Recent References (2010-Present) on the Administration of Cholinergic Agents Using ALZET® Osmotic Pumps

Acetylcholine

Q9514: M. A. Ulleryd, *et al.* RNA sequencing data describing transcriptional changes in aorta of ApoE-/- mice after alpha 7 nicotinic acetylcholine receptor (alpha7nAChR) stimulation. Data in Brief 2020;30(105415
Agents: Alpha 7 nicotinic acetylcholine receptor agonist **Vehicle:** Cyclodextrin; Saline; **Route:** SC; **Species:** Mice; **Pump:** 2004; **Duration:** 8 weeks;
ALZET Comments: Dose (50 µmo/kg/day); 28% cyclodextrin used; Controls received mp w/ vehicle; animal info (Male apoE-/- mice, 10 weeks old); pumps replaced every 4 weeks; Alpha 7 nicotinic acetylcholine receptor agonist aka α7nAChR agonist; gene therapy;

Atropine

Q8110: I. Malaspinas, *et al.* Blockade of the cholinergic system during sensitization enhances lung responsiveness to allergen in rats. Clin Exp Pharmacol Physiol 2018;45(12):1293-1301
Agents: Atropine **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Pump:** 2ML; **Duration:** Not stated;
ALZET Comments: Dose (10 mg/kg); Controls received mp w/ vehicle; animal info (13 weeks old, Brown Norway); dependence;

Q4725: T. Kashihara, *et al.* beta(2)-Adrenergic and M(2)-muscarinic receptors decrease basal t-tubular L-type Ca(2+) channel activity and suppress ventricular contractility in heart failure. European Journal of Pharmacology 2014;724(;):122-131
Agents: Atropine; ICI-118,551 **Vehicle:** Saline; DMSO; **Route:** Not Stated; **Species:** Mice; **Pump:** 1004; **Duration:** 21 days;
ALZET Comments: Animal info (male, C57BL6, 8-10 weeks old); cardiovascular;

Q4399: M. Demion, *et al.* Trpm4 Gene Invalidation Leads to Cardiac Hypertrophy and Electrophysiological Alterations. PLoS One 2014;9(U821-U848
Agents: Atropine **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Pump:** 2001; **Duration:** 6 hours;
ALZET Comments: Animal info (male, Trpm4 -/-, 12-32 weeks old); cardiovascular;

Carbachol

Q4121: Y. Suzuki, *et al.* Vagal Hyperactivity Due to Ventromedial Hypothalamic Lesions Increases Adiponectin Production and Release. Diabetes 2014;63(1637-1648
Agents: Carbachol **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Pump:** Not Stated; **Duration:** 5 days;
ALZET Comments: Controls received mp w/ vehicle; animal info (female, Sprague-Dawley, 13 weeks old); carbachol is a parasympathetic stimulator; obesity;

Q1999: A. Osaki, *et al.* Enhanced expression of nesfatin/nucleobindin-2 in white adipose tissue of ventromedial hypothalamus-lesioned rats. Neuroscience Letters 2012;521(1):46-51
Agents: Carbachol **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Pump:** Not Stated; **Duration:** 5 days;
ALZET Comments: Controls received mp w/ vehicle; animal info (Sprague Dawley, female, 13 wks old)

Q0242: J. M. Van Kampen, *et al.* Agonist-induced restoration of hippocampal neurogenesis and cognitive improvement in a model of cholinergic denervation. Neuropharmacology 2010;58(6):921-929
Agents: Physostigmine; carbachol; nicotine; pirenzepine; oxotremorine; mecamylamine **Vehicle:** Saline; **Route:** CSF/CNS; **Species:** Rat; **Pump:** 2002; 2004; **Duration:** Not Stated;
ALZET Comments: Controls received mp w/ vehicle; animal info (female, Sprague Dawley, 250 g.); neurodegenerative (Alzheimer's Disease)

Oxotremorine

Q0242: J. M. Van Kampen, *et al.* Agonist-induced restoration of hippocampal neurogenesis and cognitive improvement in a model of cholinergic denervation. Neuropharmacology 2010;58(6):921-929
Agents: Physostigmine; carbachol; nicotine; pirenzepine; oxotremorine; mecamylamine **Vehicle:** Saline; **Route:** CSF/CNS; **Species:** Rat; **Pump:** 2002; 2004; **Duration:** Not Stated;
ALZET Comments: Controls received mp w/ vehicle; animal info (female, Sprague Dawley, 250 g.); neurodegenerative (Alzheimer's Disease)

