



Kidney Research Using ALZET® Osmotic Pumps

ALZET Osmotic Pumps have been a valuable tool for researchers to investigate kidney function and related physiological systems. Highlighted below are a few research applications in which the pumps have been used, as well as relevant resources. The following list of references is a compilation of kidney research from the past few years. To obtain a complete listing of earlier references or additional technical information, please contact ALZET Technical Support by email at alzet@durect.com.

Study Applications

- Kidney disease, chronic & acute
- Kidney injury
- Hypertension
- Renin-angiotensin-aldosterone system
- Renal kallikrein-kinin system
- Mineral homeostasis
- Podocyte function/injury
- Glomerulus function/injury

Resources and Tools

Catheters:

DURECT Corporation offers a range of specialized catheters, compatible with ALZET pumps, to enable targeted delivery to tissues, organs, or a specific site. ALZET pumps can be attached to catheter tubing with I.D ranging from 0.58 mm to 0.76 mm (0.023"-0.030"). For more information consult the [catheter information](#) on our website.



Rat Intraperitoneal Catheter



Mouse Intraperitoneal Catheter

Surgical Protocols:

Written protocols are available on our website. A surgical implantation video is also available, which describes proper preparation of the ALZET pump and surgical techniques for implantation in mice and rats. These can be found on the [downloads page](#) of our website.



Recent References (2022 - Present) Using ALZET® Osmotic Pumps

Q11293: L. Fang, *et al.* Adipolin protects against renal injury via PPARalpha-dependent reduction of inflammasome activation. *iScience* 2023;26(5):106591

Agents: MCC950 **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6J; **Pump:** 2006; **Duration:** 42 days; **ALZET Comments:** Dose (5 mg/kg/day); animal info (Male and female; 8 weeks old);

Q11268: M. H. Hsu, *et al.* Increased Circulating ADMA in Young Male Rats Caused Cognitive Deficits and Increased Intestinal and Hippocampal NLRP3 Inflammasome Expression and Microbiota Composition Alterations: Effects of Resveratrol. *Pharmaceuticals (Basel)* 2023;16(6):

Agents: Dimethylarginine, asymmetric **Vehicle:** Saline; **Route:** IP; **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** Not Stated; **Duration:** Not Stated;

ALZET Comments: Dose (0.25 mmol/kg/day); Controls received mp w/ vehicle; animal info (Male; ~50 g); enzyme inhibitor (Nitric oxide synthase); behavioral testing (Water maze);

Q11252: A. Bruder-Nascimento, *et al.* Progranulin Maintains Blood Pressure and Vascular Tone Dependent on EphrinA2 and Sortilin1 Receptors and Endothelial Nitric Oxide Synthase Activation. *Journal of the American Heart Association* 2023;12(16): e030353

Agents: Angiotensin II; aldosterone; progranulin, recombinant **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Strain:** C57BL6/J wild type; **Pump:** 1002; 1007D; **Duration:** 7 days; 14 days;

ALZET Comments: Dose: Ang II 490ng/min/kg; Aldo 600 µg/kg/day; recomb. progranulin 20µg/day; controls received mp w/ vehicle; animal info: 11-13 wk old male and female; blood pressure measured via radiotelemetry (see fig.1 pg. 5);

Q11247: M. Bode, *et al.* Complement component C3 as a new target to lower albuminuria in hypertensive kidney disease. *British Journal of Pharmacology* 2023;180(18):2412-2435

Agents: Angiotensin II **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; **Pump:** 1002; **Duration:** 2 weeks;

ALZET Comments: Dose (1.5 ng/g/min); animal info (Male); Blood pressure measured via tail cuff method; nephrology (hypertensive kidney disease)

Q11244: X. Bai, *et al.* Sodium butyrate regulation of NLRP3-Ser295 phosphorylation inhibits hypertensive nephropathy. *Journal of Functional Foods* 2023;107

Agents: Angiotensin II **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** 2004; **Duration:** 28 days;

ALZET Comments: Dose (75 ng/min); controls received mp w/ vehicle; animal info: male rats measuring 225 ± 25 g; blood pressure measured via tail cuff; see pg.3 fig 1B;

Q11237: S. N. Arkhipov, *et al.* Probenecid slows disease progression in a murine model of autosomal dominant polycystic kidney disease. *Physiological Reports* 2023;11(7):e15652

Agents: Probenecid **Vehicle:** Saline **Route:** SC **Species:** Mice **Strain:** C57BL/6N; Pkd1 RC/RC **Pump:** 2006 **Duration:** 42d

ALZET Comments: Dose (180µg/day); Controls received mp w/ vehicle; animal info (10.5 mo old); post op (Buprenorphine) Industry authored (Henry Ford Health); Long- term subcutaneous administration of probenecid with osmotic pumps resolved a series of experimental limitations...includes continuous delivery of drug vs multiple daily injections...avoid drug delivery with drinking water." p. 9

Q11235: X. An, *et al.* Renoprotection by Inhibiting Connexin 43 Expression in a Mouse Model of Obesity-Related Renal Injury. *Diabetes, Metabolic Syndrome and Obesity* 2023;16(1415-1424

Agents: Oligodeoxynucleotide, Cx43 antisense; Oligodeoxynucleotide, scrambled **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Strain:** C57BL/6; **Pump:** Not Stated; **Duration:** 4 weeks;

ALZET Comments: animal info: 5 wk old; antisense (Cx43); "In this study, after four-week targeting Cx43 with the antisense oligodeoxynucleotide (AS) by an implanted osmotic pump, we found that the body weight and liver weight of ORI mice were significantly improved, and the ACR, glomerular expansion and podocyte injury of ORI mice were also improved." p. 9

Q11141: W. Machelak, *et al.* The role of GDF11 during inflammation - An overview. *Life Sciences* 2023;322(121650

