



**Recent References (2015-2020) on Angiogenesis Research
Using ALZET® Osmotic Pumps**

Q8506: B. Gomes de Almeida Schirmer, *et al.* The NO-donor MPC-1011 stimulates angiogenesis and arteriogenesis and improves hindlimb ischemia via a cGMP-dependent pathway involving VEGF and SDF-1alpha. *Atherosclerosis* 2020;304(30-38

Agents: MPC-1011; Cilostazol **Vehicle:** Not stated; **Route:** SC; **Species:** Rat; **Pump:** 2004; **Duration:** Not stated;
ALZET Comments: Dose (3.6 mg/day MPC-1011; 100 mg/kg/bi-daily Cilostazol); animal info (Four-week-old male Sprague-Dawley rats); MPC-1011 aka novel NO-donor; cardiovascular;

Q8469: A. Frisch, *et al.* Apelin Controls Angiogenesis-Dependent Glioblastoma Growth. *Int J Mol Sci* 2020;21(11):

Agents: Apelin-13 **Vehicle:** CSF, Artificial; **Route:** CNS/CSF; **Species:** Mice; **Pump:** 1002; **Duration:** 14 days;
ALZET Comments: Dose (30 µg); Controls received mp w/ vehicle; animal info (APLNKO mice); Apelin-13 aka APLN; ALZET brain infusion kit 3 used; Brain coordinates (1 mm anterior and 1.5 mm right to the bregma); cancer (Glioblastoma);

Q8459: S. Esteban, *et al.* Endothelial MT1-MMP targeting limits intussusceptive angiogenesis and colitis via TSP1/nitric oxide axis. *EMBO Mol Med* 2020;12(2):e10862

Agents: GDGRGDACK **Vehicle:** Dextran Sulfate; **Route:** SC; **Species:** Mice; **Pump:** 1003D; **Duration:** 3 days;
ALZET Comments: Dose (2.4 mg/mouse/day); 1% Dextran Sulfate used; animal info (C57BL/6 wild-type mice, 8-20 weeks old); peptides; gene therapy;

Q7604: S. Perveen, *et al.* MIF inhibition enhances pulmonary angiogenesis and lung development in congenital diaphragmatic hernia. *Pediatr Res* 2019;85(5):711-718

Agents: MIF inhibitor, Nitrofen **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Pump:** Not Stated; **Duration:** 21 days;
ALZET Comments: Dose (200 mg- Nitrofen, 1.8 mg/kg/day- MIF inhibitor); animal info (Adult,); MIF inhibitor aka ISO-92; enzyme inhibitor (MIF inhibitor); dependence;

Q8258: Y. T. Lin, *et al.* Cordycepin Suppresses Endothelial Cell Proliferation, Migration, Angiogenesis, and Tumor Growth by Regulating Focal Adhesion Kinase and p53. *Cancers (Basel)* 2019;11(2):

Agents: Cordycepin **Vehicle:** DMSO; **Route:** SC; **Species:** Mice; **Pump:** Not stated; **Duration:** 7 days;
ALZET Comments: Dose (2.4 mg/kg/day); Controls received mp w/ vehicle; animal info (BALB/c,); dependence;

Q7343: X. Huang, *et al.* Resveratrol Promotes Diabetic Wound Healing via SIRT1-FOXO1-c-Myc Signaling Pathway-Mediated Angiogenesis. *Front Pharmacol* 2019;10(421

Agents: EX-527; 10068-F4 **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Pump:** 1002; **Duration:** 4 weeks;
ALZET Comments: Dose (EX-527 5 mg/kg/day, 10068-F4 30mg/kg/day); Controls received mp w/ vehicle; animal info (BKS.Cg-Dock7mC=CLepdb=J mice, 8 weeks old); enzyme inhibitor (EX-527 is an SIRT1 inhibitor, 10058-F4 is a c-Myc inhibitor); diabetes;

R0372: J. Hong, *et al.* Relaxin gene therapy: A promising new treatment option for various diseases with aberrant fibrosis or irregular angiogenesis. *Mol Cell Endocrinol* 2019;

Agents: Relaxin, human recomb. **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat (pregnant); **Pump:** Not Stated; **Duration:** Not Stated;
ALZET Comments: Dose (2000 ng/h); Resultant plasma level (RLX level close to 0.5 ng/mL); gene therapy;