Physostigmine

Q5056: D. P. Holschneider, *et al.* Remote brain network changes after unilateral cortical impact injury and their modulation by acetylcholinesterase inhibition. J Neurotrauma 2013;30(11):907-19
Agents: physostigmine **Vehicle:** water; **Route:** SC; **Species:** Rat; **Pump:** 2ML4; **Duration:** 3 weeks;
ALZET Comments: controls received mp w/ saline; animal info: sprague-dawley, male, 250-300g; functionality of mp verified by residual volume; enzyme inhibitor (Acetylcholine); neurodegenerative (Traumatic brain injury); except for model number, paper does not mention ALZET much; dose: 1.6 micromoles/kg/day

Q2076: R. Miyazaki, *et al.* Acetyleholinesterase inhibitors attenuate angiogenesis. Clinical Science 2012;123(3-4):241-249
Agents: Physostigmine **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Pump:** Not Stated; **Duration:** 2 weeks;
ALZET Comments: Animal info (C57BL/6, 9 wks old); enzyme inhibitor (acetylcholinesterase); hindlimb ischemia

R0292: H. P. M. Van Helden, *et al.* Non-enzymatic pretreatment of nerve agent (soman) poisoning: A brief state-of-the-art review. TOXICOLOGY LETTERS 2011;206(1):35-40
Agents: Physostigmine; scopolamine; pyridostigmine bromide **Vehicle:** Not Stated; **Route:** SC; **Species:** Guinea pig; **Pump:** Not Stated; **Duration:** 12 days;
ALZET Comments:

Q0242: J. M. Van Kampen, *et al.* Agonist-induced restoration of hippocampal neurogenesis and cognitive improvement in a model of cholinergic denervation. Neuropharmacology 2010;58(6):921-929
Agents: Physostigmine; carbachol; nicotine; pirenzepine; oxotremorine; mecamylamine **Vehicle:** Saline; **Route:** CSF/CNS; **Species:** Rat; **Pump:** 2002; 2004; **Duration:** Not Stated;
ALZET Comments: Controls received mp w/ vehicle; animal info (female, Sprague Dawley, 250 g.); neurodegenerative (Alzheimer's Disease)

Q10264: B. Mauck, *et al.* Cholinesterase inhibitors and stress: effects on brain muscarinic receptor density in mice. Neurotoxicology 2010;31(5):461-7
Agents: Pyridostigmine Bromide; Physostigmine **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Pump:** Not Stated; **Duration:** 7 days;
ALZET Comments: Dose (Pyridostigmine Bromide 3 or 10 mg/kg/day; Physostigmine 2.88 mg/kg/day); animal info (Male C57Bl6 mice weighing approx. 25 g); neurodegenerative (Gulf War Syndrome);

Q0425: B. Mauck, *et al.* Cholinesterase inhibitors and stress: Effects on brain muscarinic receptor density in mice. Neurotoxicology 2010;31(5):461-467
Agents: Pyridostigmine bromide; physostigmine **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Pump:** Not Stated; **Duration:** 30 days;
ALZET Comments: Controls received mp w/saline; animal info (male, C57BL6, 25 g); enzyme inhibitor (cholinesterase)

Pyridostigmine

Q9011: S. P. Singh*, et al.* Acetylcholinesterase Inhibitor Pyridostigmine Bromide Attenuates Gut Pathology and Bacterial Dysbiosis in a Murine Model of Ulcerative Colitis. Digestive Diseases and Sciences 2020;65(1):141-149
Agents: Sodium sulfate; Pyridostigmine bromide **Vehicle:** Saline; **Route:** IP; **Species:** Mice; **Pump:** Not Stated; **Duration:** 7 days;
ALZET Comments: Dose (2 mg/day/kg PB); Controls received mp w/ vehicle; animal info (Pathogen-free 5–6-week-old C57BL/6 mice); Sodium sulfate aka DSS, Pyridostigmine bromide aka PB; dependence;

Q8901: Y. Ma*, et al.* Brain-Derived Acetylcholine Maintains Peak Bone Mass in Adult Female Mice. Journal of Bone and Mineral Research 2020;35(8):1562-1571
Agents: Pyridostigmine bromide **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Pump:** Not Stated; **Duration:** 6 weeks;
ALZET Comments: Dose (1 mg/kg/day); animal info (Twelve-month-old female mice/15-month old male mice); dependence;

