References on the Administration of Drugs of Abuse  
(including Amphetamines, Barbiturates, Cocaine, GHB, Heroin, Nicotine, and PCP)  
Using ALZET® Osmotic Pumps

1. Amphetamines

Q7057: P. Petschner, et al. Gene expression analysis indicates reduced memory and cognitive functions in the hippocampus and increase in synaptic reorganization in the frontal cortex 3 weeks after MDMA administration in Dark Agouti rats. BMC Genomics 2018;19(1):580  
**Agents:** Methamphetamine, 3,4-methylenedioxy  
**Vehicle:** Saline;  
**Route:** SC;  
**Species:** Rat;  
**Pump:** 2001;  
**Duration:** ALZET  
**Comments:** Controls received mp w/ vehicle; animal info (8-week old Dark Agouti rats weighing 152 +/- 3.58 g); 3,4-methylenedioxymethamphetamine aka MDMA or ecstasy;

Q7002: P. Petschner, et al. Gene expression analysis indicates reduced memory and cognitive functions in the hippocampus and increase in synaptic reorganization in the frontal cortex 3 weeks after MDMA administration in Dark Agouti rats. BMC Genomics 2018;19(1):580  
**Agents:** Methamphetamine, 3,4-methylenedioxy  
**Vehicle:** Saline;  
**Route:** SC;  
**Species:** Rat;  
**Pump:** 2001;  
**Duration:** ALZET  
**Comments:** Controls received mp w/ vehicle;

**Agents:** Amphetamine  
**Vehicle:** saline, bacteriostatic;  
**Route:** SC;  
**Species:** Rat;  
**Pump:** 2ML2;  
**Duration:** 7, 13 days;  
**ALZET Comments:** Dose (0.1 or 0.32 mg/kg/h), (2ML2 pump 0.5 μl/h); Controls received mp w/ vehicle; animal info (male, Sprague-Dawley, 300-350g); behavioral testing (operant chambers); comparison of IP injection vs mp; dependence;

**Agents:** Amphetamine  
**Vehicle:** DMSO; acetic acid; water;  
**Route:** SC;  
**Species:** Rat;  
**Pump:** 2ML1;  
**Duration:** 7 days;  
**ALZET Comments:** Dose (1.5 mg/kg/day); 2% acetic acid, 25% DMSO used; Controls received mp w/ vehicle; animal info (Male Sprague–Dawley rats weighing 300–350 g); dependence

Q6443: S. V. Kyosseva, et al. Chronic administration of MDMA (“ECSTASY”) increases insulin-regulated glucose transporter GLUT4 in rat brain and heart. 2017;  
**Agents:** Methamphetamine, 3,4-methylenedioxy  
**Vehicle:** Saline;  
**Route:** SC;  
**Species:** Rat;  
**Pump:** 2ML2;  
**Duration:** 10 days;  
**ALZET Comments:** Dose (0.3 or 3 mg/kg/day); animal info (Sprague-Dawley rats);

2. Cocaine

**Agents:** Cocaine  
**Vehicle:** Route;  
**Species:** Pump;  
**Duration:** ALZET  
**Comments:**

**Agents:** Cocaine hydrochloride  
**Vehicle:** Saline, sterile;  
**Route:** SC;  
**Species:** Rat;  
**Pump:** 2ML2;  
**Duration:** 2 weeks;  
**ALZET Comments:** Controls received mp w/ vehicle; animal info (male, Holtzmann/Harlan Sprague Dawley); no stress (see pg.53); post op. care (topical antibiotic ointment); behavioral testing (saccharin intake); dependence; pumps removed after 2 weeks;

Q3606: C. M. Pudiak, et al. Tolerance to cocaine in brain stimulation reward following continuous cocaine infusions. Pharmacology Biochemistry and Behavior 2014;122(246-252
Agents: Cocaine  
Vehicle: Saline; sodium metabisulfate  
Route: SC  
Species: Rat  
Pump: 2ML2  
Duration: 14 days

**ALZET Comments:** Controls received mp w/ vehicle; animal info (male, Long-Evans, 275-350g); functionality of mp verified by residual volume; 0.3% sodium metabisulfate used to prevent degredation; stress/adverse reaction: (see pg.294); post op. care (neosporin); dependence; "Cocaine delivered continuously via osmotic minipump may better mimic the high drug-plasma concentrations maintained by an addict during a binge than daily administered cocaine injections." pg 250; pumps removed after 14 days; pumps primed at 37C for at least 4 hours;

**Q3579:** P. A. Narayana, *et al.* Chronic cocaine administration causes extensive white matter damage in brain: Diffusion tensor imaging and immunohistochemistry studies. PSYCHIATRY RESEARCH-NEUROIMAGING 2014;221(3):220-230

