9130: W. Zhong, *et al.* Blockade of peripheral nociceptive signal input relieves the formation of spinal central sensitization and retains morphine efficacy in a neuropathic pain rat model. *Neuroscience Letters* 2020;716(134643)

Agents: Ropivacaine **Vehicle:** Saline; **Route:** CSF/CNS (sciatic nerve); **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 2ML1; **Duration:** 7 days;

ALZET Comments: Dose (10 µl/hour); 0.9% NaCl used; animal info (male Sprague-Dawley rats, 200–250 g, aged 6–8 weeks); spinal cord injury;

Q9861: X. Zhang, *et al.* Low catechol-O-methyltransferase and stress potentiate functional pain and depressive behavior, especially in female mice. *Pain* 2020;161(2):446-458

Agents: Catechol-O-methyltransferase inhibitor **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; **Pump:** 1002; **Duration:** 2 weeks;

ALZET Comments: 0.9% Saline used; Controls received mp w/ vehicle; animal info (8-12 weeks old, 18-30 g.); behavioral testing (Forced Swim Test); Catechol-O-methyltransferase aka COMT inhibitor ; dependence;

Q9868: W. Zhang, *et al.* Inhibition of NADPH oxidase within midbrain periaqueductal gray decreases pain sensitivity in Parkinson's disease via GABAergic signaling pathway. *Physiological Research* 2020;

Agents: 6-hydroxydopamine **Vehicle:** CSF, Artificial; **Route:** CSF/CNS; **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** 1003D; **Duration:** 3 days;

ALZET Comments: Dose (6 ul/min); Controls received mp w/ vehicle; animal info (Male, 200-250 g); behavioral testing (Rotation Behavior Test); 6-hydroxydopamine aka 6-OHDA ; Brain coordinates (3.3 mm rostral to the interaural line, 1.4 mm left of the midline, and 6.5 and 6.8 mm ventral to the dural surface); neurodegenerative (Parkinson's Disease);

Q9455: M. Shaqura, *et al.* Neuronal aldosterone elicits a distinct genomic response in pain signaling molecules contributing to inflammatory pain. *Journal of Neuroinflammation* 2020;17(1):183

Agents: FAD286 **Vehicle:** Saline; **Route:** IV (lumbar); **Species:** Rat; **Strain:** Wistar; **Pump:** Not Stated; **Duration:** Not Stated;

ALZET Comments: Dose (0.3ug/1 µl); 0.9% NaCl used; Controls received mp w/ vehicle; animal info (male rats (180– 250g)); dependence;

Q9413: E. Persoons, *et al.* Mimicking Sampson's Retrograde Menstrual Theory in Rats: A New Rat Model for Ongoing Endometriosis-Associated Pain. *International Journal of Molecular Sciences* 2020;21(7):

Agents: Calcitonin gene-related peptide; Substance P **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** 2006; **Duration:** 6 weeks;

ALZET Comments: Dose (50 ug/kg/day); animal info (Rats, 8 to 10 weeks old); behavioral testing (Advanced Dynamic Weight Bearing Assessment, Open Field Assessment); functionality of mp verified by increased plasma levels; Calcitonin gene-related peptide aka CGRP, Substance P aka SP; peptides; dependence;



Q8633: X. Li, *et al.* Exercise training modulates glutamic acid decarboxylase-65/67 expression through TrkB signaling to ameliorate neuropathic pain in rats with spinal cord injury. *Molecular Pain* 2020;16(1744806920924511

Agents: Immunoglobulin G, TrkB **Vehicle:** PBS; **Route:** SC; **Species:** Rat; **Strain:** Sprague–Dawley; **Pump:** 2002; **Duration:** 2 weeks;

ALZET Comments: Animal info (adult female); behavioral testing (Mechanical withdrawal thresholds assessment); TrkB Immunoglobulin G aka TrkB-IgG; spinal cord injury;