Agents: GDF11, recombinant **Vehicle:** Not Stated **Route:** IP **Species:** Mice **Strain:** C57BL/6J **Pump:** Not Stated **Duration:** 7 days

ALZET Comments: Dose (1.4 µg/day); animal info (Male; 8-10 weeks old);



Q11130: C. H. Leo, *et al.* Relaxin elicits renoprotective actions accompanied by increasing bile acid levels in streptozotocin-induced diabetic mice. *Biomedicine & Pharmacotherapy* 2023;162(114578)

Agents: Relaxin-2, recombinant human **Vehicle:** Sodium acetate; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6J; **Pump:** 1002; **Duration:** 2 weeks;

ALZET Comments: Dose (0.5 mg/kg/d); Controls received mp w/ vehicle; animal info (Male 19 wks old); peptides; diabetes

Q11124: H. Kishimoto, *et al.* Indoxyl sulfate induces left ventricular hypertrophy via the AhR-FGF23-FGFR4 signaling pathway. *Frontiers in Cardiovascular Medicine* 2023;10(990422)

Agents: H3B-6527 **Vehicle:** Saline; **Route:** IP; **Species:** Mice; **Strain:** C57BL/6J; **Pump:** 2002; 1004; **Duration:** 4 weeks;

ALZET Comments: Dose (7.5 mg/kg); Controls received mp w/ vehicle; animal info (Male; 8 wks old; Fed high phosphorous diet); H3B is an FGFR4 inhibitor; 2002 pumps replaced biweekly

Q11098: X. Dai, *et al.* Thymus transplantation regulates blood pressure and alleviates hypertension-associated heart and kidney damage via transcription factors FoxN1 pathway. *International Immunopharmacology* 2023;116(109798)

Agents: Angiotensin II **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6J; **Pump:** 2006 **Duration:** Not Stated

ALZET Comments: Dose (1000 ng/kg/d); Controls received mp w/ vehicle; animal info (Male; 8 weeks old; Avg weight 20 g); Blood pressure measured via tail-cuff method, see Fig. 1; cardiovascular (hypertension)

Q11095: Z. Chen, *et al.* Reduction of anaerobic glycolysis contributes to angiotensin II-induced podocyte injury with foot process effacement. *Kidney International* 2023;103(4):735-748

Agents: Angiotensin II **Vehicle:** Saline; **Route:** Not Stated; **Species:** Mice; **Strain:** PKM2fl/fl/Cre+; PKM2fl/fl/Cre-;

Pump: 2004; **Duration:** 4 weeks;

ALZET Comments: Dose (700 ng/kg/min); Controls received mp w/ vehicle; animal info (8 wks old; Male); Therapeutic indication (Podocyte injury);

Q11080: B. Jiang, *et al.* Hedgehog-induced ZFYVE21 promotes chronic vascular inflammation by activating NLRP3 inflammasomes in T cells. *Science Signaling* 2023;16(Agents: Vismodegib; GANT61; MCC950; SAG **Vehicle:** Not Stated;

Route: SC; **Species:** Mice; **Strain:** SCID/bg; **Pump:** 1004; **Duration:** 28 days;

ALZET Comments: Dose (Vismodegib 12 mg/kg/day; GANT61 6 mg/kg/day; MCC950 4 mg/kg/day, SAG 15 mg/kg/day); Controls received mp w/ vehicle; animal info (Female; 6-12 weeks old); immunology;

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 wks); 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

Q11070: R. Brinks, *et al.* Nrf2 Activation Does Not Protect from Aldosterone-Induced Kidney Damage in Mice. *Antioxidants (Basel)* 2023;12(3)

Agents: Aldosterone **Vehicle:** EtOH; PBS; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; **Pump:** 1004; **Duration:** 28 days;

ALZET Comments: Dose (125 µg/kg/day); 15% EtOH in PBS used; animal info (Male; 36 total; 12 wks old); Blood pressure measured via tail-cuff method; nephrology (kidney damage)

Q11047: A. Kopacz, *et al.* Co-administration of angiotensin II and simvastatin triggers kidney injury upon heme oxygenase-1 deficiency. *Free Radical Biology and Medicine* 2023;205(188-201)

Agents: Angiotensin II **Vehicle:** Saline; **Route:** Not Stated; **Species:** Mice; **Strain:** HO-1 KO; **Pump:** 2004 **Duration:** 28 days

ALZET Comments: Dose: (2500 ng/kg/min); controls received mp w/ vehicle; animal info: 6-month-old; nephrology

Q11051: J. C. Li, *et al.* Angiotensin II mediates hypertensive cardiac fibrosis via an Erbb4-IR-dependent mechanism. *Molecular Therapy Nucleic Acids* 2023;33(180-190)

Agents: Angiotensin II **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; **Pump:** 2004; **Duration:** 28 days;

ALZET Comments: Dose (1.46 mg/kg/day); controls received mp w/ vehicle; animal info: age of 8–10 wks; blood pressure measured via noninvasive tail cuff (p.181) Fig.1 C; Hypertensive cardiovascular disease; "Indeed, chronic Ang II infusion markedly upregulated cardiac Erbb4-IR, which was associated with hypertension and development of hypertensive cardiac disease, as demonstrated by significant reductions in LVEF and LVFS and increases in LV mass and cardiac fibrosis." p.4



Q11043: D. Jiang, *et al.* Natriuretic peptides potentiate cardiac hypertrophic response to noradrenaline in rats. *Peptides* 2023;166(171035)

Agents: Noradrenaline; Atrial natriuretic peptide; C-type natriuretic peptides **Vehicle:** Ascorbic acid; glutathione; saline; **Route:** SC; IV (jugular); **Species:** Rat; **Strain:** Wistar; **Pump:** 2002; **Duration:** 14 days;

ALZET Comments: Dose: 30 µg/h; ANP, CNP: 1.0 µg/h; 0.005% ascorbic acid and 5 mM glutathione; 0.9% saline used; animal info: Nine-week-old male; peptides; PE catheter used; cardiovascular; "In the present study, persistent administration of ANP and CNP augmented cardiac hypertrophic response to NA infused continuously for 14 days in rats, suggesting a possible pro-hypertrophic action of natriuretic peptides on the heart."

