

OptiPrep™ Mini-Review MS13

Endocytosis – a bibliographical review

The following references are concerned with the pathways of the endocytic process and describe the use of iodixanol gradients for the purification of a variety of membrane compartments.

- ◆ References are primarily sorted into **cell/tissue type**, or occasionally a cell process: e.g. **virus processing**
- ◆ Each **cell/tissue type** is sorted according to the **principal analytical study**.
- ◆ In each section or subsection references are listed alphabetically according to **first author**; a particular reference may appear in more than one subsection
- ◆ Note that the companion **Mini-Review MS14** summarizes the available methods for fractionation of components of the endocytic system

There are also several Application Sheets, accessible from the “Subcellular Membranes Index”, devoted to the use of cultured cells or mammalian liver:

- ◆ Cultured cells – buoyant density gradients: **Application Sheet S44**
- ◆ Cultured cells/rat liver – self-generated gradients: **Application Sheet S43**
- ◆ Rat liver – gradients for study of late endosome/lysosome events: **Application Sheet S52**
- ◆ Rat liver – sedimentation velocity gradients: **Application Sheet S42**
- ◆ **Application Sheet S54** (Lysosomes (ER/endosomes/plasma membrane)) also addresses the separation of lysosomes, plasma membrane and endosomes

There are three other **Mini-Reviews** that provide bibliographies of papers reporting the analysis of lipid-rich plasma membrane domains, which may also be relevant in the endocytic process

- ◆ **MS06** Lipid rich detergent-resistant domains from vertebrate cells and tissues
- ◆ **MS07** Detergent-free strategy for lipid raft isolation
- ◆ **MS08** Purification of caveolae in gradients prepared from OptiPrep™
- ◆ All of the Application Sheets and Mini-Reviews can be found in the on the OptiPrep™ Applications/Mini-Reviews flash-drive or on the following website: www.axis-shield-density-gradient-media.com. On the website click on the “Methodology” tab for the Application Sheets..
- ◆ To assist the identification of a relevant reference in the following index **key words are highlighted in blue**

Adipocytes

Methodology

Sadler, J.B.A., Lamb, C.A., Gould, G.W. and Bryant, N.J. (2016) *Iodixanol gradient centrifugation to separate components of the low-density membrane fraction from 3T3-L1 adipocytes* Cold Spring Harb. Protoc., doi:10.1101/pdb.prot083709

Arabidopsis

Plant receptors

Groen, A.J., de Vries, S.C. and Lilley, K.S. (2008) *A proteomics approach to membrane trafficking* Plant Physiol., **147**, 1584-1589

Airway epithelial cells

Cystic fibrosis membrane conductance regulator

Bomberger, J.M., MacEachran, D., Ye, S., Swiatecka-Urban, A., et al (2007) *CFTR inhibitory factor (CIF) reduces the plasma membrane expression of CFTR by altering intracellular trafficking of CFTR to the lysosomal pathway* FASEB J., **21**, 944.4

Bomberger, J.M., Ye, S., MacEachran, D.P., Koeppen, K., et al (2011) *A Pseudomonas aeruginosa toxin that hijacks the host ubiquitin proteolytic system* PLoS Pathog., **7**: e1001325

Bomberger, J.M., Guggino, W.B. and Stanton, B.A. (2011) *Methods to monitor cell surface expression and endocytic trafficking of CFTR in polarized epithelial cells* In Cystic Fibrosis, Methods Mol. Biol. (eds. Amaral, M.D. and Kunzelmann, K.) Springer Science+Business Media, pp 271-283

Astrocytes

Notch signalling

Valapala, M., Hose, S., Gongora, C., Dong, L., et al (2013) *Impaired endolysosomal function disrupts Notch signalling in optic nerve astrocytes* Nat. Commun., **4**: 1629

Persistent fetal vasculature

Zigler Jr. J.S., Valapala, M., Shang, P., Hose, S., Goldberg, M.F. and Sinha, D. (2016) *β A3/A1-crystallin and persistent fetal vasculature (PFV) disease of the eye* Biochim. Biophys. Acta, **1860**, 287–298