Q8644: J. Li, *et al.* Prolonged Use of NMDAR Antagonist Develops Analgesic Tolerance in Neuropathic Pain via Nitric Oxide Reduction-Induced GABAergic Disinhibition. *Neurotherapeutics* 2020;17(3):1016-1030

Agents: MK801; TrkB-Fc **Vehicle:** Saline; **Route:** CSF/CNS (Intrathecal); **Species:** Mice; Rat; **Strain:** Sprague-Dawley; **Pump:** 1004; 2ML4; **Duration:** 11 days;

ALZET Comments: Dose (5 ug/day MK801; 0.2 ug/day TrkB-Fc); Controls received mp w/ vehicle; animal info (Adult male rats, 250-300 g; Adult male mice, 6 to 7 weeks old); behavioral testing (Mechanical Nociception Assays; Thermal Nociception Assays); MK801 aka N-methyl-D-aspartate receptor antagonist; spinal cord injury;

Q10025: S. Ilari, *et al.* Natural Antioxidant Control of Neuropathic Pain-Exploring the Role of Mitochondrial SIRT3 Pathway. *Antioxidants (Basel)* 2020;9(11):

Agents: Bergamot Polyphenolic fraction; Pregabalin **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** Not Stated; **Duration:** 21 days;

ALZET Comments: Dose (25, 50, 75 mg/kg Bergamot Polyphenolic fraction; 10 mg/kg Pregabalin); 0.9% NaCl used; Controls received mp w/ vehicle; animal info (8 week old male 225-250 g); behavioral testing (Mechanical allodynia, Mechanical hyperalgesia, Thermal hyperalgesia); Bergamot Polyphenolic fraction aka BPF; spinal cord injury;

Q8542: R. Hornung, *et al.* Reduced activity of GAD67 expressing cells in the reticular thalamus enhance thalamic excitatory activity and varicella zoster virus associated pain. *Neuroscience Letters* 2020;736(135287

Agents: Estradiol benzoate, 17-beta- **Vehicle:** PEG; **Route:** SC; **Species:** Rat; **Strain:** Long Evans; **Pump:** Not stated; **Duration:** 28 days;

ALZET Comments: Dose (750 ng/6 ul/day); animal info (Transgenic male (300 g) and female rats (260 g)); replacement therapy (estradiol);

Q8472: T. Fujimura, *et al.* The pain-relieving effects of lactoferrin on oxaliplatin-induced neuropathic pain. *Journal of Veterinary Medical Science* 2020;

Agents: Lactoferrin, human recombinant **Vehicle:** PBS; **Route:** IV (external jugular); **Species:** Mice; **Strain:** ICR; **Pump:** Not Stated; **Duration:** 2 weeks;

ALZET Comments: Dose (10 mg/kg/day); Controls received mp w/ vehicle; animal info (five-week-old male mice); human recombinant lactoferrin aka rhLf; dependence;

Q6948: Y. Zhang, *et al.* Hyperbaric oxygen produces a nitric oxide synthase-regulated anti-allodynic effect in rats with paclitaxel-induced neuropathic pain. *Brain Research* 2019;

Agents: S-Methyl-L-thiocitrulline **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** 1007D; **Duration:** 7 days;

ALZET Comments: Dose (0.5 ± 0.1 µL/hr/day); 0.9% saline used; animal info (male); post op. care (Ampicillin, meloxicam); enzyme inhibitor (S-Methyl-L-thiocitrulline is a neuronal nitric oxide synthase (nNOS) inhibitor); Brain coordinates (AP–1.0 mm, ML –2.0 mm, DV –3.5mm from bregma); bilateral cannula used; dependence;

Q6990: L. Zhang, *et al.* Chronic pain induces nociceptive neurogenesis in dorsal root ganglia from Sox2-positive satellite cells. *Glia* 2019;

Agents: Tetrodotoxin **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** Not Stated; **Pump:** 2002; **Duration:** 14 days;

ALZET Comments: Dose (0.5 µL/hr); animal info (Male mice 8–12 weeks old, 25–30 g); To block the injured sciatic nerve, the outlet of minipump was placed to 5 mm proximal to the ligature.