**Agents:** Cocaine  
Vehicle: Saline;  
Route: SC  
Species: Rat  
Pump: 2ML4  
Duration: 28 days

**ALZET Comments:** Controls received mp w/ vehicle; animal info (male, Sprague Dawley, 280-300g); behavioral testing (fine motor movement; ambulation; rearing activities; general motor behavior); dependence; MRI; pumps primed for 24 hours in 37C saline;

**Q3428:** F. F. Caputi, *et al.* Dynorphin/KOP and nociceptin/NOP gene expression and epigenetic changes by cocaine in rat striatum and nucleus accumbens. PROGRESS IN NEURO-PSYCHOPHARMACOLOGY & BIOLOGICAL PSYCHIATRY 2014;49(13):36-46

**3. GHP (Gamma-hydroxybutyrate)**


**ALZET Comments:** Hydroxybutyrate, gamma-; Saline; SC; Rat; 2,10 days; Controls received mp w/ vehicle; dependence; agent is a drug of abuse, known as "liquid ecstasy" or GHB (sodium oxybate); pump model not listed.

**4. Heroin**

**Q4818:** S. Daniels, *et al.* Alterations of naltrexone-induced conditioned place avoidance by pre-exposure to high fructose corn syrup or heroin in Sprague–Dawley rats. Psychopharmacology 2016;233(3):425-433

**Agents:** Heroin  
Vehicle: Route: SC  
Species: Rat  
Pump: 2ML2  
Duration: 14 days

**ALZET Comments:** Controls received mp w/ vehicle; animal info (male, Sprague Dalwley, 175-200g); behavioral testing (place conditioning); used wound clips; Dose (3.5 mg/kg/day);

**Q2457:** A. M. Williams, *et al.* The effect of intermittent alcohol vapor or pulsatile heroin on somatic and negative affective indices during spontaneous withdrawal in Wistar rats. Psychopharmacology 2012;223(1):75-88

**Agents:** Heroin  
Vehicle: SC  
Route: SC  
Species: Rat  
Pump: 2ML4  
Duration: 30 days

**ALZET Comments:** Control animals received mp w/ vehicle; animal info (Wistar, male, 70 days old); pulsatile delivery; "By filling the pumps with saline and attaching polyethylene (PE60) tubing to the pump, based on the tubing inner diameter and pump flow rate characteristics, the volume needed for different infusion periods (e.g., 14- or 10-h periods) could be determined"; "the tubing was filled with alternating heroin solution and mineral oil"; pulsatile delivery; good methods, pg 78; image of pump with connected Lynch coil; wound clips used; post op. care (Baytril); behavioral testing (elevated plus maze forced swim test)


**Agents:** Heroin hydrochloride; morphine sulfate  
Vehicle: Saline;  
Route: SC  
Species: Mice  
Pump: 2001  
Duration: ALZET

**ALZET Comments:** Controls received mp w/vehicle; dependence; animal info (adult, male, CD-1)
Q0587: B. Kest, et al. Gnao1 (G-alpha, PROTEIN) IS A LIKELY GENETIC CONTRIBUTOR TO VARIATION IN PHYSICAL DEPENDENCE ON OPIOIDS IN MICE. Neuroscience 2009;162(4):1255-1264

Agents: Morphone; heroin 
Vehicle: Saline; Route: SC; Species: Mice; Pump: 2001; Duration: 7 days;

ALZET Comments: Animal info (Naive, adult, 7-12 wks old, male, AcB/BcA)


Agents: Heroin 
Vehicle: Saline; Route: SC; Species: Rat; Pump: 2ML2; Duration: 192 hours;

ALZET Comments: Comparison of sc injections & pellet vs. mp; dependence; 3 day recovery period; pumps connected to a novel gating device to allow on-off delivery; assembly schematic (p. 131); infusions were delivered in 48 hour intervals; animal info (m, wistar, 300-380 grams)

5. nicotine

Q8581: B. Kim, et al. Chronic nicotine impairs sparse motor learning via striatal fast-spiking parvalbumin interneurons. Addict Biol 2020;e12956

Agents: Nicotine ditartrate 
Vehicle: Saline; Route: SC; Species: Mice; Pump: 1004; Duration: 2 weeks;

ALZET Comments: Dose (24 mg/kg/day); Controls received mp w/ vehicle; animal info (2- to 3-month-old C57BL/6J male mice); behavioral testing (Open field test; light-dark transition; rotarod test); dependence;


Agents: Nicotine 
Vehicle: Not stated; Route: SC; Species: Rat; Pump: Not stated; Duration: 6 weeks;

ALZET Comments: Dose (3 mg/kg/day); Controls received mp w/ vehicle; animal info (Sprague-Dawly rats, 2-4 months old); toxicology;


Agents: Zonisamide; Nicotine 
Vehicle: Not stated; Route: SC; Species: Rat; Pump: 2ML1; Duration: 7 days;