Q11039: J. Huang, *et al.* Effects of Mineralocorticoid Receptor Blockade and Statins on Kidney Injury Marker 1 (KIM-1) in Female Rats Receiving L-NAME and Angiotensin II. *International Journal of Molecular Sciences* 2023;24(7):

Agents: Angiotensin II **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Strain:** Wistar; **Pump:** 2001; **Duration:** 2 days; 3 days;

ALZET Comments: Dose (225 µg/kg/day); animal info: 8–10wk female weighing 180 to 260 g; blood pressure measured via Tail cuff; good methods: "Concentrations of ANG II to fill the minipumps were calculated based on the mean pump rate provided by the manufacturer and the body weight of the animals on the day prior to implantation of the pump."

Q11033: T. Zhang, *et al.* The protective effects of a novel AT₂ receptor agonist, beta-Pro(7)Ang III in ischemia-reperfusion kidney injury. *Biomedicine & Pharmacotherapy* 2023;161(114556)

Agents: Angiotensin III, β-pro7 **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Strain:** C57BL/6J; **Pump:** 2001; **Duration:** 7 days;

ALZET Comments: Dose: β-Pro7Ang III (0.1 mg/kg/day); animal info: Male 6–8 wk, unilateral ischemia-reperfusion injury; β-Pro7Ang III is novel AT₂ receptor agonist; (ischemia-reperfusion kidney injury); "Administration of β-Pro7Ang III via mini-pump improved kidney structure and reduced interstitial collagen accumulation, in parallel with an alteration of macrophage phenotype and anti-inflammatory cytokine release, therefore mitigating the downstream progression of ischemic AKI."

Q11022: Y. Wang, *et al.* CCN2 deficiency in smooth muscle cells triggers cell reprogramming and aggravates aneurysm development. *JCI Insight* 2023;8(1):

Agents: Angiotensin II **Vehicle:** Saline; **Route:** Not Stated; **Species:** Mice; **Strain:** CCN2-floxed; **Pump:** 2006; 1007D; **Duration:** 42 days; 7 days;

ALZET Comments: Dose (500 ng/kg/min); Controls received mp w/ vehicle; Blood pressure measurements see (pg.5) Fig. 2E; cardiovascular: abdominal aortic aneurysm

Q11016: P. Verdino, *et al.* Development of a long-acting relaxin analogue, LY3540378, for treatment of chronic heart failure. *British Pharmacological Society* 2023;180(15):1965-1980

Agents: Isoproterenol hydrochloride **Vehicle:** PBS; sodium ascorbate; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6J; **Pump:** 1002; **Duration:** 14 days;

ALZET Comments: Dose Isoproterenol (15 mg/kg/day); Controls received mp w/ vehicle; animal info: Male, 11 wks; post op. care: Postoperative analgesia was achieved with single dose of meloxicam 4 mg/kg; half-life (p.13); chronic heart failure

Q11011: M. E. Turner, *et al.* Vascular calcification maladaptively participates in acute phosphate homeostasis. *Cardiovascular Research* 2023;119(4):1077-1091

Agents: Calcitriol **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 2ML1; **Duration:** 8 days;

ALZET Comments: Dose (0.5 µg/kg/day); animal info: (15–16 wk); chronic kidney disease, phosphate homeostasis

Q11002: D. Solise, *et al.* Inhibition of angiotensin II type 1 receptor agonistic autoantibodies by direct binding does not impact reduced uterine perfusion pressure offspring birthweight and blood pressure at adulthood. *American Journal of Obstetrics and Gynecology MFM* 2023;5(6):100945

Agents: n7AAc **Vehicle:** Saline **Route:** Not Stated **Species:** Rat **Strain:** Sprague-Dawley **Pump:** 2002 **Duration:** Not Stated

ALZET Comments: Dose (24 µg/d); Controls received mp w/ vehicle; animal info: rat dams w/ reduced uterine perfusion pressure; mean arterial pressure measured; peptides; Preeclampsia

Q10997: M. Shi, *et al.* VEGFR2 insufficiency enhances phosphotoxicity and undermines Klotho's protection against peritubular capillary rarefaction and kidney fibrosis. *American Journal of Physiology Renal Physiology* 2023;324(1):F106-F123

Agents: Klotho protein, recombinant **Vehicle:** Saline; **Route:** IP; **Species:** Mice; **Strain:** kl/kl; **Pump:** 1004; **Duration:** 4 wks

ALZET Comments: Dose (0.3 mg/kg body wt/mo); Controls received mp w/ vehicle; klotho is an antiaging protein



Q10987: D. Rogacka, *et al.* Inhibition of phosphodiesterase 5A by tadalafil improves SIRT1 expression and activity in insulin-resistant podocytes. *Cellular Signalling* 2023;105(110622

Agents: Tadalafil **Vehicle:** DMSO; **Route:** SC; **Species:** Rat; **Strain:** Wistar; **Pump:** 2001; **Duration:** 7 days;

ALZET Comments: Dose Tadalafil (2.5 mg/kg/day); Controls received mp w/ vehicle; animal info: Male; post op. care (Butomidor (10 mg/ml) and gentamicin (50 mg/ml) were subcutaneously administered; tadalafil is a highly selective inhibitor of PDE5A on SIRT1 expression and activity; diabetes;