Q7037: J. Zhang, *et al.* Neuroinflammation and central PI3K/Akt/mTOR signal pathway contribute to bone cancer pain. *Mol Pain* 2019;15(1744806919830240

Agents: Rapamycin, LY294002, Interleukin-1 Receptor antagonist, SC144, etanercept, **Vehicle:** CSF, artificial; **Route:** CSF/CNS (midbrain periaqueductal gray); **Species:** Rat; **Strain:** Wistar; **Pump:** 1001D; **Duration:** Not Stated;

ALZET Comments: animal info (200-250 gr rats); rapamycin is an mTOR inhibitor; LY294002 is a PI3K inhibitor; IL-1Ra is an IL-1b receptor antagonist, SC144 is a gp130 antagonist, etanercept is a TNF- α receptor antagonist; ALZET brain infusion kit used; Brain coordinates (7.6 mm posterior to the bregma, 0.65mm lateral to the midline, and 4.2 mm ventral to the brain surface); Therapeutic indication (bone cancer pain);

Q9044: M. Yamada, *et al.* Increased Expression of Fibronectin Leucine-Rich Transmembrane Protein 3 in the Dorsal Root Ganglion Induces Neuropathic Pain in Rats. *Journal of Neuroscience* 2019;39(38):7615-7627

Agents: Goat anti-FLRT3; Goat IgG **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Wistar; **Pump:** 1002; **Duration:** Not Stated;

ALZET Comments: Dose (0.2 μ l/hr); animal info (Male, , 6-10 weeks old); Goat anti-Fibronectin leucine-rich transmembrane protein 3 aka Goat anti-FLRT3; dependence;

Q7671: L. Sun, *et al.* MicroRNA-211-5p Enhances Analgesic Effect of Dexmedetomidine on Inflammatory Visceral Pain in Rats by Suppressing ERK Signaling. *J Mol Neurosci* 2019;68(1):19-28

Agents: Dexmedetomidine **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** Not Stated;

Duration: 1 week;

ALZET Comments: Dose (25 μ g/mL); Controls received mp w/ vehicle; animal info (, Male, 400 g); Dexmedetomidine aka DEX; enzyme inhibitor (α 2 adrenergic receptor agonist); bilateral cannula used; dependence;

Q6999: S. J. Shiue, *et al.* Mesenchymal stem cell exosomes as a cell-free therapy for nerve injury-induced pain in rats. *Pain* 2019;160(1):210-223

Agents: Exosomes, human umbilical cord mesenchymal stem cell **Vehicle:** Saline; **Route:** CSF/CNS (intrathecal); **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 2001; **Duration:** 7 days;

ALZET Comments: Dose (1.2 mg/mL/ hr); Controls received mp w/ vehicle; animal info (Male rats, 200 to 250 g); Therapeutic indication (neuropathic pain);

Q7427: M. Shinoda, *et al.* Spinal glial cell line-derived neurotrophic factor infusion reverses reduction of Kv4.1-mediated A-type potassium currents of injured myelinated primary afferent neurons in a neuropathic pain model. *Mol Pain* 2019;15(1744806919841196

Agents: Glial cell line-derived neurotrophic factor, recombinant human **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 2001; **Duration:** 7 days;

ALZET Comments: Dose (0.5 mg/ml); Controls received mp w/ vehicle; animal info (adult male rats weighing 210 to 240 g); Therapeutic indication (neuropathic pain);

Q8294: K. M. Nation, *et al.* Sustained exposure to acute migraine medications combined with repeated noxious stimulation dysregulates descending pain modulatory circuits: Relevance to medication overuse headache. *Cephalalgia* 2019;39(5):617-625

