References on Opioid Receptor Research
Using ALZET® Osmotic Pumps

Agents: Nalmefene Vehicle: Saline; Route: SC; Species: Mice; Pump: 2004; Duration: 14 days;
ALZET Comments: Dose (5 mg/kg/day); Controls received mp w/ vehicle; animal info (Male and female C57BL/6J mice, 8 weeks old); behavioral testing (forced swim test, Conditioned place aversion, Marble burying, Dark-light emergence test); Nalmefene aka NMF; neurodegenerative (Depression);

Q8391: J. M. Bossert, et al. In a Rat Model of Opioid Maintenance, the G Protein-Biased Mu Opioid Receptor Agonist TRV130 Decreases Relapse to Oxycodone Seeking and Taking and Prevents Oxycodone-Induced Brain Hypoxia. Biol Psychiatry 2020;88(12):935-944
Agents: Buprenophrine; TRV130 Vehicle: Not stated; Route: SC; Species: Rat; Pump: Not stated; Duration: 14 days;
ALZET Comments: Dose (0, 3, 6, or 9 mg/kg/day); Controls received mp w/ vehicle; animal info (Sprague Dawley rats, 250 to 350 g (males) or 175 to 225 g (females)); TRV130 aka G protein–biased mu opioid receptor agonist; dependence;

Agents: Fentanyl citrate; morphine sulphate salt pentahydrate Vehicle: PBS; water, sterile; Route: SC; Species: Mice (transgenic); Pump: 1007D; Duration: 7 days;
ALZET Comments: Dose (Fentanyl (2mg/kg/day); Morphine (17 mg/kg/day)); animal info (knock-in mice with 11S/T-A mutations (Oprm1tm3.1Shlz, MGI:6117673, 11S/T-A)); behavioral testing (hot plate test; open field locomotion test); dependence; “...we used subcutaneously implanted osmotic pumps to deliver opioids at a constant rate. This approach is a powerful means of assessing both tolerance and dependence in rodents” (p.5)

Agents: Morphine HCl Vehicle: Saline; Route: SC; Species: Rat; Pump: 2ML1; Duration: 5 days;
ALZET Comments: Dose (6 mg/kg); Controls received mp w/ vehicle; animal info (6-week-old Jcl Wistar male rats); dependence;

Agents: Olanzapine, Samidorphan Vehicle: Not stated; Route: SC; Species: Rat; Pump: Not Stated; Duration: 2 days;
ALZET Comments: animal info (Female,); Olanzapine aka OLZ, Samidorphan aka SAM; dependence;

Agents: Morphine Sulfate Vehicle: Saline; Route: SC; Species: Rat; 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, Sprague Dawley, 175-200 g); post op. care (Gentamycin); neurodegenerative (Functional Pain Syndrome);

Agents: Morphine Sulfate Vehicle: Water; Route: SC; Species: Rat; Pump: 2ML1; Duration: 7 days;
ALZET Comments: Dose (50 mg/kg/day); animal info (Male, Sprague Dawley, 4-7 weeks old); dependence;

Agents: Morphine sulfate Vehicle: Water; Route: SC; Species: Rat; Pump: 2ML1; Duration: 7 days;
ALZET Comments: Dose (80mg/kg/day); animal info (5-6 Weeks); tolerance;
Agents: Sumatriptan Vehicle: Saline; Route: SC; Species: Rat; Pump: 2001; Duration: 7 days;
ALZET Comments: Controls received mp w/ vehicle; animal info (male, Sprague Dawley, 175-200g); post op. care (gentamicin 8 mg/kg SC); behavioral testing (von Frey filaments; tail flick test); Dose (0.6 mg/kg/day);

Agents: DAMGO Vehicle: Water, distilled; DMSO; saline; Route: CSF/CNS; Species: Mice; Pump: Not Stated; Duration: 5 Days;
ALZET Comments: Controls received mp w/ vehicle; animal info (male, C57BL6J or alpha2A- KO, 8-10 weeks old); ALZET brain infusion kit 3 used; Dose (DAMGO 4.7 nmol/day); used 7 day pump;

Agents: Rapamycin; CTOP; LY297002 Vehicle: DMSO; saline; Route: CSF/CNS; Species: Rat; Pump: Not Stated; Duration: 14 days;
ALZET Comments: Controls received mp w/ saline; animal info (Wistar, 200-250g); 50% DMSO used; cancer (breast; bone); dose-response (pg 2015); behavioral testing (hindpaw withdrawal latency); Rapamycin is an mTOR antagonist; CTOP is an MOR antagonist; LY297002 an PI3K inhibitor;