Q7543: J. Zhou, *et al.* Lactate potentiates angiogenesis and neurogenesis in experimental intracerebral hemorrhage. *Experimental & Molecular Medicine* 2018;50(7):78

Agents: oxamate; L-lactate, Sodium **Vehicle:** CSF, Artificial; Saline, Sterile; **Route:** CSF/CNS (lateral ventricle); CSF/CNS (globus pallidus); **Species:** Rat; **Pump:** Not Stated; **Duration:** 2, 7, 14 days;
ALZET Comments: oxamate 7 or 14 days; L-lactate 2 or 7 days; Dose ((OXA 10, 25, 50 mM), (L-lactate 5, 10, 25 mM)); Controls received sham surgery and mp w/ vehicle; animal info (male, Sprague-Dawley, 220-250g); behavioral testing (modified neurological severity score); oxamate aka OXA is an LDH inhibitor; enzyme inhibitor (lactate dehydrogenase);



ischemia (intracerebral hemorrhage); pump model not stated but flow rate was listed at 0.5 $\mu\text{L/h}$; Therapeutic indication (lactate may assist to facilitate angiogenesis and neurogenesis following ICH);

Q7165: Yanru Zhao¹, Mengwen Yan^{1,2,*}, Chen Chen^{1,*}, Wei Gong^{1,3}, Zhongwei Yin¹, Huaping, *et al.* MiR-124 aggravates failing hearts by suppressing CD151-facilitated angiogenesis in heart. *Oncotarget* 2018;9(18):14382-14396

Agents: Angiotensin II **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Pump:** 1004; **Duration:** 28 days;

ALZET Comments: Dose (1.5 mg/kg/day); animal info (Male C57BL/6 mice (22–25 g));

Q8087: H. Lin, *et al.* Extracellular Lactate Dehydrogenase A Release From Damaged Neurons Drives Central Nervous System Angiogenesis. *EBioMedicine* 2018;27(71-85

Agents: CD31 antibody, LHDA **Vehicle:** Saline; **Route:** CSF/CNS; **Species:** Mice; **Pump:** 1007D; **Duration:** 1 week;

ALZET Comments: Dose (0, 10, 100 $\mu\text{g/kg/day}$ -LHDA,); Controls received mp w/ vehicle; animal info (C57BL/6J); Brain coordinates (0.2 mm posterior, 2.5 mm left, and 3 mm depth from the skull surface); bilateral cannula used; cyanoacrylate adhesive; neurodegenerative (Angiogenesis);

Q7908: Z. C. Hesp, *et al.* Proliferating NG2-Cell-Dependent Angiogenesis and Scar Formation Alter Axon Growth and Functional Recovery After Spinal Cord Injury in Mice. *J Neurosci* 2018;38(6):1366-1382

Agents: Ganciclovir **Vehicle:** Saline, physiological; **Route:** CSF/CNS (lateral ventricle); **Species:** Mice; **Pump:** 1002; 1007D;

Duration: 7, 11, 14 days;

ALZET Comments:

Q6336: M. L. Zhu, *et al.* Berberine promotes ischemia-induced angiogenesis in mice heart via upregulation of microRNA-29b. *Clinical and Experimental Hypertension* 2017;39(7):672-679

Agents: miR-29b antagomir **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Pump:** Not Stated; **Duration:** 4 weeks;

ALZET Comments: Controls received mp w/ vehicle; animal info (8–12 week-old male C57BL6 mice); cardiovascular;

Q5725: S. Zhao, *et al.* Tetramethylpyrazine attenuates carbon tetrachloride-caused liver injury and fibrogenesis and reduces hepatic angiogenesis in rats. *Biomedicine & Pharmacotherapy* 2017;86(521-530

Agents: Angiotensin II **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Rat; **Pump:** 2004; 2ML4; **Duration:** 5 weeks;

ALZET Comments: Controls received mp w/ saline; animal info (male, Sprague Dawley, 180-220g); cardiovascular; peptides; Dose (25 $\mu\text{g/kg/hr}$);