Q10985: L. A. Ramirez, *et al.* Perinatal intermittent hypoxia increases early susceptibility to ANG II-induced hypertension in adult male but not in female Sprague-Dawley rats. *American Journal of Physiology Renal Physiology* 2023;324(5):F483-F493

Agents: Angiotensin II **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 2001; **Duration:** 12 days;

ALZET Comments: Dose (400 ng/kg/min); animal info: Female 15 wk of age; Blood pressure measured via: telemetry, (see pg. 487); hypertension, intermittent hypoxia

Q10981: L. Pioppi, *et al.* FTIR Analysis of Renal Tissue for the Assessment of Hypertensive Organ Damage and proANP(31-67) Treatment. *International Journal of Molecular Sciences* 2023;24(6):

Agents: Atrial natriuretic peptide 31-67, pro- **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** DSS; **Pump:** Not Stated; **Duration:** Not Stated;

ALZET Comments: Dose (50 ng/kg/day); Controls received mp w/ vehicle; animal info: male (150g initially); hypertension

Q10978: R. Patel, *et al.* Signaling through the IL-6-STAT3 Pathway Promotes Proteolytically-Active Macrophage Accumulation Necessary for Development of Small AAA. *Vascular and Endovascular Surgery* 2023;57(5):433-444

Agents: Interleukin-6 **Vehicle:** Saline, sterile **Route:** IP **Species:** Mice **Strain:** C57BL/6; IL-6KO **Pump:** 1004 **Duration:** 21d

ALZET Comments: Dose: (4.36 µg/kg/day); Controls received mp w/ vehicle; post op. care (subcutaneous injection of 0.05 mg/kg buprenorphine); functionality of mp verified by IL-6 plasma levels; abdominal aortic aneurysm; immunology

Q10971: Y. Okamura, *et al.* Human Omentin-1 Administration Ameliorates Hypertensive Complications without Affecting Hypertension in Spontaneously Hypertensive Rats. *International Journal of Molecular Sciences* 2023;24(4):

Agents: Omentin-1, human **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** SHR; **Pump:** 2002; **Duration:** 14 days;

ALZET Comments: Dose (18 µg/kg/day); Controls received mp w/ vehicle; animal info: Male WKY and SHR (65–68 wk); Blood pressure measured via: Tail cuff; Blood pressure measurement results (pg.2) fig.1; hypertension

Q10965: S. M. Mutchler, *et al.* Validation of commercially available antibodies directed against subunits of the epithelial Na(+) channel. *Physiological Reports* 2023;11(1):e15554

Agents: Aldosterone **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; **Pump:** 2002; **Duration:** 2 weeks;

ALZET Comments: Dose (240 µg/kg/day); animal info: Male; nephrology; immunology

Q10957: Y. Li, *et al.* Simultaneous late-gadolinium enhancement and T1 mapping of fibrosis and a novel cell-based combination therapy in hypertensive mice. *Biomedicine & Pharmacotherapy* 2023;158(114069

Agents: Serelaxin **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; **Pump:** 1007D; **Duration:** 7 days;

ALZET Comments: Dose (0.5/mg/kg/day); animal info (12 week, male, K/DOCA/salt injured, 25–30 g); Blood pressure measured via Tail cuff, (p.9) see Fig. 3; hypertension;

Q10950: P. J. Azurmendi, *et al.* Behavior of the renal kallikrein in spontaneously hypertensive rats: Influence of sexual hormones and aldosterone-sensitive distal nephron ion channels. *Peptides* 2023;160(170925

Agents: Benzamil **Vehicle:** Methanol; **Route:** SC; **Species:** Rat; **Strain:** SHR; **Pump:** Not Stated; **Duration:** 3 days;

ALZET Comments: Dose (0.175 mg/day); 4% glucose solution used; Controls received mp w/ vehicle; animal info: SHR of either sex, (4 to week 12 of age.); Blood pressure measured via an indirect technique using a MK III S Physiograph, (see pg. 3 fig. 1); Bz is an ENac blocker; cardiovascular; (hypertension)

Q10719: N. Vergara, *et al.* The Direct Effect of Fibroblast Growth Factor 23 on Vascular Smooth Muscle Cell Phenotype and Function. *Nephrology, Dialysis, Transplantation* 2023;38(2):322-343

Agents: Fibroblast growth factor 23, recombinant **Vehicle:** Buffer, A5Su; **Route:** SC; **Species:** Rat; **Strain:** Wistar; **Pump:** 2004; **Duration:** 14 days;

ALZET Comments: Dose (15 µg/day); Controls received mp w/ vehicle; animal info (Male rats; 8 weeks old; 250-300 g); post op. care (Buprenorphine 75 mg/kg); Blood pressure measured via tail-cuff method; chronic kidney disease



Q10524: Z. Fu, *et al.* Mutagenesis of the cleavage site of (pro)renin receptor abrogates aldosterone-salt-induced hypertension and renal injury in mice. *American Journal of Physiology* 2023;324(1):F1-F11

Agents: Aldosterone **Vehicle:** Saline; **Route:** SC **Species:** Mice **Strain:** PRR R279V/L28V mutant **Pump:** 1002

Duration: 14 days

ALZET Comments: Dose (0.4 mg/kg/day); Controls received mp w/ vehicle; animal info (Male; 16-20 wks); blood pressure measured with implantable radiotelemetric device; cardiovascular (hypertension)

Q10459: E. O. Cruz-Lopez, *et al.* Blood pressure-independent renoprotective effects of small interference RNA targeting liver angiotensinogen in experimental diabetes. *British Pharmacological Society* 2023;180(1):80-93

Agents: Valsartan; Captopril **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Strain:** Ren2; **Pump:** 2ML4; **Duration:** 3 weeks;