Agents: Sumatriptan succinate or Morphine Sulfate **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** 2001; **Duration:** 7 days;

ALZET Comments: Dose (Sumatriptan succinate- 0.6 mg/kg/day or 3 mg/kg/day or Morphine Sulfate- 7.68 mg/kg/day); 0.9% Saline used; Controls received mp w/ vehicle; animal info (Male, , 175-200g); dependence;

Q8286: T. Miladinovic, *et al.* Spinal microglia contribute to cancer-induced pain through system xC⁻-mediated glutamate release. *Pain Rep* 2019;4(3):e738

Agents: Sulfasalazine **Vehicle:** Ammonium Hydroxide; **Route:** IP; **Species:** Mice; **Strain:** BALB/c; **Pump:** 1002;

Duration: 14 days;

ALZET Comments: Dose (6.6 mg/kg/day); Controls received mp w/ vehicle; animal info (, 4-6 weeks old); behavioral testing (Nociception Test); Sulfasalazine aka SSZ; cancer (Cancer-induced pain);



Q7578: S. Lux, *et al.* The antinociceptive effect of resveratrol in bone cancer pain is inhibited by the Silent Information Regulator 1 inhibitor selisistat. *J Pharm Pharmacol* 2019;71(5):816-825

Agents: Selistate **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Strain:** BALB/c; **Pump:** 10074D; **Duration:** 1 week;
ALZET Comments: Dose (0.5 lg/h); Controls received mp w/ vehicle; animal info (Male mice (20–30 g)); cancer (pain); Therapeutic indication (cancer pain (nociception));

Q8248: G. W. Lee, *et al.* Central VEGF-A pathway plays a key role in the development of trigeminal neuropathic pain in rats. *Mol Pain* 2019;15(1744806919872602

Agents: VEGF-A164 antibody **Vehicle:** Not stated; **Route:** SC; **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** 2001;
Duration: 7 days;
ALZET Comments: Dose (250 ng or 500 ng/day); Controls received mp w/ vehicle; animal info (Male, , 200-230 g); bilateral cannula used; neurodegenerative (Neuropathic pain);

Q8235: Y. Kuthati, *et al.* Melatonin MT2 receptor agonist IIK-7 produces antinociception by modulation of ROS and suppression of spinal microglial activation in neuropathic pain rats. *J Pain Res* 2019;12(2473-2485

Agents: MT2 agonists (IIK-7 or 4-p) **Vehicle:** Not stated; **Route:** SC; **Species:** Rat; **Strain:** Wistar; **Pump:** Not stated; **Duration:** 7 days;
ALZET Comments: Dose (IIK-7- 0.5 ug/hr or 4-p- 1 ug/hr); Controls received mp w/ vehicle; animal info (Male,); MT2 agonist aka IIK-7 or 4-p ;

Q8735: S. M. Green-Fulgham, *et al.* Oxycodone, fentanyl, and morphine amplify established neuropathic pain in male rats. *Pain* 2019;160(11):2634-2640

Agents: Fentanyl **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** 2001; **Duration:** 5 days;
ALZET Comments: Dose (0.01 mg/kg/hr); Controls received mp w/ vehicle; animal info (Male, , 10 weeks old); dependence;

Q7994: A. K. Feehan, *et al.* Morphine immunomodulation prolongs inflammatory and postoperative pain while the novel analgesic ZH853 accelerates recovery and protects against latent sensitization. *J Neuroinflammation* 2019;16(1):100

Agents: Endomorphin analog **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** 2001; **Duration:** 5 days;
ALZET Comments: Dose (1 ul/hr); 0.9% Saline used; Controls received mp w/ vehicle; animal info (Male, , 59-67 days old, 250-300 g); Endomorphin analog aka ZH853; dependence;

Q8189: R. de la Puerta, *et al.* BMP-7 protects male and female rodents against neuropathic pain induced by nerve injury through a mechanism mediated by endogenous opioids. *Pharmacol Res* 2019;150(104470