Q8832: C. Rocha-Resende*, et al.* Immunomodulatory role of non-neuronal cholinergic signaling in myocardial injury. JCI Insight 2019;5(**Agents:** Pyridostigmine bromide **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Pump:** 1002; **Duration:** 7 days;
ALZET Comments: Dose ()3 mg/kg/day); Controls received mp w/ vehicle; animal info (C57BL/6J, 8-10 weeks old); Pyridostigmine aka PYR; immunology;

Q7531: R. M. Lataro*, et al.* Chronic Treatment With Acetylcholinesterase Inhibitors Attenuates Vascular Dysfunction in Spontaneously Hypertensive Rats. American Journal of Hypertension 2019;32(6):579-587
Agents: Pyridostigmine Bromide; Donepezil **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Pump:** 2004; **Duration:** 16 weeks;
ALZET Comments: Dose (Pyridostigmine bromide at 1.5 mg/kg/day; Donepzeil at 1.4 mg/kg/day); animal info (5 week old male SHR and Wistar Kyoto rats); pumps replaced every 4 weeks; long-term study; enzyme inhibitor (Pyridostigmine Bromide inhibits plasma acetylcholinesterase activity; Donepezil inhibts brain acetylcholinesterase activity); cardiovascular; Four pump replacements were performed; BP measured via Tail-cuff method;

Q4881: B. C. Halil Sayin, Philippe Chevalier, Christian Barrès, Claude Julien. Assessment of cardiac autonomic tone in conscious rats. Autonomic Neuroscience: Basic and Clinical 2016;194(26-31
Agents: Pyridostigmine bromide **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Pump:** 2ML4; **Duration:** 3 weeks;
ALZET Comments: animal info (male, SHR, 46 weeks old); cardiovascular; bp measured using radiotelemetry; Dose (15 mg/kg/day);

Q5005: R. M. Lataro*, et al.* Acetylcholinesterase Inhibition Attenuates the Development of Hypertension and Inflammation in Spontaneously Hypertensive Rats. American Journal of Hypertension 2015;28(10):1201-8
Agents: Pyridostigmine bromide; donepezil **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Pump:** 2004; **Duration:** 16 weeks;
ALZET Comments: animal info (male, Wistar-Kyoto or SHR); pumps replaced every 4 weeks; long-term study; cardiovascular; bp measured using tail cuff; Dose (Pyridostigmine bromide 1.5 mg/kg/day; donepezil 1.4 mg/kg/day);

Q3860: M. T. Durand*, et al.* Pyridostigmine Restores Cardiac Autonomic Balance after Small Myocardial Infarction in Mice. PLoS One 2014;9(U327-U335
Agents: Pyridostigmine **Vehicle:** Saline, sterile; **Route:** SC; **Species:** Mice; **Pump:** 1004; **Duration:** 4 weeks;
ALZET Comments: Controls received mp w/ vehicle; animal info (male, C57BL6, 10-15 weeks old, 25-30g); ischemia (cardiac); cardiovascular; pyrostigmine is an acetylcholinesterase inhibitor; pyrostigmine aka PYR; bp measured using radiotelemetry; pumps primed at 37C saline for 48 hours;

Q3265: M. Richtsfeld*, et al.* Prolonged Administration of Pyridostigmine Impairs Neuromuscular Function with and without Downregulation of Acetylcholine Receptors. Anesthesiology 2013;119(2):412-421
Agents: Pyridostigmine **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Pump:** 2ML4; **Duration:** 14 days; 28 days;
ALZET Comments: Controls received mp w/ vehicle; animal info (male, Sprague Dawley, 220-260g); dose-response (p.416, 418); post op. care (antibiotic ointment); incision closed with (4-0) suture;

R0292: H. P. M. Van Helden, *et al.* Non-enzymatic pretreatment of nerve agent (soman) poisoning: A brief state-of-the-art review. TOXICOLOGY LETTERS 2011;206(1):35-40
Agents: Physostigmine; scopolamine; pyridostigmine bromide **Vehicle:** Not Stated; **Route:** SC; **Species:** Guinea pig; **Pump:** Not Stated; **Duration:** 12 days;
ALZET Comments:

Q0425: B. Mauck, *et al.* Cholinesterase inhibitors and stress: Effects on brain muscarinic receptor density in mice. Neurotoxicology 2010;31(5):461-467
Agents: Pyridostigmine bromide; physostigmine **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Pump:** Not Stated; **Duration:** 30 days;
ALZET Comments: Controls received mp w/saline; animal info (male, C57BL6, 25 g); enzyme inhibitor (cholinesterase)