BHK cells

Helicobacter pylori toxin

Molinari, M., Galli, C., Norais, N., Telford, J.L., et al (1997) *Vacuoles induced by Helicobacter pylori toxin contain both late endosomal and lysosomal markers* J. Biol. Chem., **272**, 25339-25344

Brain tissue/neural cells (see also “Astrocytes” and “Glial cells”)

β -amyloid precursor protein

Sato, N., Shinohara, M., Rakugi, H. and Morishita, R. (2012) *Dual effects of statins on $A\beta$ metabolism: upregulation of the degradation of APP-CTF and $A\beta$ clearance* Neurodegener. Dis., **10**, 305–308

Shinohara, M., Sato, N., Kurinami, H., Takeuchi, D., et al (2010) *Reduction of brain β -amyloid ($A\beta$) by fluvastatin, a hydroxymethylglutaryl-CoA reductase inhibitor, through increase in degradation of amyloid precursor protein C-terminal fragments (APP-CTFs) and $A\beta$ clearance* J. Biol. Chem., **285**, 22091–22102

Tamboli, I.Y., Hampel, H., Sandhoff, K. and Walter, J. (2006) *Accumulation of sphingolipids increases secretion of the amyloid β -peptide by stabilization of the β -amyloid precursor protein* Alzheimers Dement., **2**, Suppl. 1, S528-S529

Dendritic trafficking

Schwenk, B.M., Lang, C.M., Hogg, S., Tahirovic, S., et al (2014) *The FTL risk factor TMEM106B and MAP6 control dendritic trafficking of lysosomes* EMBO J., **33**, 450-467

Early endosome maturation

Candiello, E., Kratzke, M., Wenzel, D., Cassel, D. and Schu, P. (2016) *AP-1/ σ 1A and AP-1/ σ 1B adaptor proteins differentially regulate neuronal early endosome maturation via the Rab5/Vps34-pathway* Sci. Rep., **6**: 29950

Glycolipids

Takamura, A., Higaki, K., Ninomiya, H., Takai, T., et al (2011) *Lysosomal accumulation of Trk protein in brain of G_{MI} -gangliosidosis mouse and its restoration by chemical chaperone* J. Neurochem., **118**, 399–406

Hereditary spastic paraplegia

Khundadze, M., Kollmann, K., Koch, N., Biskup, C., et al (2013) *A hereditary spastic paraplegia mouse model supports a role of ZFYVE26/SPASTIZIN for the endolysosomal system* PloS Genet., **9**: e1003988

Trk protein

Fu, X., Yanga, Y., Xua, C., Niua, Y., et al (2011) *Retrolinkin cooperates with endophilin A1 to mediate BDNF–TrkB early endocytic trafficking and signaling from early endosomes* Mol. Biol. Cell, **22**, 3684-3698

Takamura, A., Higaki, K., Ninomiya, H., Takai, T., et al (2011) *Lysosomal accumulation of Trk protein in brain of G_{MI} -gangliosidosis mouse and its restoration by chemical chaperone* J. Neurochem., **118**, 399–406

Caco-2 cells

Cholera toxin

Orlandi, P.A. (1997) *Protein-disulfide isomerase-mediated reduction of the A subunit of cholera toxin in a human intestinal cell line* J. Biol. Chem., **272**, 4591-4599

Van den Broeck, D., Lagrou, A.R. and De Wolf, M.J.S. (2007) *Distinct role of clathrin-mediated endocytosis in the functional uptake of cholera toxin* Acta Biochim. Polonica, **54**, 757-767

Methodology

Li, X. and Donowitz, M. (2008) *Fractionation of subcellular membrane vesicles of epithelial and nonepithelial cells by OptiPrep™ density gradient ultracentrifugation* In Methods Mol. Biol., **440**, Exocytosis and Endocytosis (ed. Ivanov, A.I.) Humana Press, Totowa, NJ, pp 97-110

