ZEISS Axio Scan.Z1

A Reference List for Automated Slide Scanning

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Introduction

Classical light microscopes are well-established instruments for a wide variety of applications in life sciences research. In order to cater for the large variety of sample types, carriers and complex research questions, open interfaces and a very high level of flexibility is highly desirable.

With the pace of modern scientific research demanding many multiple repeats, it is now very often the case that tens of hundreds of samples need to be imaged, quantified and analyzed in order to address your research questions. The benefits of imaging multiple samples for reliable and quantifiable results are clear, but this can lead to practical challenges that need to be overcome.

Automatic scanning and digitization of microscope slides addresses these challenges by minimizing the amount of time and effort required to set up and manage the acquisition, analysis and maintenance of instruments and work-

flows. Axio Scan.Z1 is a high throughput slide scanner that is not only a hands-off machine but also offers great configuration flexibility to grow with your needs.

As a highly automated and easy to operate instrument, this slide scanner has the clear task of automatically imaging slides. In order to fulfil this demand, Axio Scan.Z1 provides 24/7 hassle free operation with automatic sample loading to reach the much-desired high productivity for your microscopy. Reliable ZEISS components guarantee you virtual slides of a consistently high quality, especially when capturing fluorescence images at unprecedented speed.

Generating a wealth of reliable data, Axio Scan.Z1 tackles your most demanding virtual microscopy research tasks as easily as it handles your routine work. With this list you get an overview of successful and published use cases for the proven slide scanner Axio Scan.Z1.

Cancer research

Publication
Nelson, M., et al. (2014) **The sodium channel β1 subunit mediates outgrowth of neurite-like processes on breast cancer cells and promotes tumour growth and metastasis.** International Journal of Cancer, 135(10), 2338–2351. doi:10.1002/ijc.28890
Merino, D., et al. (2014) **Proapoptotic Bim suppresses breast tumor cell metastasis and is a target gene of SNAI2.** Oncogene (Nature), 1-9. doi:10.1038/onc.2014.313
Hedbaeck, N., Jensen, D. H., et al. (2014) **MiR-21 Expression in the tumor stroma of oral squamous cell carcinoma: an independent Biomarker of Disease Free Survival.** PLoS ONER, 9(4): e95193. doi:10.1371/journal.pone.0095193
Arya, M., et al. (2015) **Targets of Wnt/ß-Catenin transcription in penile carcinoma.** PLoS ONE, 10(4): e0124395. doi:10.1371/journal.pone.0124395