Scopolamine

Q9153: S. K. Benassi, *et al.* Two decades of research towards a potential first anti-epileptic drug. Seizure 2021;90(99-109
Agents: Scopolamine hydrobromide **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Pump:** 2002; **Duration:** 14 days;
ALZET Comments: Dose (0.5 mg/kg); Controls received mp w/ vehicle; animal info (adult male Wistar rats, 190-300 g); neurodegenerative (Traumatic brain injury);

Q8681: J. Morisset. Life with the pancreas: A personal experience. Adv Med Sci 2020;65(1):46-64
Agents: Scopolamine, N-methyl; **Vehicle:** Saline; **Route:** Abdomen; **Species:** Rat; **Pump:** Not stated; **Duration:** 14 days;
ALZET Comments: Dose (25 mg kg-1 day); Controls received mp w/ vehicle; N-methyl-Scopolamine aka muscarinic antagonist; dependence;

Q8665: M. Middelhoff, *et al.* Prox1-positive cells monitor and sustain the murine intestinal epithelial cholinergic niche. Nature Communications 2020;11(1):111
Agents: Scopolamine **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Pump:** 2001; 2006; **Duration:** 7 days;
ALZET Comments: Dose (0.5 mg/KG BW/day); Controls received mp w/ vehicle; animal info (mice aged 8–10 weeks); Scopolamine aka nonselective cholinergic muscarinic receptor antagonist; dependence;

Q8655: Y. Matsuda, *et al.* NFE2L2 activator RS9 protects against corneal epithelial cell damage in dry eye models. PLoS One 2020;15(4):e0229421
Agents: Scopolamine **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Pump:** Not stated; **Duration:** 3 days;
ALZET Comments: Dose (12.5 mg/day); animal info (Sprague-Dawley rats); dependence;

Q7485: C. Simsek, *et al.* Changes in Murine Subbasal Corneal Nerves After Scopolamine-Induced Dry Eye Stress Exposure. Invest Ophthalmol Vis Sci 2019;60(2):615-623
Agents: Scopolamine **Vehicle:** PBS; **Route:** SC; **Species:** Mice; **Pump:** 1002; **Duration:** 28 days;
ALZET Comments: Dose (0.2 mg/kg/day); Controls received mp w/ vehicle; animal info (8-week-old WT BALB/c male mice 27–31 g); Therapeutic indication (experimental dry eye);

Q6743: H. Pierce, *et al.* Cholinergic Signals from the CNS Regulate G-CSF-Mediated HSC Mobilization from Bone Marrow via a Glucocorticoid Signaling Relay. Cell Stem Cell 2017;20(5):648-658 e4
Agents: Pirenzepine; Scopolamine hydrobromide; Metyrapone; luteinizing hormone; ACTH **Vehicle:** PBS; **Route:** CSF/CNS (Third ventricle); **Species:** Mice (knockout); **Pump:** 1002; **Duration:** Not Stated;
ALZET Comments: Dose (0.6 mg/kg/day Pirenzepine; 1.0 mg/kg Scopolamine hydrobromide; 100mg/kg/day Metyrapone; 2.8 mg/kg/day ACTH; 16ug/day LH); Controls received mp w/ vehicle; animal info (wild-type and Chrm1−/−); luteinizing hormone aka LH and adrenocorticotropic hormone aka ACTH; peptides; Brain coordinates (A/P −1.6 mm posterior to bregma, D/V −4.7 mm);

Q6369: U. Gehlsen*, et al.* A semifluorinated alkane (F4H5) as novel carrier for cyclosporine A: a promising therapeutic and prophylactic option for topical treatment of dry eye. Graefes Arch Clin Exp Ophthalmol 2017;255(4):767-775
Agents: Scopolamine **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Pump:** 1002; **Duration:** 2 weeks;
ALZET Comments: Dose (0.1 mg/day); animal info (10–12-week-old female C57BL/6 mice); Therapeutic indication (experimental dry eye);

Q4293: H. Saijo*, et al.* Microangiopathy triggers, and inducible nitric oxide synthase exacerbates dextran sulfate sodium-induced colitis. LABORATORY INVESTIGATION 2015;95(728-748
Agents: Butylscopolamine **Vehicle:** PBS; **Route:** SC; **Species:** Mice; **Pump:** 1007D; **Duration:** 3 days; 5 days; 7 days;;
ALZET Comments: Animal info (male, C57BL6J, 9-10 weeks old); ischemia (colitis);