ALZET Comments: Dose: Valsartan (4 mg/kg/day); Captopril (6 mg/kg/day); animal info: Male, heterozygous, 10wk, 300–500g; Blood pressure measured via: radiotelemetry transmitters, results see (pg.5) antihypertensive;

Q11226: E. Toda, *et al.* Inhibition of the chemokine signal regulator FROUNT by disulfiram ameliorates crescentic glomerulonephritis. *Kidney International* 2022;102(6):1276-1290

Agents: Disulfiram; DSF-41 **Vehicle:** 2-hydroxypropyl-beta-cyclodextrin **Route:** Not Stated **Species:** Rat

Strain: Wistar-Kyoto **Pump:** 2ML1; **Duration:** Not Stated;

ALZET Comments: Dose: Disulfiram 100 mg/kg per day; DSF-41 20 mg/kg; 50% 2-hydroxypropyl-beta-cyclodextrin vehicle used; Controls received mp w/ vehicle; immunology;

Q11204: A. V. Mikhailov, *et al.* Calmodulin-dependent protein kinase II activation promotes kidney mesangial expansion in streptozotocin-induced diabetic mice. *Heliyon* 2022;8(11):e11653

Agents: KN-93; K9-92 **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Strain:** FVB; **Pump:** 1004; **Duration:** 4 weeks

ALZET Comments: Dose: (70 µg/kg/day); Controls received mp w/ vehicle; animal info: 4 mo old female; KN-93 is a small molecule CaMKII inhibitor; diabetes;

Q11203: A. Medipally, *et al.* Role of protease-activated receptor-1 (PAR-1) in the glomerular filtration barrier integrity. *Physiological Reports* 2022;10(15):e15343

Agents: TFLLR-NH2 **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** Not Stated;

Duration: 7 days;

ALZET Comments: Dose: TFLLR-NH2 (0.25 and 0.50 µmol/kg/day); animal info: male rats (120–140g); Blood pressure measured via: Tail cuff; Blood pressure measurement (p.7) see Fig. 5; TFLLR-NH2 is a PAR1 agonist;

Q11188: Y. Liu, *et al.* Angiotensin 1-7 and its analogue decrease blood pressure but aggravate renal damage in preeclamptic mice. *Experimental Animals* 2022;71(4):519-528

Agents: Angiotensin 1-7; AVE099 **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Strain:** WT; C57BL/6;

Pump: Not Stated; **Duration:** Not Stated;

ALZET Comments: Dose (25 µg/kg/h); animal info: 6–8 weeks, 18–20 g; Blood pressure measured via tail-cuff method; Blood pressure measurement (see pg.522) Fig.1; proteinuria

Q11191: S. M. Liu, *et al.* Intermedin Alleviates Vascular Calcification in CKD through Sirtuin 3-Mediated Inhibition of Mitochondrial Oxidative Stress. *Pharmaceuticals (Basel)* 2022;15(10):

Agents: Intermedin 1-53 **Vehicle:** PBS; **Route:** IP; **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 2004; **Duration:** 4 weeks;

ALZET Comments: Dose: 100 ng/kg/h; Controls received mp w/ vehicle; animal info: 8wk male

Q11185: K. Lin, *et al.* Inhibition of MyD88 attenuates angiotensin II-induced hypertensive kidney disease via regulating renal inflammation. *International Immunopharmacology* 2022;112(109218)

Agents: Angiotensin II **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; **Pump:** 1004; **Duration:** 4 weeks;

ALZET Comments: Dose: (1000 ng/kg/min); animal info: 6-week-old male; Blood pressure measured via: non-invasive tail-cuff telemetric blood pressure system, measurement see graph (p.7); cardiovascular (hypertension)

Q11179: X. T. Li, *et al.* Sirtuin 7 mitigates renal ferroptosis, fibrosis and injury in hypertensive mice by facilitating the KLF15/Nrf2 signaling. *Free Radical Biology and Medicine* 2022;193(Pt 1):459-473

Agents: Angiotensin II **Vehicle:** Saline, sterile; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; **Pump:** 1002; **Duration:** 2 weeks;

ALZET Comments: Dose (1.5 mg/kg/d); Controls received mp w/ vehicle; animal info (male) Blood pressure measured via Tail cuff; Blood pressure measurement (p.462) see Fig.1A;