Cancer research

Publication
Nedergaard, M. K., et al. (2015) **^{18}F-FET microPET and microMRI for anti-VEGF and anti-PlGF response assessment in an orthotopic murine model of human glioblastoma.** PLoS ONE 10(2): e0115315. doi:10.1371/journal.pone.0115315 Keywords: ImageJ, IHC, microvessel, ImmunoRatio
Henrik Holten-Rossing, et al. (2015) **Optimizing HER2 assessment in breast cancer: application of automated image analysis.** Breast Cancer Research and Treatment, online, p. 1-9. doi:10.1007/s10549-015-3475-3 Keywords: breast cancer, invasive ductal carcinoma, HER2, FISH (not Axio Scan.Z1), HER2-CONNECT, image analysis
Michaela Nelson, M., et al. (2015) **Nav1.5 regulates breast tumor growth and metastatic dissemination in vivo** Oncotarget, 6:32. doi:10.18632/oncotarget.5441
Saul, L., et al. (2016) **IgG subclass switching and clonal expansion in cutaneous melanoma and normal skin** Scientific Reports, 6:29736. doi:10.1038/srep29736
Qian, B.-Z., et al. (2015) **FLT1 signaling in metastasis-associated macrophages activates an inflammatory signature that promotes breast cancer metastasis** J. Exp. Med., 212:9, 1433–1448. doi:10.1084/jem.20141555
Hamilton,N., et al. (2015) **Impaired light detection of the circadian clock in a zebrafish melanoma model** Cell Cycle, 14:8, 1232-1241. doi:10.1080/15384101.2015.1014146 Keywords: cancer, cell cycle, circadian clock, light input, melanoma, zebrafish
Giuliano, A., et al. (2016) **Quantitative Expression and Co-Localization of Wnt Signalling Related Proteins in Feline Squamous Cell Carcinoma** PLoS ONE 11(8): e0161103. doi:10.1371/journal.pone.0161103
Sjödahl, G., et al. (2017) **Molecular classification of urothelial carcinoma: global mRNA classification versus tumour-cell phenotype classification** J Pathol 2017; 242: 113–125. doi:10.1002/path.4886 Keywords: cancer, image analysis, PathXL
Yan, D., et al. (2017) **Inhibition of colony stimulating factor-1 receptor abrogates microenvironment-mediated therapeutic resistance in gliomas** Oncogene (2017) 36, 6049–6058. doi:10.1038/onc.2017.261 Keywords: cancer, image analysis, TissueQuest and StrataQuest software (TissueGnos-tics)
Barth, C. W., et al. (2017) **Optimizing fresh specimen staining for rapid identification of tumor biomarkers during surgery** Theranostics; 7(19): 4722-4734. doi:10.7150/thno.21527 Keywords: cancer, image analysis, MatLab, LSM 880
Tian, L., et al. (2017) **Mutual Regulation of Tumour Vessel Normalization and Immunostimulatory Reprogramming** Nature. 2017 April 13; 544(7649): 250–254. doi:10.1038/nature21724
Baker, S. C., et al. (2018) **Differentiation-associated urothelial cytochrome P450 oxidoreductase predicates the xeno-biotic-metabolizing activity of "luminal" muscle-invasive bladder cancers** Molecular Carcinogenesis. 57:606–618. doi:10.1002/mc.22784
Ottaviani, S., et al. (2018) **TGF-β induces miR-100 and miR-125b but blocks let-7a through LIN28B controlling PDAC pro-gression** NATURE COMMUNICATIONS. 9:1845. doi:10.1038/s41467-018-03962-x Keywords: 40×
May, S., et al. (2018) **Mbd2 enables tumourigenesis within the intestine while preventing tumour-promoting inflammation** J Pathol 2018; 245: 270–282. doi:10.1002/path.5074
Colin, D. J., et al. (2018) **Experimental Model of Human Malignant Mesothelioma in Athymic Mice** Int. J. Mol. Sci. 2018, 19, 1881. doi:10.3390/ijms19071881
Ouarné, M., et al. (2018) **BMP9, but not BMP10, acts as a quiescence factor on tumor growth, vessel normalization and metastasis in a mouse model of breast cancer** Journal of Experimental & Clinical Cancer Research 37:209. doi:10.1186/s13046-018-0885-1

Cancer research

Publication
Risom, T., at al. (2018) **Differentiation-state plasticity is a targetable resistance mechanism in basal-like breast cancer** NATURE COMMUNICATIONS, 9:3815. doi:10.1038/s41467-018-05729-w
Gambera, S., et al. (2018) **Clonal dynamics in osteosarcoma defined by RGB marking** NATURE COMMUNICATIONS, 9:3994. doi:10.1038/s41467-018-06401-z
Cunnea, P., et al. (2018) **Clinical value of bioelectrical properties of cancerous tissue in advanced epithelial ovarian cancer patients** Scientific Reports, 8:14695. doi:10.1038/s41598-018-32720-8 Keywords: image analysis (QuPath)
Cao, K., et al. (2018) **Quantitative Analysis of Seven New Prostate Cancer Biomarkers and the Potential Future of the 'Biomarker Laboratory'** Diagnostics, 8, 49. doi:10.3390/diagnostics8030049 Keywords: TMA, 40×