Q3274: W. W. Chen*, et al.* Lycium barbarum Polysaccharides Prevent Memory and Neurogenesis Impairments in Scopolamine-Treated Rats. PLoS One 2014;9(2):U1116-U1128
Agents: Scopolamine **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Pump:** 2ML4; **Duration:** 28 days;
ALZET Comments: Control animals received mp w/ saline; animal info (male, Sprague Dawley, 200-220 g, adult);

Q5958: D. Y. Yoo*, et al.* Effects of luteolin on spatial memory, cell proliferation, and neuroblast differentiation in the hippocampal dentate gyrus in a scopolamine-induced amnesia model. Neurol Res 2013;35(8):813-20
Agents: Scopolamine **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Pump:** 2ML4; **Duration:** 28 days;
ALZET Comments: Controls received mp w/ vehicle; Dose (44 mg/ml delivered at 2.5 ml/h); functionality of mp verified (The release of SCO was
confirmed by the increase of locomotor activity and mydriasis);

Q2091: E. R. Gross*, et al.* Neuronal Serotonin Regulates Growth of the Intestinal Mucosa in Mice. Gastroenterology 2012;143(2):408-U430
Agents: Scopolamine **Vehicle:** Saline; **Route:** IP; **Species:** Mice; **Pump:** Not Stated; **Duration:** 3, 7, 14 days;
ALZET Comments: Controls received mp w/ vehicle; animal info (SERTKO, TPH1KO, wt)

Q1530: D. Y. Yoo*, et al.* Effects of a new synthetic butyrylcholinesterase inhibitor, HBU-39, on cell proliferation and neuroblast differentiation in the hippocampal dentate gyrus in a scopolamine-induced amnesia animal model. NEUROCHEMISTRY INTERNATIONAL 2011;59(5):722-728
Agents: Scopolamine **Vehicle:** Saline, physiological; **Route:** SC; **Species:** Rat; **Pump:** 2ML4; **Duration:** 28 days;
ALZET Comments: Controls received mp w/ vehicle; animal info (Wistar, male)

Q1417: D. Y. Yoo*, et al.* Effects of Nelumbo nucifera Rhizome Extract on Cell Proliferation and Neuroblast Differentiation in the Hippocampal Dentate Gyrus in a Scopolamine-induced Amnesia Animal Model. PHYTOTHERAPY RESEARCH 2011;25(6):809-815
Agents: Scopolamine **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Pump:** Not Stated; **Duration:** 28 days;
ALZET Comments: Controls received mp w/ vehicle; animal info (male, Wistar, 5 wks old)

Q1379: S. Viau*, et al.* No consequences of dietary n-3 polyunsaturated fatty acid deficiency on the severity of scopolamine-induced dry eye. Graefes Archive for Clinical and Experimental Ophthalmology 2011;249(4):547-557
Agents: Scopolamine **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Pump:** 2ML2; **Duration:** 10 days;
ALZET Comments: Animal info (Lewis, female, 6 wks old)

R0292: H. P. M. Van Helden*, et al.* Non-enzymatic pretreatment of nerve agent (soman) poisoning: A brief state-of-the-art review. TOXICOLOGY LETTERS 2011;206(1):35-40
Agents: Physostigmine; scopolamine; pyridostigmine bromide **Vehicle:** Not Stated; **Route:** SC; **Species:** Guinea pig; **Pump:** Not Stated; **Duration:** 12 days;
ALZET Comments:

Q2214: J. P. Raufman*, et al.* Muscarinic receptor subtype-3 gene ablation and scopolamine butylbromide treatment attenuate small intestinal neoplasia in Apc(min/+) mice. Carcinogenesis: Integrative Cancer Research 2011;32(9):1396-1402
Agents: Scopolamine butylbromide **Vehicle:** PBS; **Route:** SC; **Species:** Mice; **Pump:** 2004; **Duration:** 8 weeks;
ALZET Comments: Controls received mp w/ vehicle; animal info (6 wks old, male, APC min/+); pumps replaced after 4 weeks; post op. care (betadine)

Q1500: P. Jain*, et al.* An NGF mimetic, MIM-D3, stimulates conjunctival cell glycoconjugate secretion and demonstrates therapeutic efficacy in a rat model of dry eye. Experimental Eye Research 2011;93(4):503-512
Agents: Scopolamine hydrobromide **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Pump:** 2ML2; 2ML4; **Duration:** 14, 28 days;
ALZET Comments: Controls did not receive any scopolamine; animal info (male, Sprague Dawley, 6-8 wks old)