Q4836: L. S. Hwa, et al. Dissociation of u-opioid receptor and CRF-R1 antagonist effects on escalated ethanol consumption and mPFC serotonin in C57BL/6J mice. Addiction Biology 2016;21(111-124
Agents: CP154526; naltrexone Vehicle: DMSO; CSF, artificial; Route: CSF/CNS; Species: Mice; Pump: 1002; Duration: 14 days;
ALZET Comments: Controls received mp w/ vehicle; animal info (male, C58BL/6J, 8 weeks old); functionality of mp verified by IAA drinking test or morphine-sensitive tail withdrawal; ALZET brain infusion kit 3 used; 4% DMSO used; Cannula placement verified via Nissl staining;

Agents: Naloxone Vehicle: Saline, normal; Route: SC; Species: mice; Pump: 1007D; Duration: 7 days;
ALZET Comments: Controls received mp w/ vehicle; animal info: obesity induced, C57black/6J male mice, 6 wks old; functionality of mp verified by behavioral test; dose-response (pg 13, 14); dose-response (pg 13, 14); behavioral testing (Porsolt forced swim, Elevated Plus Maze, Dowel Gnawing); delayed delivery (24 hours via a 1.5 cm vinyl catheter); Isoflurane anesthesia used; minipump combined with a dose of 1 mg/kg/day of rimonabant (rim nal) injected IP; Dose: 0.5 mg/mouse/day

Agents: Nicotine hydrogen tartrate salt Vehicle: Saline; Route: SC; Species: Mice; Pump: 2002; Duration: 14 days; 28 days;
ALZET Comments: Controls received mp w/ vehicle; animal info (male, ICR, 8-10 weeks old); behavioral testing (elevated plus maze; hyperalgesia); Dose (24 mg/kg/day);

Agents: FSLRRY-NH2 Vehicle: Saline; Route: SCF/CNS; Species: Rat; Pump: Not Stated; Duration: 20 hours;
ALZET Comments: Controls received mp w/ vehicle; animal info (Wistar 200-250g); cancer (bone); no stress (see pg. 1476); behavioral testing (mechanical paw withdrawal, thermal hyperalgesia); peptides;

Agents: Morphine; PD168,077; L745,870 Vehicle: DMSO; saline; Route: SC; Species: Rat; Pump: 2ML1; Duration: 6 days;
ALZET Comments: Controls received mp w/ vehicle; animal info (adult male Sprague-dawley rats, 250-300g); 2% DMSO used; Combinational treatments; anesthetized with ketamine and medetomidine; PD168,077 is a dopamine D4 receptor agonist; L745,870 is a dopamine D4 receptor antagonist; Dose (morphine 20 mg/kg/day; PD168,077 1 mg/kg/day; L745,870 1 mg/kg/day);

Agents: Transforming growth factor-B1 Vehicle: HCl; albumin; Route: SC; Species: Mice (transgenic); Pump: 1002; Duration: 14 days;
ALZET Comments: Controls received mp w/ vehicle; animal info (male, BAMBI-KO or WT, 14-18 weeks old); behavioral testing (von Frey monofilaments; formalin test); Transforming growth factor-B1 aka TGF-B1; sciatic nerve crush injury;

Q3152: M. Shaqura, et al. Reduced Number, G Protein Coupling, and Antinociceptive Efficacy of Spinal Mu-Opioid Receptors in Diabetic Rats Are Reversed by Nerve Growth Factor. JOURNAL OF PAIN 2013;14(7):720-730
Agents: Nerve growth factor Vehicle: CSF, artificial; rat serum albumin; Route: CSF/CNS (intrathecal); Species: Rat; Pump: 2001; Duration: 7 days;
ALZET Comments: Controls received mp w/ vehicle; animal info (male, Wistar, 225g); behavioral testing (paw pressure test); peptides; used PE-10 attached to PE-60 catheter

Agents: Naloxone; naltrindole Vehicle: Saline; Route: SC; Species: Rat; Pump: 1007D; Duration: Not Stated;
ALZET Comments: Control animals received mp w/ vehicle; animal info (Sprague Dawley, 250-350 g)

Agents: Nor-binaltorphimine; senktide Vehicle: Sodium bicarbonate; Route: IP; Species: Rat; Pump: 2002; Duration: 14 days;
ALZET Comments: Controls received mp w/ vehicle; animal info (female, Wistar-Imamichi, 20 days old); Nor-binaltorphimine aka nor-BNI; Nor-binaltorphimine is a KOR agonist; senktide NK3R agonist;

Agents: Nerve growth factor, beta Vehicle: CSF, artificial; albumin, rat serum; Route: CSF/CNS (intrathecal); Species: Rat; Pump: 2001; Duration: 7 days;
ALZET Comments: Control animals received mp w/ vehicle; animal info (Sprague Dawley, 250-350 g)