Q6470: A. L. Guan, *et al.* Role of Jagged1-Hey1 Signal in Angiotensin II-induced Impairment of Myocardial Angiogenesis. *Chin Med J (Engl)* 2017;130(3):328-333

Agents: Angiotensin II **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Pump:** Not Stated; **Duration:** 2 weeks;

ALZET Comments: Dose (200 ng/kg/min); animal info (8-week-old male C57BL/6 mice); cardiovascular;

Q5811: L. Feng, *et al.* EphA4 may contribute to microvessel remodeling in the hippocampal CA1 and CA3 areas in a mouse model of temporal lobe epilepsy. *Mol Med Rep* 2017;15(1):37-46

Agents: unclustered ephrin A5 Fc, clustered (C) ephrin A5 Fc, antibody, IgG **Vehicle:** CSF, artificial; **Route:** CSF/CNS; **Species:** Mice; **Pump:** 1007D; **Duration:** Not Stated;

ALZET Comments: Controls received mp w/ vehicle; animal info (C57BL/6, 5-6 weeks old) ALZET brain infusion kit 3 used; no stress "All mice survived, and no apparent behavioral discomfort was observed." (see pg. 41); Therapeutic indication (angiogenesis, Temporal lobe epilepsy); Dose (50 $\mu\text{g/mL}$);

Q6017: N. Clere, *et al.* Pro-Angiogenic Effects of Low Dose Ethoxidine in a Murine Model of Ischemic Hindlimb: Correlation between Ethoxidine Levels and Increased Activation of the Nitric Oxide Pathway. *Molecules* 2017;22(4):

Agents: Ethoxide, glucose **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Pump:** 2004; **Duration:** 21 days;

ALZET Comments: animal info (8 weeks); 5% glucose; average plasma concentration between 18.34 and 46.97 nM ethoxidine; Therapeutic indication (ischemia; angiogenesis; neovascularization); Dose (0.14 ng/kg)



Q6321: S. C. Chen, *et al.* Administration of sonic hedgehog protein induces angiogenesis and has therapeutic effects after stroke in rats. *Neuroscience* 2017;352(285-295

Agents: Sonic hedgehog protein, Cyclopamine, antibody, anti-VEGF **Vehicle:** PBS; **Route:** CSF/CNS; **Species:** Rat; **Pump:** 1007D; **Duration:** 7 days;

ALZET Comments: Dose (1 mg/mL Shh, 20 µM Shh plus Cyc, 25 µg/ml Shh plus VEGF antibody); animal info (Male Sprague–Dawley rats); Cyclopamine is a sonic hedgehog protein inhibitor; Brain coordinates (bregma -0.8 mm anteroposterior, ±1.5 mm mediolateral, and -4.5 mm dorsoventral);

Q5856: M. Goda, *et al.* Nerve growth factor facilitates perivascular innervation in neovasculatures of mice. *J Pharmacol Sci* 2016;131(4):251-8

Agents: Nerve Growth Factor **Vehicle:** Saline; **Route:** SC; IP; **Species:** Mice; **Pump:** 1003D, 1007D, 1002; **Duration:** 3 days, 7 days, 10 days, 14 days;

ALZET Comments: Controls received mp w/ vehicle; Therapeutic indication (Angiogenesis);

Q6037: Q. Duan. Deregulation of XBP1 expression contributes to myocardial vascular endothelial growth factor-A expression and angiogenesis during cardiac hypertrophy in vivo. *Aging Cell* 2016;

Agents: Isoproterenol hydrochloride **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Pump:** 1007D, 1002; **Duration:** 2 weeks;

ALZET Comments: Controls received sham surgery; animal info (C57BL/6, 8 weeks old); Therapeutic indication (ER stress, Heart failure); Dose (15 mg/kg/day);

Q5311: L. Chen, *et al.* 20-HETE contributes to ischemia-induced angiogenesis. *Vascul Pharmacol* 2016;83(57-65

Agents: DDMS; 6,15-20-HEDGE **Vehicle:** Not Stated; **Route:** Intramuscular (hindlimb gracilis); **Species:** Mice; **Pump:** 2002, 2004; **Duration:** 32 days;