- Q11174:** P. Li, *et al.* Perirenal adipose afferent nerves sustain pathological high blood pressure in rats. *Nature Communications* 2022;13(1):3130
Agents: Angiotensin II **Vehicle:** Not Stated **Route:** Not Stated **Species:** Rat **Strain:** Wistar Kyoto **Pump:** 2006
Duration: 6 weeks
ALZET Comments: Dose: 200 ng/kg/min; 0.9% Saline vehicle used Controls received mp w/ vehicle; animal info: Male 250 g; Blood pressure measured via: tail cuff; Blood pressure results (see pg.3); Hypertension
- Q11162:** B. Kloth, *et al.* Piezo2 is not an indispensable mechanosensor in murine cardiomyocytes. *Scientific Reports* 2022;12(1):8193
Agents: Angiotensin II; isoprenaline **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6J WT; WT-Cre+; Piezo2-KO;
Pump: 2004; 1007D; **Duration:** 1 week; 3 weeks;
ALZET Comments: Dose: Angiotensin II (2.5 mg/kg/per day); Isoprenaline (30 mg/kg/per day); Controls received mp w/ vehicle; animal info: 10 to 12 weeks; wound clips used;
- Q11160:** C. W. Kim, *et al.* Dahl salt-resistant rats are protected against angiotensin II-induced hypertension. *Biochemical Pharmacology* 2022;203(115193)
Agents: Angiotensin II **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Rat; **Strain:** SS; SR; **Pump:** 2002; **Duration:** 2 wks
ALZET Comments: Dose: 10 ng/kg/min or 50 ng/kg/min; dose response: "Infusion of low dose angiotensin II (10 ng/kg/min) transiently increased the SBP in SS rats at 1 week. (B) The angiotensin II (50 ng/kg/min) increased the SBP in SS rats, but not SR rats." p. 2; animal info: 6wk male; blood pressure measured via: tail-cuff, results see (pg.2) Fig.1;
- Q10948:** H. Ishigooka, *et al.* Novel Complement C5 Small-interfering RNA Lipid Nanoparticle Prolongs Graft Survival in a Hypersensitized Rat Kidney Transplant Model. *Transplantation* 2022;106(12):2338-2347
Agents: Cyclosporin **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Rat; **Strain:** Lewis; **Pump:** 2ML4; **Duration:** 7 days;
ALZET Comments: Dose (CsA 0.3 mg/body/day); animal info (Male);
- Q10943:** J. Hu, *et al.* Alteration in Rab11-mediated endocytic trafficking of LDL receptor contributes to angiotensin II-induced cholesterol accumulation and injury in podocytes. *Cell Proliferation* 2022;55(6):e13229
Agents: Angiotensin II **Vehicle:** Saline; **Route:** Not Stated; **Species:** Mice; **Strain:** C57BL6; **Pump:** 2004; **Duration:** 8 weeks;
ALZET Comments: Dose (700 ng/kg/min); 0.9% saline used; Controls received mp w/ vehicle; animal info (male, 8wk old); pumps replaced after 4 weeks; nephrology (chronic kidney disease)
- Q10939:** X. He, *et al.* TIGAR deficiency sensitizes angiotensin-II-induced renal fibrosis and glomerular injury. *Physiological Reports* 2022;10(8):e15234
Agents: Angiotensin II **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** TIGAR KO on C57BL/6J background;
Pump: Not Stated; **Duration:** 4 weeks;
ALZET Comments: Dose (1 µg/kg/min); Controls received mp w/ vehicle; animal info (Male; 4 months old); Blood pressure measured via tail-cuff method; cardiovascular (hypertension); nephrology
- Q10930:** L. P. Blanco, *et al.* Modulation of the Itaconate Pathway Attenuates Murine Lupus. *Arthritis & Rheumatology* 2022;74(12):1971-1983
Agents: Itaconate, 4-octyl **Vehicle:** Cyclodextrin, 2-hydroxypropyl-beta; **Route:** SC; **Species:** Mice; **Strain:** NZW × NZB;
Pump: 2006; **Duration:** Not Stated;
ALZET Comments: Dose (14 µg/kg/minute); 40% 2-hydroxypropyl-beta cyclodextrin used; Controls received mp w/ vehicle; animal info (Female 30 weeks old); immunology; nephrology; lupus
- Q10903:** P. Zhou, *et al.* Metabolic Advantage of 25(OH)D(3) versus 1,25(OH)(2)D(3) Supplementation in Infantile Nephropathic Cystinosis-Associated Adipose Tissue Browning and Muscle Wasting. *Cells* 2022;11(20):
Agents: 25(OH)D3; 1,25(OH)2D3 **Vehicle:** Ethylene glycol; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6 WT; **Pump:** 2006;
Duration: 6 weeks;
ALZET Comments: Dose-response: (25(OH)/D3: 25, 50 or 75 µg/kg/day); 1,25(OH)2D3: 20, 40 or 60 ng/kg/day); Controls received mp w/ vehicle; animal info (Mice Ctns-/-); behavioral testing (Rotarod activity; Forelimb grip strength); infantile nephropathic cystinosis



Q10841: T. Yang, *et al.* Cell-Specific Actions of the Prostaglandin E-Prostanoid Receptor 4 Attenuating Hypertension: A Dominant Role for Kidney Epithelial Cells Compared With Macrophages. *Journal of the American Heart Association* 2022;11(19):e026581

Agents: Angiotensin II **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; **Pump:** 2004; **Duration:** 3 weeks; **ALZET Comments:** Dose (1000 ng/kg/min); animal info: male; Blood pressure measured via radiotelemetry, (p.6) see fig. 1;

Q10832: P. Xu, *et al.* Erythrocyte Transglutaminase-2 Combats Hypoxia and Chronic Kidney Disease by Promoting Oxygen Delivery and Carnitine Homeostasis. *Cell Metabolism* 2022;34(2):299-316 e6

Agents: Angiotensin II **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** EpoR-Cre+ Tgm2flox/flox; EpoR-Cre+ mutant; **Pump:** Not Stated; **Duration:** Not Stated;

ALZET Comments: Dose: (500 ng/kg/min) Controls received mp w/ vehicle; animal info: Mice 8-12weeks, age matched t mice; Blood pressure measured via: tail cuff; Blood pressure measurements (p.309) see fig.5b;

Q10800: T. C. Wu, *et al.* Tolvaptan Reduces Angiotensin II-Induced Experimental Abdominal Aortic Aneurysm and Dissection. *Vascular Pharmacology* 2022;144(106973)

Agents: Angiotensin II **Vehicle:** Saline **Route:** SC **Species:** Mice **Strain:** Apo-E knockout, C57BL/6 **Pump:** 2004 **Duration:** 28 days

ALZET Comments: Dose (1000 ng/kg/min); Controls received mp w/ vehicle; animal info C57BL/6 (Male; 12-14 weeks); Blood pressure measured via noninvasive tail-cuff system; Therapeutic indication (Abdominal aortic aneurysm);

Q10764: B. Wang, *et al.* WNT1-Inducible Signaling Pathway Protein 1 Regulates Kidney Inflammation Through the NF-kappaB Pathway. *Clinical Science (Lond)* 2022;136(1):29-44