Neuroscience

Publication
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Guo, Q., et al. (2015) **Whole-brain mapping of inputs to projection neurons and cholinergic interneurons in the dorsal stria-tum.** PLoS ONE, 10(4): e0123381. doi:10.1371/journal.pone.0123381
Ulusoy, A., et al. (2015) **Neuron-to-neuron α-synuclein propagation in vivo is independent of neuronal injury.** Acta Neuropathologica Communications, 3(13). doi:10.1186/s40478-015-0198-y
Perez, J. D., et al. (2015) **Quantitative and functional interrogation of parent-of-origin allelic expression biases in the brain** eLife 2015;4:e07860. doi:10.7554/eLife.07860.001
Doyle, W. I., et al. (2016) **Faecal bile acids are natural ligands of the mouse accessory olfactory system** Nature Communications, 7:11936. doi:10.1038/ncomms11936
Stanley B. Prusiner, S.B., et al. (2015) **Evidence for α-synuclein prions causing multiple system atrophy in humans with parkinsonism** PNAS, E5308–E5317. doi:10.1073/pnas.1514475112
Rappeneau, V., et al. (2015) **Enhanced Cocaine-Associated Contextual Learning in Female H/Rouen Mice Selectively Bred for Depressive-Like Behaviors:** **Molecular and Neuronal Correlates** International Journal of Neuropsychopharmacology, 1–12. doi:10.1093/ijnp/pyv022
Woerman, A. L., et al. (2015) **Propagation of prions causing synucleinopathies in cultured cells** PNAS, E4949–E4958. doi:10.1073/pnas.1513426112
Reimann, R. R., et al. (2016) **Differential Toxicity of Antibodies to the Prion Protein** PLoS Pathog 12(1): e1005401. doi:10.1371/journal.ppat.1005401
Wagner, J., et al. (2015) **Reducing tau aggregates with anle138b delays disease progression in a mouse model of tauopathies** Acta Neuropathol, 130:619–631. doi:10.1007/s00401-015-1483-3
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Neuroscience

Publication

Soreq, L., et al. (2017)
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Cell Reports 18, 557–570. doi:10.1016/j.celrep.2016.12.011

Wood, K. C., et al. (2017)
Acute Inactivation of Primary Auditory Cortex Causes a Sound Localisation Deficit in Ferrets
PLoS ONE 12(1): e0170264. doi:10.1371/journal.pone.0170264

El Behi, M., et al. (2017)
Adaptive human immunity drives remyelination in a mouse model of demyelination
BRAIN 2017: 140; 967–980. doi:10.1093/brain/awx008
Keywords: multiple sclerosis; remyelination; lymphocytes; neuroinflammation

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Activation of the Hypoglossal to Tongue Musculature Motor Pathway by Remote Control
Scientific Reports: 7:45860. doi:10.1038/srep45860

Oprych, K., et al. (2016)
Common olfactory ensheathing glial markers in the developing human olfactory system
Brain Struct Funct (2017) 222:1877–1895. doi:10.1007/s00429-016-1313-y

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Altered Functional Connectivity Following an Inflammatory White Matter Injury in the Newborn Rat: A High Spatial and Temporal Resolution Intrinsic Optical Imaging Study
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Keywords: Fiji

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TDP-43 Depletion in Microglia Promotes Amyloid Clearance but Also Induces Synapse Loss
Neuron. 2017 Jul 19; 95(2): 297–308.e6. doi:10.1016/j.neuron.2017.05.037

Yabut, O.R., et al (2016)
Loss of Suppressor of Fused in Mid-Corticogenesis Leads to the Expansion of Intermediate Progenitors
J Dev Biol; 4(4). doi:10.3390/jdb4040029

Cha, M., et al. (2017)
Repetitive motor cortex stimulation reinforces the pain modulation circuits of peripheral neuropathic pain
Scientific Reports; 7: 7986. doi:10.1038/s41598-017-08208-2

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AAV5-miHTT gene therapy demonstrates suppression of mutant huntingtin aggregation and neuronal dysfunction in a rat model of Huntington's disease
Gene Therapy (2017) 24, 630–639. doi:10.1038/gt.2017.71
Keywords: ImageJ, ZEN 2 lite

Shin, J. H. (2017)
Differential coding of reward and movement information in the dorsomedial striatal direct and indirect pathways
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Plank, A.-Ch., et al. (2018)
Early Alterations in Operant Performance and Prominent Huntingtin Aggregation in a Congenic F344 Rat Line of the Classical CAGn51trunc Model of Huntington Disease
Disease Front. Neurosci. 12:11. doi:10.3389/fnins.2018.00011
Keywords: Huntington disease, transgenic rat model, F344 rat, behavioral phenotyping, operant conditioning, huntingtin aggregates