Agents: recombinant BMP-7 **Vehicle:** CSF; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; BMP-7+/-; **Pump:** 1002;
Duration: 14 days;
ALZET Comments: Dose (6µg/kg/day); Controls received mp w/ vehicle; animal info (8–10 weeks old wild type 3 (male and female mice); recombinant BMP-7 aka rBMP-7; neurodegenerative (BMP-7 and its type I receptors were detected in regions of the nervous system involved in pain transmission, processing, and modulation);

Q8573: David H. Kim¹, James D. Beckett^{1*}, Varun Nagpal¹, Manuel A. Seman-Senderos^{1,2}, Russell A. Gould^{1,3}, Tyler J. Creamer⁴, Elena Gallo MacFarlane^{1,4}, Yichun Chen¹, Djahida Bedja⁵, Jonathan T. Butcher³, Wayne Mitzner⁶, Rosanne Rouf⁵, Shoji Hata⁷, Daniel S. Warren⁴, Harry C. Dietz^{1,8†}. Calpain 9 as a therapeutic target in TGFβ-induced mesenchymal transition and fibrosis. *Science Translational Medicine* 2019;

Agents: Bleomycin; Angiotensin II **Vehicle:** Saline; **Route:** Not stated; **Species:** Mice; **Strain:** Wild-type; **Pump:** 1007D; 2004;
Duration: 10 days; 28 days;
ALZET Comments: Dose (1.5 U/kg Bleomycin; 1.2 ug/kg/min Angiotensin II); Controls received mp w/ vehicle; animal info (mice, 6 weeks old); Blood pressure measured via tail cuff method; cardiovascular;



Q8158: P. Alvarez, *et al.* Unpredictable stress delays recovery from exercise-induced muscle pain: contribution of the sympathoadrenal axis. *Pain Rep* 2019;4(5):e782

Agents: Epinephrine **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 2004; **Duration:** 2 weeks;
ALZET Comments: Dose (5.4 mg/0.25 mL/h); Controls received mp w/ vehicle; animal info (adult male rats, weighing 250 to 400 g (approximately 8-12 weeks old)); antisense (intrathecal b2-adrenergic receptor antisense);

Q7270: L. S. Almeida, *et al.* Amylin, a peptide expressed by nociceptors, modulates chronic neuropathic pain. *Eur J Pain* 2019;23(4):784-799

Agents: Amylin **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Wistar; **Pump:** 2001; **Duration:** 7 days;
ALZET Comments: Dose (2 µg/kg/hr); Controls received mp w/ vehicle; animal info (male rats, 175 and 225 g); behavioral testing (von Frey, pinprick and acetone tests); spinal cord injury;

Q7036: X. Zhang, *et al.* Sustained stimulation of beta2- and beta3-adrenergic receptors leads to persistent functional pain and neuroinflammation. *Brain, Behavior, and Immunity* 2018;73(5):20-32

Agents: OR486, ICI118551, SR59230A, Etanercept, SB203580, and U0126 **Vehicle:** DMSO, ethanol, saline; **Route:** SC; **Species:** Rat; **Strain:** Not Stated; **Pump:** 2002; **Duration:** 14 days;
ALZET Comments: Dose (OR486 (15 mg/kg/day), ICI118551 (1.5 mg/kg/day), SR59230A (1.67 mg/kg/day)), SB203580 (12 µg/day), U0126 (12 µg/day) and Etanercept (10 µg/day); OR486 was dissolved in DMSO/ethanol/0.9% saline at 5:2:3 ratio. ICI118551 and SR59230A were dissolved in DMSO and 0.9% saline at 1:4 ratio; Etanercept, SB203580, and U0126 were dissolved in DMSO and 0.9% saline at 1:1 ratio. Controls received mp w/ vehicle; OR486 is a COMT inhibitor, ICI118551 is a β2AR antagonist; SR59230A is a β3AR antagonist; enzyme inhibitor (catechol-O-methyltransferase); delayed delivery (the Lynch method was used to delay delivery of ICI118551+SR59230A until day 7 using coiled PE50 polyethylene tubing);