Agents: Immunoglobulin G; WISP1, antibody **Vehicle:** Not Stated; **Route:** IP; **Species:** Mice; **Strain:** C57BL/6 **Pump:** 1007D **Duration:** 7 days;

ALZET Comments: Controls received mp w/ vehicle; animal info (Male; Weighed 20-25 g; 7-8 weeks old; Induced overt diabetes and developed chronic kidney fibrosis; Therapeutic indication (Inflammation in kidney disease);

Q10763: M. Wang, *et al.* Improved Renal Denervation Mitigated Hypertension Induced by Angiotensin II Infusion. *Journal of Visualized Experiments* 2022;183):

Agents: Angiotensin II **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6 **Pump:** Not Stated **Duration:** Not Stated

ALZET Comments: Dose: (1,000 ng/kg/min) Controls received mp w/ vehicle; animal info: 14-week-old mice; post op. care: povidone-iodine; warmed electric blanket for recovery and post-operative monitorin; meloxicam (0.5 mg/kg, SC); Blood pressure measured via: Tail cuff; Blood pressure measurements (p.6) see fig. 2; good methods see pg. 2,3; Hypertension

Q10718: A. E. Vendrov, *et al.* Renal NOXA1/NOX1 Signaling Regulates Epithelial Sodium Channel and Sodium Retention in Angiotensin II-induced Hypertension. *Antioxidants & Redox Signaling* 2022;36(7-9):550-566

Agents: Angiotensin II **Vehicle:** Sodium chloride **Route:** SC **Species:** Mice **Strain:** Not Stated **Pump:** 1002 **Duration:** 14d

ALZET Comments: Dose (500 ng/kg/min); 0.9% NaCl used; animal info (male; bred in-house; 4-months old; surgically implanted with systemic BP transmitters); blood pressure measured via telemetry; cardiovascular (hypertension)

Q10714: W. H. van Megen, *et al.* Differential Parathyroid and Kidney Ca(2+)-Sensing Receptor Activation in Autosomal Dominant Hypocalcemia 1. *EBioMedicine* 2022;78(103947)

Agents: Etecalcetide hydrochloride **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Strain:** C57BL/6J;

Pump: 2002; 2001; **Duration:** 7 days;

ALZET Comments: Dose (5 mg/ml, 20 mg/ml); animal info (18 male, avg 10 weeks); renal (calcium)

Q10698: A. S. Terker, *et al.* Kir4.2 Mediates Proximal Potassium Effects on Glutaminase Activity and Kidney Injury. *Cell Reports* 2022;41(12):111840

Agents: Aldosterone **Vehicle:** Polyethylene glycol 200; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6/wild-type; Kir4.2-/-;

Pump: 1004; 1007D; **Duration:** 3 weeks; 7 days;

ALZET Comments: Dose (240 ug/kg/day); (180 mg/kg/day); Controls received mp w/ vehicle; animal info (male, aged 8-12 weeks; (WT, 9 weeks)); chronic kidney disease (kidney injury)

Q10633: B. M. Oliveira, *et al.* Calcitriol Reduces the Inflammation, Endothelial Damage and Oxidative Stress in AKI Caused by Cisplatin. *International Journal of Molecular Science* 2022;23(24):

Agents: Calcitriol **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Hannover; **Pump:** 2004; **Duration:** 5 days;

ALZET Comments: Dose (6 ng/day); (0.9% NaCl) used; Controls received mp w/ vehicle; animal info (male 200-300 g) immunology;



Q10673: A. Schulz, *et al.* The Soluble Fms-like Tyrosine Kinase-1 Contributes to Structural and Functional Changes in Endothelial Cells in Chronic Kidney Disease. *International Journal of Molecular Sciences* 2022;23(24):

Agents: sFlt-1, recombinant mouse; IgG-Fc, control **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6;

Pump: 1007D; **Duration:** 3 days;

ALZET Comments: Dose (300 ng/h); Controls received mp w/ vehicle; sFlt-1 is a recombinant mouse VEGF receptor 1-Fc; chronic kidney disease

Q10646: R. Perez-Villavicencio, *et al.* Effect of Empagliflozin on Sphingolipid Catabolism in Diabetic and Hypertensive Rats. *International Journal of Molecular Sciences* 2022;23(5):

Agents: Angiotensin II **Vehicle:** Isoflurane; **Route:** SC; **Species:** Rat; **Strain:** Wistar; **Pump:** 2002; **Duration:** 2 weeks;

ALZET Comments: Dose (435 ng/kg/min); Controls received mp w/ vehicle; animal info (Male; 350-360 g); post op. care (Empagliflozin treatment for 2 weeks); cardiovascular (hypertension); diabetes;

Q10605: E. Mironova, *et al.* NOXA1-Dependent NADPH Oxidase 1 Signaling Mediates Angiotensin II Activation of The Epithelial Sodium Channel. *American Journal of Physiology* 2022;323(6):F633-F641

Agents: Angiotensin II **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Strain:** Wild-type (C57BL/6J); **Pump:** 1007D; **Duration:** 48 hours; 72 hours;

ALZET Comments: Dose (500 ng/kg/min); animal info 2–3 mo old male and female; cardiovascular;

Q10595: S. Majumder, *et al.* Toll-like Receptor 4 Mutation Protects the Kidney From Ang-II-Induced Hypertensive Injury. *Pharmacological Research* 2022;175(106030)

Agents: Angiotensin II **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** C3H/HeOuj; **Pump:** 1004; **Duration:** 4 weeks;

ALZET Comments: Dose (1000 ng/kg/min); animal info (10-12 wks; standard chow); Blood pressure measured via tail cuff;