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Astaxanthin is neuroprotective in an aged mouse model of Parkinson's disease
Oncotarget, 2018, Vol. 9, (No. 12), pp: 10388-10401.
Keywords: NearCYTE software

Niquille, M., et al. (2018)
Neurogliaform cortical interneurons derive from cells in the preoptic area
eLife 2018;7:e32017. doi:10.7554/eLife.32017
Keywords: Photoshop CC, FIJI

Tiffany L. Sudduth, T. L., et al. (2017)
Neurovascular astrocyte degeneration in the hyperhomocysteinemia model of vascular cog-nitive impairment and dementia (VCID)
Neuroscience; 341: 42–51. doi:10.1016/j.neuroscience.2016.11.024

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Activin receptors regulate the oligodendrocyte lineage in health and disease
Acta Neuropathologica 135:887–906. doi:10.1007/s00401-018-1813-3

Neuroscience

Publication
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Morel, S., et al. (2018) **Correlating Clinical Risk Factors and Histological Features in Ruptured and Unruptured Human Intracranial Aneurysms: The Swiss AneuX Study** J Neuropathol Exp Neurol, Vol. 77, No. 7, pp. 555–566. doi:10.1093/jnen/nly031 Keywords : Image analysis with ZEN, NIH Image software (NIH AutoExtractor 1.51)
Runegaard, A.H., et al. (2018) **Locomotor- and Reward-Enhancing Effects of Cocaine Are Differentially Regulated by Chemogenetic Stimulation of Gi-Signaling in Dopaminergic Neurons** eNeuro, 5(3) e0345-17.2018 1–28. doi:10.1523/ENEURO.0345-17.2018
Gravesen Salinas, C. B., et al. (2018) **Integrated Brain Atlas for Unbiased Mapping of Nervous System Effects Following Liraglutide Treatment** SCIENTIFIC ReporTS, 8:10310. doi:10.1038/s41598-018-28496-6 Keywords: Light Sheet Fluorescence Microscopy, combining different imaging modalities
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Zhu, F., et al. (2018) **Architecture of the Mouse Brain Synaptome** Neuron 99, 781–799. doi:10.1016/j.neuron.2018.07.007 Keywords: TIFF export, FIJI

Plant biology

Publication
Rousseau, D., et al. (2015) **Fast virtual histology using X-ray in-line phase tomography: application to the 3D anatomy of maize developing seeds** Plant Methods 11:55. doi:10.1186/s13007-015-0098-y

Developmental biology

Publication
Azzarelli, R., et al. (2017) **Multi-site Neurogenin3 Phosphorylation Controls Pancreatic Endocrine Differentiation** Developmental Cell 41, 274–286. doi:10.1016/j.devcel.2017.04.004
Bin, B.H. et al. (2017) **Requirement of zinc transporter ZIP10 for epidermal development: Implication of the ZIP10–p63 axis in epithelial homeostasis** PNAS 2017 114 (46) 12243-12248. doi:10.1073/pnas.1710726114
Albers, E., et al. (2018) **Loss of PICH Results in Chromosomal Instability, p53 Activation, and Embryonic Lethality** Cell Rep. 2018 Sep 18; 24(12): 3274–3284. doi:10.1016/j.celrep.2018.08.071

Immunology

Publication
Hitchcock, J.R., et al. (2015) **Inflammation drives thrombosis after Salmonella infection via CLEC-2 on platelets** J Clin Invest. 125(12):4429–4446. doi:10.1172/JCI79070
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Immunology

Publication

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TWEAK mediates inflammation in experimental atopic dermatitis and psoriasis
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Progressive Changes in CXCR4 Expression That Define Thymocyte Positive Selection Are Dispensable For Both Innate and Conventional αβT-cell Development
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Therapeutic efficacy of a combined sage and bitter apple phytopharmaceutical in chronic DSS-induced colitis
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A Context-Dependent Role for αv Integrins in Regulatory T Cell Accumulation at Sites of Inflammation
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Apolipoprotein AI prevents regulatory to follicular helper T cell switching during atherosclerosis
NATURE COMMUNICATIONS, 9:1095. doi:10.1038/s41467-018-03493-5