Q6907: D. Xu, *et al.* Participation of pro-inflammatory cytokines in neuropathic pain evoked by chemotherapeutic oxaliplatin via central GABAergic pathway. *Mol Pain* 2018;14(17):4806918783535

Agents: Interleukin 1 receptor antagonist; SC144; etanercept **Vehicle:** CSF, artificial; **Route:** CSF/CNS (periaqueductal gray); **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 1003D; **Duration:** 3 days;
ALZET Comments: Controls received mp w/ vehicle; animal info (Adult male rats weighing 200–250 g); enzyme inhibitor (IL-1Ra is a IL-1b receptor antagonist; SC144 is a gp130 antagonist to block IL-6R, and etanercept is a TNF-α receptor antagonist); ALZET brain infusion kit used; Brain coordinates (7.6 mm posterior to the bregma, 0.65 mm lateral to the midline, and 4.2 mm ventral to the brain surface);

Q8777: Y. Wang, *et al.* Targeting Calpain for Heart Failure Therapy: Implications From Multiple Murine Models. *JACC: Basic to Translational Science* 2018;3(4):503-517

Agents: Isoproterenol **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6N; CAPN1-OE; **Pump:** 1004; **Duration:** 2 weeks;
ALZET Comments: Dose (30 mg/kg/day); Controls received mp w/ agent; animal info (9-10 weeks, male,); comparison of myocardial infarction surgery or transverse aortic banding vs mp; ischemia (Myocardial infarction); cardiovascular; mp used to induce chronic heart failure in mice;

Q7884: A. Van Elstraete, *et al.* The Opiorphin Analog STR-324 Decreases Sensory Hypersensitivity in a Rat Model of Neuropathic Pain. *Anesthesiology* 2018;126(6):2102-2111

Agents: STR-324 **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 2ML1; **Duration:** 7 days;
ALZET Comments: Dose (10, 50, 250 µg/10 µL); Controls received sham surgery and mp w/ vehicle; animal info (male, 250-275g); behavioral testing (Von Frey test, Thermal Paw Withdrawal, Paw Posture Rating); STR-324 is a pyroglutamate-opiorphin which provides a similar level of analgesia as opiorphin; neurodegenerative (peripheral mononeuropathy);

Q6900: Tramullas M, *et al.* MicroRNA-30c-5p modulates neuropathic pain in rodents. *Science Translational Medicine* 2018;10(453):

Agents: Transforming growth factor-β1 **Vehicle:** Hydrochloric acid; albumin; PBS; **Route:** Not Stated; **Species:** Mice (knockout); **Strain:** BAMBI^{-/-}; **Pump:** 1002; **Duration:** 14 days;
ALZET Comments: Dose (6.2 ng/hour); animal info (mice); Therapeutic indication (chronic pain);



Q7304: K. Stockstill, *et al.* Dysregulation of sphingolipid metabolism contributes to bortezomib-induced neuropathic pain. *J Exp Med* 2018;215(5):1301-1313

Agents: FTY720, ponesimod, NIBR14 **Vehicle:** Saline; **Route:** CSF/CNS (intrathecal; L5/L6 lumbar); **Species:** Rat, Mice; **Strain:** Sprague Dawley; **Pump:** 2001; **Duration:** 6 days;

ALZET Comments: 5% Tween 80, 5% ethanol, saline used; Controls received mp w/ vehicle; animal info (Male, Sprague Dawley rats, 200–220 g); animal info (Male, rats, 200–220 g); FTY720 AKA fingolimod; Ponesimod AKA ACT-128800; NIBR14 is a methyl ester pro-drug; FTY720 AKA fingolimod; Ponesimod AKA ACT-128800; NIBR14 is a methyl ester pro-drug;