ALZET Comments: Dose (40 mg/kg/day Zonisamide, 10, 25 and 50 mg/kg/day Nicotine); animal info (Male S286L-TG and wild-type littermates); Zonisamide aka ZNS; neurodegenerative (Epilepsy);


Agents: Nicotine Hydrogen Tartrate 
Vehicle: Salline; Route: CNS/CSF; Species: Rat; Pump: 2ML2; Duration: 21 days;

ALZET Comments: Dose (4.5 mg/kg/day); Controls received mp w/ vehicle; animal info (Sprague Dawley, 6 or 14 weeks old); ischemia (Stroke);


Agents: Nicotine 
Vehicle: Alcohol, Saline; Route: SC; Species: Rat; Pump: Not stated; Duration: Not stated;

ALZET Comments: Dose (6 mg/kg/day); Controls received mp w/ vehicle; animal info (Sprague Dawley (Time pregnant) rats); behavioral testing (Y maze); toxicology;

6. Pentobarbital


Agents: Pentobarbital 
Vehicle: Saline; Route: CSF/CSF; Species: Rat; Pump: 2001; Duration: 7 days;

ALZET Comments: Controls received mp w/ vehicle; tolerance; dependence; one week recovery period after cannula placement

**Agents:** Pentobarbital **Vehicle:** Saline; **Route:** CSF/CNS; **Species:** Rat; **Pump:** 2ML1; **Duration:** 6 days;

**ALZET Comments:** Controls received mp with vehicle; tolerance; dependence; animals allowed one week recovery after cannula placement


**Agents:** Pentobarbital **Vehicle:** Route: CSF/CNS; **Species:** Rat; **Pump:** 2ML1; **Duration:** 7 days;

**ALZET Comments:** guide cannula implanted; rats were allowed 1 week recovery before implantation of pump; tolerance; dependence


**Agents:** Pentobarbital **Vehicle:** Saline; **Route:** CSF/CNS; **Species:** Rat; **Pump:** 2ML1; **Duration:** 6 days;

**ALZET Comments:** controls received mp w/saline; tolerance


**Agents:** Pentobarbital **Vehicle:** Saline; **Route:** CSF/CNS; **Species:** Rat; **Pump:** 2ML1; **Duration:** 7 days;

**ALZET Comments:** controls received mp w/saline; tolerance

7. Phencyclidine


**Agents:** Phencyclidine hydrochloride **Vehicle:** Saline, sterile, physiological; **Route:** SC; **Species:** Rat; **Pump:** 2ML4; **Duration:** 14 days;

**ALZET Comments:** Control animals received mp w/vehicle; animal info (Sprague Dawley, male, wks old, 160-200 g, 280-320 g)


**Agents:** Phencyclidine **Vehicle:** SC; **Species:** Rat; **Pump:** 2ML2; **Duration:** 14 days;

**ALZET Comments:** Controls received mp w/saline; animal info (Lister hooded, male); post op. care (Baitril, Rimadyl); "Using PCP mini-pump infusion instead of the well described intraperitoneal dosing bears the advantage of reducing the animal's stress levels, bypasses the risk of potential mis-dosing that could arise from multiple dosing events and consequently may reduce the number of animals needed." pg 69

P7825: G. Pitas, et al. Anti-phencyclidine monoclonal antibody binding capacity is not the only determinant of effectiveness, disproving the concept that antibody capacity is easily surmounted. Drug Metabolism and Disposition 2006;34(6):906-912

**Agents:** Phencyclidine HCL **Vehicle:** Saline, sterile; **Route:** SC; **Species:** Rat; **Pump:** 2ML1; **Duration:** 4 days;

**ALZET Comments:** Functionality of mp verified by serum PCP concentrations; half-life (pg. 907) 3.9 hours in rats; tolerance; animal info (male, Sprague-Dawley, 270-300 g.)

P6979: F. Sams-Dodd. (+) MK-801 and phencyclidine induced neurotoxicity do not cause enduring behaviours resembling the positive and negative symptoms of schizophrenia in the rat. BASIC & CLINICAL PHARMACOLOGY & TOXICOLOGY 2004;95(5):241-246

**Agents:** MK-801; phencyclidine hydrochloride **Vehicle:** Sodium chloride; **Route:** SC; **Species:** Rat; **Pump:** 2ML2; **Duration:** 6 days;

**ALZET Comments:** Controls received mp w/ vehicle; dose-response; comparison of SC injections vs. mp; post op. care (wound plast); NMDA antagonists

**Agents:** Phencyclidine; phencyclidine HCL; **Vehicle:** Saline; sterile; **Route:** SC; **Species:** Rat; **Pump:** 2ML2; **Duration:** 14 days;

**ALZET Comments:** Controls received mp w/ vehicle; serum levels taken; good methods p. 1093; half-life (p. 1093) = 3.9 h in rats; dependence; behavioral study