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In Vivo MRI of Functionalized Iron Oxide Nanoparticles for Brain Inflammation
Contrast Media & Molecular Imaging, vol 2018, Article ID 3476476. doi:10.1155/2018/3476476

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Bifidobacterium breve MRx0004 protects against airway inflammation in a severe asthma model by suppressing both neutrophil and eosinophil lung infiltration
Scientific Reports, 8:12024. doi:10.1038/s41598-018-30448-z

Vukmanovic-Stejic, M., et al. (2018)
Enhancement of cutaneous immunity during aging by blocking p38 mitogen-activated protein (MAP) kinase–induced inflammation
Allergy Clin Immunol, 142(3): 844–856. doi:10.1016/j.jaci.2017.10.032

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3Control of primary mouse cytomegalovirus infection in lung nodular inflammatory foci by cooperation of interferon-gamma expressing CD4 and CD8 T cells
PLoS Pathog 14(8): e1007252. doi:10.1371/journal.ppat.1007252

Regeneration

Publication

Ferreira-Gonzalez1, S., et al. (2018)
Paracrine cellular senescence exacerbates biliary injury and impairs regeneration
NATURE COMMUNICATIONS,9:1020, doi:10.1038/s41467-018-03299-5
Keywords: FIJI ImageJ

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Ghrelin therapy mitigates bone marrow injury and splenocytopenia by sustaining circulating G-CSF and KC increases after irradiation combined with wound
Cell Biosci 8:27, doi:10.1186/s13578-018-0225-3
Keywords: Image analysis with ZEN 2

Regeneration

Publication
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Rapid Endothelialization of Off-the-Shelf Small Diameter Silk Vascular Grafts
JACC: Basic to Translational Science Vol. 3, No. 1, doi:10.1016/j.jacbts.2017.12.003

Other Diseases

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Impact of Zostavax Vaccination on T-Cell Accumulation and Cutaneous Gene Expression in the Skin of Older Humans After Varicella Zoster Virus Antigen–Specific Challenge
Journal of Infectious Diseases, 218(S2):S88–S98, doi:10.1093/infdis/jiy420
Drareni, K., et al. (2018)
GPS2 Deficiency Triggers Maladaptive White Adipose Tissue Expansion in Obesity via HIF1A Activation
Cell Rep. 2018 Sep 11; 24(11): 2957–2971.e6. doi:10.1016/j.celrep.2018.08.032

Further applications

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The neurotrophic receptor Ntrk2 directs lymphoid tissue neovascularization during Leishmania donovani infection
PLoS Pathogens, 11(2): e1004681. doi:10.1371/journal.ppat.1004681
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Yes-associated protein (YAP) is a negative regulator of chondrogenesis in mesenchymal stem cells.
Arthritis Research & Therapy, 17(147), 1-14. doi:10.1186/s13075-015-0639-9
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Gdf5 progenitors give rise to fibrocartilage cells that mineralize via hedgehog signaling to form the zonal enthesis
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Automated high-throughput analysis of B cell spreading on immobilized antibodies with whole slide imaging
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PLoS ONE 11(6): e0155990. doi:10.1371/journal.pone.0155990
Bell, L. C. K., et al. (2016)
In Vivo Molecular Dissection of the Effects of HIV-1 in Active Tuberculosis
PLoS Pathog 12(3): e1005469. doi:10.1371/journal.ppat.1005469
Wilhelm, A., et al. (2015)
CD248/endosialin critically regulates hepatic stellate cell proliferation during chronic liver injury via a PDGF-regulated mechanism
Gut 65:1175–1185. doi:10.1136/gutjnl-2014-308325
Rouillon, J., et al. (2015)
Serum proteomic profiling reveals fragments of MYOM3 as potential biomarkers for monitoring the outcome of therapeutic interventions in muscular dystrophies
Human Molecular Genetics, 24:17, 4916–4932. doi:10.1093/hmg/ddv214
Rocheteau, P., at al. (2015)
Sepsis induces long-term metabolic and mitochondrial muscle stem cell dysfunction amenable by mesenchymal stem cell therapy
Nature Communications, 6:10145. doi:10.1038/ncomms10145