ALZET Comments: Controls received mp w/ vehicle; animal info (Balb/c mice, 12 wk old); functionality of mp verified by blood pressure and blood perfusion scans; dose-response (pg. 61); good methods (pg. 58); ischemia (peripheral); tissue perfusion (intramuscular); Polyethylene catheter tubing used (inner ID 0.8 mm); Dose (5 mg/kg/day);

Q4886: Y. S. B. X. Q. W. T. L. Y. D. &, *et al.* The Ephrin-A5/EphA4 Interaction Modulates Neurogenesis and Angiogenesis by the p-Akt and p-ERK Pathways in a Mouse Model of TLE. *MOLECULAR NEUROBIOLOGY* 2016;53(561-576

Agents: Ephrin-A5-Fc; immunoglobulin G2A **Vehicle:** CSF, artificial; **Route:** CSF/CNS (hippocampus); **Species:** Mice; **Pump:** 1007D; **Duration:** 7 days;

ALZET Comments: Controls received mp w/ vehicle; animal info (male, C57BL6, 18-21g, 5-6 weeks old); ALZET brain infusion kit used; no stress (see pg. 563) All mice survived the operation, remained active, ate well, and appeared to be well groomed."; behavioral testing (seizure frequency); Cannula placement verified via histological analysis; pumps primed in 37C PBS overnight; used dentyl acrylic;

Q4538: S. Morita, *et al.* Vascular endothelial growth factor-dependent angiogenesis and dynamic vascular plasticity in the sensory circumventricular organs of adult mouse brain. *Cell and Tissue Research* 2015;359(865-884

Agents: Ara-C **Vehicle:** Saline; **Route:** CSF/CNS; **Species:** Mice; **Pump:** 2002; **Duration:** 10 days;

ALZET Comments: Controls received mp w/ vehicle; animal info (male, C57BL6J, adult, P70-P84); comparison of IP injection vs mp; cardiovascular; "This infusion method is effective for suppressing cell proliferation in the subventricular zone and minimizes surgery damage to brain tissues" pg 867;

Q4241: Y. Minami, *et al.* Prostaglandin 12 analog suppresses lung metastasis by recruiting pericytes in tumor angiogenesis. *INTERNATIONAL JOURNAL OF ONCOLOGY* 2015;46(548-554

Agents: Betaprost sodium **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Pump:** Not Stated; **Duration:** 3 weeks;

ALZET Comments: Controls received mp w/ water, distilled; animal info (female, C57BL6, 8-10 weeks old, 20-25g); cancer (lung); Betaprost sodium aka BPS; Betaprost sodium is a stable PGI2 analog;

Q5225: Y. Liu, *et al.* Angiotensin-(1-7) Suppresses Hepatocellular Carcinoma Growth and Angiogenesis via Complex Interactions of Angiotensin II Type 1 Receptor, Angiotensin II Type 2 Receptor and Mas Receptor. *Mol Med* 2015;21(626-36



Agents: Angiotensin (1-7), A-779, PD123319 **Vehicle:** saline; **Route:** SC; **Species:** mice; **Pump:** Not Stated; **Duration:** 21 days; **ALZET Comments:** Controls received mp w/ vehicle; animal info: Male BALB/c mice (6–8 wks old); functionality of mp verified by measurement of tumor volumes; cancer (Hepatocellular Carcinoma); peptides; Dose: (200 ng/kg/min) Ang-(1–7), (800 ng/kg/min) Ang-(1–7), (800 ng/kg/min) A779, (10 mg/kg/day) PD123319

Q4501: J. Liu, *et al.* The effect of chronic stress on anti-angiogenesis of sunitinib in colorectal cancer models. *PSYCHONEUROENDOCRINOLOGY* 2015;52(130-142

Agents: Norepinephrine bitartrate hydrate; propranolol **Vehicle:** Ascorbic acid; PBS; **Route:** SC; **Species:** Mice; **Pump:** 1004; **Duration:** 20 days;

ALZET Comments: Animal info (female, BALB/c, 5-7 weeks old); cancer (colorectal carcinoma, human);

Q3977: Y. C. Lim, *et al.* Proinsulin C-Peptide Prevents Impaired Wound Healing by Activating Angiogenesis in Diabetes. *Journal of Investigative Dermatology* 2015;135(269-278