Q7264: C. Rivat, *et al.* Inhibition of neuronal FLT3 receptor tyrosine kinase alleviates peripheral neuropathic pain in mice. *Nat Commun* 2018;9(1):1042

Agents: RNA, small interfering (Flt3, scrambled) **Vehicle:** Not Stated; **Route:** CSF/CNS (Intrathecal); **Species:** Mice; **Strain:** C57BL/6 naive, Flt3KO; **Pump:** 1002; **Duration:** 6 days;

ALZET Comments: Dose (12.53 ng/ml); animal info (mice, mice 25–30 g.); behavioral testing (reflexive tail flick); spinal cord injury; stress/adverse reaction: (see pg. 10);

Q6892: B. Remeniuk, *et al.* Disease modifying actions of interleukin-6 blockade in a rat model of bone cancer pain. *Pain* 2018;159(4):684-698

Agents: TB-2-081 **Vehicle:** PEG 400; **Route:** SC; **Species:** Rat; **Strain:** Not Stated; **Pump:** 2001; **Duration:** 7 days;

ALZET Comments: Dose (1 mg/kg/day); Controls received mp w/ vehicle; cancer (bone);

Q8143: K. M. Nation, *et al.* Lateralized kappa opioid receptor signaling from the amygdala central nucleus promotes stress-induced functional pain. *Pain* 2018;159(5):919-928

Agents: Morphine Sulfate **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** 2001; **Duration:** 7 days;

ALZET Comments: Dose (7.68 mg/kg/day); 0.9% Saline used; Controls received mp w/ vehicle; animal info (Male, , 175-200 g); post op. care (Gentamycin); neurodegenerative (Functional Pain Syndrome);

Q7232: T. Miladinovic, *et al.* Functional effects of TrkA inhibition on system xC(-)-mediated glutamate release and cancer-induced bone pain. *Mol Pain* 2018;14(1744806918776467

Agents: AG879 **Vehicle:** DMSO; **Route:** IP; **Species:** Mice; **Strain:** BALB/c; **Pump:** 1002; **Duration:** Not Stated;

ALZET Comments: Dose (5 mg/kg/day); animal info (immunocompetent female mice, 4 to 6 weeks old, 20g); AG879 is a TrkA inhibitor; enzyme inhibitor (Tyrosine kinase A); cancer (Breast cancer);

Q6913: Michael Mousseau, *et al.* Microglial pannexin-1 channel activation is a spinal determinant of joint pain. *Science Advances* 2018;4(8):

Agents: A740003; mimetic peptide inhibitor of Panx1; 10panx; scrpanx; Mac1-saporin; Saporin **Vehicle:** Not Stated; **Route:** CSF/CNS (intrathecal); **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** Not Stated; **Duration:** 7 days;

ALZET Comments: animal info (adult male rats); enzyme inhibitor (P2X7R antagonist A740003); Therapeutic indication (arthritis);

Q7768: S. Kim, *et al.* Acupuncture Resolves Persistent Pain and Neuroinflammation in a Mouse Model of Chronic Overlapping Pain Conditions. *J Pain* 2018;19(12):1384 e1-1384 e14

Agents: Dinitrocatechol, 3,5- **Vehicle:** saline, DMSO and ethanol buffered; **Route:** SC; **Species:** Mice (adult); **Strain:** C57BL/6; MRL/MpJ; **Pump:** 1002; **Duration:** 13 days;

ALZET Comments: Dose (15 mg/kg/d); 5:2:3 ratio of DMSO, ethanol and saline used; Controls received mp w/ vehicle; animal info (12-16 weeks, male and female,); behavioral testing (von Frey test); comparison of acupuncture vs mp; 3,5-Dinitrocatechol AKA OR486 is a COMT inhibitor; enzyme inhibitor (catechol-O-methyltransferase);