Further applications

Publication

Wu, J., et al. (2016)
Influence of Androgen Receptor in Vascular Cells on Reperfusion following Hindlimb Ischaemia
PLoS ONE 11(5): e0154987. doi:10.1371/journal.pone.0154987

Brinkmann, V., et al. (2016)
Immunodetection of NETs in Paraffin-Embedded Tissue
Front Immunol. 2016; 7: 513. doi:10.3389/fimmu.2016.00513
Keywords: NETs, immunodetection, paraffin-embedded tissue, image analysis (Fiji / ImageJ), antigen retrieval

Prodger, J. L., et al. (2016)
Chemokine Levels in the Penile CoronalSulcus Correlate with HIV-1 Acquisition and Are Re-duced by Male Circumcision in Rakai, Uganda
PLoS Pathog 12(11): e1006025. doi:10.1371/journal.ppat.1006025
Keywords: HIV, image analysis (Definiens)

Kasparek, P., et al. (2017)
KLK5 and KLK7 Ablation Fully Rescues Lethality of Netherton Syndrome-Like Phenotype
PLoS Genet 13(1): e1006566. doi:10.1371/journal.pgen.1006566

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Blocking two-component signalling enhances Candida albicans virulence and reveals adaptive mechanisms that counteract sustained SAPK activation
PLoS Pathog 13(1): e1006131. doi:10.1371/journal.ppat.1006131

Ericsson, A., et al. (2017)
The effects of dual PPARa/c agonism compared with ACE inhibition in the BTBRob/ob mouse model of diabetes and diabetic nephropathy
Physiol Rep, 5 (5), 2017, e13186, doi:10.14814/phy2.13186
Keywords: MIRAX, image analysis (Visiopharm), AstraZeneca, angiotensin-converting enzyme, BTBRob/ob mouse, diabetic kidney disease, peroxisome proliferator-activated receptor

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Soluble CD146, an innovative and noninvasive biomarker of embryo selection for in vitro fertili-zation
PLoS ONE 12(3): e0173724, doi:10.1371/journal.pone.0173724
Keywords: in-vitro fertilisation, CD146

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EBioMedicine 16 (2017) 262–274, doi:10.1016/j.ebiom.2017.01.030

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Joint morphogenetic cells in the adult mammalian synovium
NATURE COMMUNICATIONS, 8:15040, doi:10.1038/ncomms15040
Keywords: stem cells

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Reduction of endoplasmic reticulum-mitochondria interactions in beta cells from patients with type 2 diabetes
PLoS ONE 12(7): e0182027, doi:10.1371/journal.pone.0182027

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Cardiac αVβ3 integrin expression following acute myocardial infarction in humans
Heart 2017;103:607–615. doi:10.1136/heartjnl-2016-310115

Lu, D., et al. (2016)
Loss of Glis2/NPHP7 causes kidney epithelial cell senescence and suppresses cyst growth in the Kif3a mouse model of cystic kidney disease
Kidney Int. 2016 June; 89(6): 1307–1323. doi:10.1016/j.kint.2016.03.006

Cui, L., et al. (2017)
End stage renal disease-induced hypercalcemia may promote aortic valve calcification via Annexin VI enrichment of valve interstitial cell derived-matrix vesicles
J Cell Physiol. 2017;232:2985–2995. doi:10.1002/jcp.25935
Keywords: Annexin VI, calcific aortic valve disease, calcification, matrix vesicles, thin sections

Skive, B., et al. (2017)
Streptococcus equi subsp. zooepidemicus Invades and Survives in Epithelial Cells
Front. Cell. Infect. Microbiol. 7:465. doi:10.3389/fcimb.2017.00465
Keywords: Image analysis with ZEN 2, microbiology, infection

Olson, P.D., et al. (2017)
Renal scar formation and kidney function following antibiotic-treated murine pyelonephritis
Dis Model Mech. 2017 Nov 1; 10(11): 1371–1379. doi:10.1242/dmm.030130

Further applications

Publication

Henriques, S. F., et al. (2018)

Different outcome of sarcoglycan missense mutation between human and mouse

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