Agents: C-peptide **Vehicle:** PBS; **Route:** SC; **Species:** Mice; **Pump:** 2004; **Duration:** 2 weeks;

ALZET Comments: Controls received sham surgery; animal info (male, C57BL6J, 6 weeks old, streptozotocin induced diabetes); cardiovascular; peptides; diabetes;

Q4457: J. Z. Hu, *et al.* miR-126 promotes angiogenesis and attenuates inflammation after contusion spinal cord injury in rats. *Brain Research* 2015;1608(191-202

Agents: miR-126 **Vehicle:** Saline; **Route:** CSF/CNS (intrathecal); **Species:** Rat; **Pump:** 1003D; **Duration:** Not Stated;

ALZET Comments: Controls received mp w/ control agomir; animal info (male, Sprague Dawley, 180-220g); spinal cord injury; post op. care (Ringer's solution administered IP 5 ml, penicillin G 40000 U IM QD for 3 days, bladders manually expressed BID); behavioral testing (locomotor testing, open field); immunology; pumps primed overnight at 37C

Q5034: T. Hongu, *et al.* Arf6 regulates tumour angiogenesis and growth through HGF-induced endothelial beta1 integrin recycling. *Nat Commun* 2015;6(7925

Agents: SecinH3 **Vehicle:** DMSO; glycerol; **Route:** SC; **Species:** Mice; **Pump:** 2001; **Duration:** 16 days;

ALZET Comments: Controls received mp w/ vehicle; animal info (male, Arf6 flox/flox, 8 weeks old); pumps replaced every 4 days; 50% DMSO used; 50% glycerol; cancer (B16 melanoma or LLC); xenograft model;

Q4436: L. S. Gutierrez, *et al.* Thrombospondin peptide ABT-898 inhibits inflammation and angiogenesis in a colitis model. *WORLD JOURNAL OF GASTROENTEROLOGY* 2015;21(6157-6166

Agents: ABG-898 **Vehicle:** Glucose, sterile; **Route:** SC; **Species:** Mice; **Pump:** Not Stated; **Duration:** 7 days;

ALZET Comments: Controls received mp w/ vehicle; animal info (WT or TSP-1 -/-); 5% glucose used; cardiovascular; immunology; peptides;

Q4414: P. Escudero, *et al.* Combined treatment with bexarotene and rosuvastatin reduces angiotensin-II-induced abdominal aortic aneurysm in apoE(-/-) mice and angiogenesis. *British Journal of Pharmacology* 2015;172(2946-2960

Agents: Rosuvastatin, Angiotensin II **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Pump:** 2004; **Duration:** 5 days;

ALZET Comments: Controls received mp w/ vehicle; animal info (apoE -/-, 8 weeks old); cardiovascular; peptides; "Because the s.c. administration of the statin using an osmotic minipump allows 100% drug bioavailability and its p.o. administration results in 34.5% bioavailability in mice (Peng et al., 2009), we chose the former route to ensure a full dosage effect." pg 2948; comparison of mp vs. oral gavage

Q4410: Q. L. Duan, *et al.* MicroRNA-214 Is Upregulated in Heart Failure Patients and Suppresses XBP1-Mediated Endothelial Cells Angiogenesis. *JOURNAL OF CELLULAR PHYSIOLOGY* 2015;230(1964-1973

Agents: Isoproterenol hydrochloride **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Pump:** 1002; 1004; **Duration:** 14 days; 28 days;

ALZET Comments: Controls received mp w/ saline; animal info (C57BL6); cardiovascular;

Q4368: W. H. Chen, *et al.* Beta-nerve growth factor promotes neurogenesis and angiogenesis during the repair of bone defects. *Neural Regeneration Research* 2015;10(1159-1165



Agents: Nerve growth factor, b- **Vehicle:** PBS; Evans blue dye; **Route:** Bone (parietal); **Species:** Rat; **Pump:** 2001; **Duration:** 7 days;

ALZET Comments: Controls received mp w/ vehicle; animal info (male, Sprague Dalwey, 250-300g); 1% Evans blue used; good methods (picture of dual cannula implantation pg 1161); Multiple pumps per animal (2); pump with agent inserted into right pocket, pump with PBS inserted into left pocket; bilateral infusion;