Agents: Naltrexone HCl Vehicle: Saline; Route: CSF/CNS; Species: Rat; Pump: 1007D; Duration: 7 days;
ALZET Comments: Control animals received mp w/ vehicle; animal info (male, Sprague Dawley, albino, 160-180g); ALZET brain infusion kit used; post op. care (ampicillin 100 mg/kg IM; meloxicam 2.0 mg/kg IM); behavioral testing (flexion reflex, flinch response, mechanical threshold pressure); Incision closed with wound clip

Agents: Morphine Vehicle: Saline; Route: SC; Species: Mice; Pump: 2001; Duration: 5 days;
ALZET Comments: Control animals received mp w/ saline; animal info (male, Swiss Webster, 20-35g); Pump not mentioned much only pg.473
**Agents:** Naltrexone; **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Pump:** 2001; **Duration:** 7 days; **ALZET Comments:** Controls received mp w/ saline; animal info (Sprague Dawley, male, 250-300 g)

**Agents:** Nicotine; **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Pump:** 2ML2; **Duration:** 14 days; **ALZET Comments:** Animal info (adolescent, adult, Wistar, male)

**Agents:** Morphine hydrochloride; **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Pump:** Not Stated; **Duration:** 5 days; **ALZET Comments:** Animal info (Sprague Dawley, male, 250-275 g)

**Agents:** Nicotine; **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Pump:** 2001; **Duration:** 6 days; **ALZET Comments:** Animal info (C57BL/6, male, DOR KO, 8-12 wks old)

Q0846: R. S. Yamdeu, et al. p38 Mitogen-activated Protein Kinase Activation by Nerve Growth Factor in Primary Sensory Neurons Upregulates &mu; Opioid Receptors to Enhance Opioid Responsiveness Toward Better Pain Control. Anesthesiology 2011;114(1):150-161
**Agents:** Fentanyl propionanilide; buprenorphine hydrochloride; **Vehicle:** Saline, isotonic; **Route:** CSF/CNS (intrathecal); **Species:** Rat; **Pump:** Not Stated; **Duration:** 96 hours; **ALZET Comments:** Controls received mp w/ vehicle; animal info (male Wistar, 200-250 g); pain

Q1406: Y. Wu, et al. JWA regulates chronic morphine dependence via the delta opioid receptor. Biochemical and Biophysical Research Communications 2011;409(3):520-525
**Agents:** Oligonucleotide, sense, JWA; oligonucleotide, antisense JWA; **Vehicle:** CSF, artificial; **Route:** CSF/CNS; **Species:** Rat; **Pump:** Not Stated; **Duration:** Not Stated; **ALZET Comments:** Animal info (adult, male, Wistar, 190 g); antisense (JWA)

**Agents:** Morphine; methadone; **Vehicle:** Water; **Route:** SC; **Species:** Rat; **Pump:** 2ML1; **Duration:** 6 days; **ALZET Comments:** Controls received mp w/ vehicle; tolerance; animal info (adult (150-250 g, male, Sprague Dawley)

**Agents:** Naloxone; BW373U86; U50,488H; morphine-6-glucuronide; morphine-3-glucuronide; wortmannin; PKI-(14-22)-amide; **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Pump:** 1007D; **Duration:** 5 days; **ALZET Comments:** Animal info (7-12 wks old, C57/BL6, male);BW373U86 also known as (±)-4-[(R)→[[25,5R]-4-allyl-2,5-dimethyl-1-piperazinyl]-3-hydroxy-hydroxybenzyl]-N,N-diethylbenzamide is a delta opioid receptor selective agonist; U50,488H also known as trans-(−)-3,4-dichloro-N-methyl-N-(2-(1-pyrrolidin)cyclohexyl)-benzeneacetamide methane sulfonate hydrate is a kappa opioid selective receptor agonist

Agents: Naltrexone, methyl  
Vehicle: Not Stated;  
Route: SC;  
Species: Mice;  
Pump: 1002;  
Duration: 12 days;  
ALZET Comments: Controls received mp w/ PBS; animal info (MOR KO, C57BL/6 wt); cancer (lung); Methyl-naltrexone (also known as MNTX) is a mu opioid receptor inhibitor


Agents: Morphine; fentanyl  
Vehicle: Not Stated;  
Route: Not Stated;  
Species: Mice;  
Pump: 1003D;  
Duration: 3 days;  
ALZET Comments: Controls received mp w/ saline; animal info (CD1 (ICR), 6-8 wks old)


Agents: Nicotine  
Vehicle: Not Stated;  
Route: Not Stated;  
Species: Mice;  
Pump: 1007D;  
Duration: 7, 14 days;  
ALZET Comments: Animal info (8-10 wks old, 20-25 g); 28-day pumps used; withdrawal