Q10583: M. Kuczeriszka, *et al.* Role of Ang1-7 in Renal Haemodynamics and Excretion in Streptozotocin Diabetic Rats. *Clinical and Experimental Pharmacology and Physiology* 2022;49(3):432-441

Agents: Angiotensin (1-7) **Vehicle:** Saline; **Route:** SC **Species:** Rat **Strain:** Sprague Dawley **Pump:** 2002 **Duration:** 2 weeks

ALZET Comments: Dose: (400 ng/min); Controls received mp w/ vehicle; animal info: Male 227–250g normoglycaemic or diabetic; Blood pressure measured via: Tail cuff, measurements (p.435) see Fig.1; diabetes

Q10578: A. Kopacz, *et al.* Angiotensin II and simvastatin together trigger kidney injury upon heme oxygenase-1 deficiency - focus on heme degradation. *Social Science Research Network* 2022;

Agents: Angiotensin II **Vehicle:** Saline; **Route:** Not Stated; **Species:** Mice; **Strain:** C57BL6; **Pump:** 2004; **Duration:** 28 days;

ALZET Comments: Dose (2500 ng/kg/min); Controls received mp w/ vehicle; animal info (Male, 6 months old);

Q10572: S. J. Khundmiri, *et al.* PPAR-Alpha Knockout Leads to Elevated Blood Pressure Response to Angiotensin II Infusion Associated with an Increase in Renal alpha-1 Na(+)/K(+) ATPase Protein Expression and Activity. *Life Sciences* 2022;296(120444)

Agents: Angiotensin II **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** WT; PPAR-alpha KO; **Pump:** Not Stated;

Duration: 12 days;

ALZET Comments: Dose (400 ng/kg/min); Controls received mp w/ vehicle; animal info (Male; 10-12 wks, 25-28 g);

Q10555: D. M. Jensen, *et al.* Broad-Acting Therapeutic Effects Of miR-29b-chitosan On Hypertension And Diabetic Complications. *Molecular Therapy* 2022;30(11):3462-3476

Agents: Angiotensin II **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Strain:** ApoE KO; C57; **Pump:** 1004; 1002;

Duration: 14 days; 28 days;

ALZET Comments: Dose: 1 ug/kg/min; Blood pressure measurement (pg.4 figure.2B, figure 2C);

Q10549: T. Iijima, *et al.* Discovery of Apararenone (MT-3995) as a Highly Selective, Potent, and Novel Nonsteroidal Mineralocorticoid Receptor Antagonist. *Journal of Medicinal Chemistry* 2022;65(12):8127-8143

Agents: Aldosterone **Vehicle:** EtOH; PEG 400; Saline; **Route:** SC; **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** 2004;

Duration: 4 weeks;

ALZET Comments: Dose (0.75 µg/h/animal); 10% EtOH, 50% PEG400, 40% saline used; Controls received mp w/ vehicle; animal info (Male 7 wks); Blood pressure measured via telemetry transmitter system; cardiovascular; Therapeutic indication (Hypertension; Kidney disease; Heart failure);



Q10543: C. Hemmers, *et al.* Chemokine CCL9 Is Upregulated Early in Chronic Kidney Disease and Counteracts Kidney Inflammation and Fibrosis. *Biomedicines* 2022;10(2):

Agents: CCL6; CCL9 **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6J; **Pump:** 2002; **Duration:** Not Stated; **ALZET Comments:** Dose (1µg/day); 0.9% NaCl used; Controls received mp w/ vehicle; animal info (Female; 8-12 weeks); immunology (chronic kidney disease)

Q10535: A. A. Gutsol, *et al.* Comparative analysis of hypertensive nephrosclerosis in animal models of hypertension and its relevance to human pathology. *Glomerulopathy. PLoS One* 2022;17(2):e0264136

Agents: Angiotensin II **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Strain:** 2K1C; **Pump:** 2004; **Duration:** 4 weeks; **ALZET Comments:** Dose (1000 ng/kg/min); animal info (Male 25-27 wks); Blood pressure measured via tail-cuff plethysmography; cardiovascular (hypertension)

Q10477: C. Feiteng, *et al.* Relaxin inhibits renal fibrosis and the epithelial-to-mesenchymal transition via the Wnt/beta-catenin signaling pathway. *Renal Failure* 2022;44(1):513-524

Agents: Relaxin **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; **Pump:** 1007D; **Duration:** 3 days; **ALZET Comments:** Dose (0.5 mg/kg/day); animal info (Male); peptides; chronic kidney disease

Q10453: D. Chen, *et al.* Qingda granule alleviate angiotensin II-induced hypertensive renal injury by suppressing oxidative stress and inflammation through NOX1 and NF-kappaB pathways. *Biomedicine & Pharmacotherapy* 2022;153(113407

Agents: Angiotensin II; Qingda granule **Vehicle:** Saline; **Route:** Not Stated; **Species:** Mice; **Strain:** C57BL/6; **Pump:** 2002; **Duration:** Not Stated; **ALZET Comments:** Dose: (500 ng/kg/min.); Controls received mp w/ vehicle; animal info: aged 6–8 wks; blood pressure measured via: noninvasive BP monitor, measurement (pg.5) fig. 1; cardiovascular (Hypertension)

Q10443: E. G. Avery, *et al.* Quantifying the impact of gut microbiota on inflammation and hypertensive organ damage. *Cardiovascular Research* 2022;

Agents: Angiotensin II **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6J; **Pump:** Not Stated; **Duration:** 2 weeks; **ALZET Comments:** Dose: (1.44 mg/kg/day); 1% NaCl vehicle used; Controls received mp w/ vehicle; animal info: male, 4wks; Blood pressure measured via: an implanted arterial catheter, measurement (pg 7) figure 4; cardiovascular; Hypertension