Q0746: R. J. Horvath, et al. Inhibition of microglial P2X(4) receptors attenuates morphine tolerance, Iba1, GFAP and &mu; opioid receptor protein expression while enhancing perivascular microglial ED2. Pain 2010;150(3):401-413

Agents: Morphine sulfate; naloxone  
Vehicle: Not Stated;  
Route: SC;  
Species: Rat;  
Pump: 2ML1;  
Duration: 1, 4, 7 days;  
ALZET Comments: Controls received mp w/ saline; animal info (male, Sprague-Dawley, 175-200 g); one pump contained morphine plus naloxone; "All morphine pumps were filled with 0.833 mg/kg/hr morphine to deliver the equivalent of twice daily 10 mg/kg injections over the course of 24 h" pg 402; tolerance


Agents: Fentanyl  
Vehicle: Saline;  
Route: SC;  
Species: Mice;  
Pump: Not Stated;  
Duration: Not Stated;  
ALZET Comments: Animal info (adult, male, CD-1); comparison of SC injections vs. mp; "Although acute fentanyl injection (0.25 mg/kg) caused hyperalgesia within 15 min, hyperalgesia was not similarly evident on infusion Day 1 even though pumps were filled with a fentanyl dose (10mg/kg/24 h) that dispenses ~0.42 mg/kg/h, almost double the dose given by bolus injection." pg 71


Agents: Buprenorphine  
Vehicle: DMSO; water;  
Route: Not Stated;  
Species: Rat;  
Pump: 2ML1;  
Duration: Not Stated;  
ALZET Comments: Controls received mp w/ vehicle; functionality of mp verified by plasma drug levels; animal info (male, Sprague Dawley, 150-200 g.); 40% DMSO used; "the osmotic minipump delivered buprenorphine efficiently and predictably" pg. 7342


Agents: Morphine-6 beta-glucuronide; MK-801  
Vehicle: Saline;  
Route: SC;  
Species: Mice;  
Pump: Not Stated;  
Duration: Not Stated;  
ALZET Comments: Animal info (adult, male, CD-1, TrKO, B6129F1); "Osmotic pumps afford continuous opioid infusions and control for hyperalgesia associated with withdrawal in opioid-dependent subjects that potentially confounds experiments in which chronic opioid treatment is accomplished via repeated acute injections." pg 1357


Agents: Fentanyl hydrochloride  
Vehicle: Saline;  
Route: SC;  
Species: Mice;  
Pump: Not Stated;  
Duration: 7 days;  
ALZET Comments: Controls received placebo pellets; dose-response (fig. 3); comparison of SC injections vs. mp; tolerance; animal info (male, Swiss Webster, 23-35 g.)

Agents: Hydromorphone Vehicle: Saline; Route: SC; Species: Mice; Pump: 2001; Duration: 7 days;
ALZET Comments: Controls received inert placebo pellet; tolerance; animal info (male, Swiss Webster, 22-30 g.); "There was substantially more tolerance with infusion treatment compared to injection treatment." pg. 43

Agents: Citalopram Vehicle: Not Stated; Route: SC; Species: Rat; Pump: 2ML2; Duration: 14 days;
ALZET Comments: Comparison of IP injections vs. mp; animal info (adult, male, Sprague Dawley, 200g.); paper incorrectly states 2ML2 pump model as 2002

Agents: Morphine Vehicle: Not Stated; Route: SC; Species: Rat (neonate); Pump: 1003D; Duration: 72 hours;
ALZET Comments: Controls received mp w/ vehicle; tolerance; post op. care (10% povidone iodine swab); animal info (P14, 30 g); Vetbond tissue adhesive used to close incision

Agents: Naltrexol HCl, 6B-; naloxone HCl Vehicle: Saline, physiological; Route: SC; Species: Mice; Pump: 2001; Duration: 7 days;
ALZET Comments: Controls received placebo pellets; dose-response (fig 3, 5); comparison of pellets, SC injections vs. mp; animal info (male, Swiss-Webster, 22-30g)

Agents: Etorphine Vehicle: Saline; Route: SC; Species: Mice; Pump: 2001; Duration: 7 days;
ALZET Comments: Controls received placebo pellet; dose-response (p. 125, 126)

Agents: Butorphanol tartrate Vehicle: Saline, physiological; Route: CSF/CNS; Species: Rat; Pump: 2001; Duration: 3 days;
ALZET Comments: Controls received mp w/ vehicle; dependence; post op. care (procaine penicillin G; animal info (male, Sprague-Dawley, 250-275 g)

Agents: Naltrexol; SNC-80 Vehicle: Not Stated; Route: SC; Species: Mice; Pump: 1003D; Duration: 3 days;
ALZET Comments: Controls received mp w/ vehicle