Li, X. and Donowitz, M. (2014) *Fractionation of subcellular membrane vesicles of epithelial and non-epithelial cells by OptiPrep™ density gradient ultracentrifugation* In Exocytosis and Endocytosis, Methods in Molecular Biology, **1174** (ed. Ivanov, A.I.) Springer Science+Business Media New York 2014, pp 85-99

Caenorhabditis elegans

Lipid transport

Kobuna, H., Inoue, T., Shibata, M., Gengyo-Ando, K., Yamamoto, A., Mitani, S. and Arai, H. (2010) *Multivesicular body formation requires OSBP-related proteins and cholesterol* PloS Genet., **6**: e1001055

Carcinoma cells

Adaptor proteins

Urbanska, A., Sadowski, L., Kalaidzidis, Y. and Miaczynska, M. (2011) *Biochemical characterization of APPL endosomes: the role of annexin A2 in APPL membrane recruitment* Traffic, **12**, 1227–1241

β-Amyloid precursor protein

Matsuda, S., Matsuda, Y., Snapp, E.L. and D’Adamio, L. (2011) *Maturation of BRI2 generates a specific inhibitor that reduces APP processing at the plasma membrane and in endocytic vesicles* Neurobiol. Aging, **32**, 1400–1408

Vorobyeva, A.G., Lee, R., Miller, S., Longen, C., Sharoni, M. et al (2014) *Cyclopamine modulates γ-secretase-mediated cleavage of amyloid precursor protein by altering its subcellular trafficking and lysosomal degradation* J. Biol. Chem., **289**, 33258–33274

Biogenesis and cargo selection

Dengje, J., Høyer-Hansen, M., Nielsen, M.O., Eisenberg, T., et al (2012) *Identification of autophagosome-associated proteins and regulators by quantitative proteomic analysis and genetic screens* Mol. Cell. Proteom., **11**: M111.014035

Clathrin-mediated

Barroso-González, J., Machado, J-D., García-Expósito, L. and Valenzuela-Fernández, A. (2009) *Moesin regulates the trafficking of nascent clathrin-coated vesicles* J. Biol. Chem., **284**, 2419–2434

Endosome maturation and processing

Huotari, J., Meyer-Schaller, N., Hubner, M., Stauffer, S., et al (2012) *Cullin-3 regulates late endosome maturation* Proc. Natl. Acad. Sci. USA, **109**, 823–828

Li, Q., Spencer, N.Y., Oakley, F.D., Buettner, G.R. and Engelhardt, J.F. (2009) *Endosomal Nox2 facilitates redox-dependent induction of NF-κB by TNF-α* Antioxid. Redox Signal., **11**, 1249–1263

Perini, E.D., Schaefer, R., Stöter, M., Kalaidzidis, Y. and Zerial, M. (2014) *Mammalian CORVET Is required for fusion and conversion of distinct early endosome subpopulations* Traffic, **15**, 1366–1389

Growth factors

Chin, L-S., Raynor, M.C., Wei, X., Chen, H-Q., et al (2001) *Hrs interacts with sorting nexin 1 and regulates degradation of epidermal growth factor receptor* J. Biol. Chem., **276**, 7069-7078

Yakymovych, I., Yakymovych, M., Zang, G., Mu, Y., Bergh, A., Landström, M. and Heldin, K.H. (2015) *CIN85 modulates TGF β signaling by promoting the presentation of TGF β receptors on the cell surface* J. Cell Biol., **210**, 319–332

Interleukin-1 receptor complex

Li, Q., Harraz, M.M., Zhou, W., Zhang, L.N., et al (2006) *Nox2 and Rac1 regulate H₂O₂-dependent recruitment of TRAFg to endosomal interleukin-1 receptor complexes* Mol. Cell. Biol., **26**, 140-154

Lipid droplets

Velikkakath, A.K.G., Nishimura, T., Oita, E., Ishihara, N., et al (2012) *Mammalian Atg2 proteins are essential for autophagosome formation and important for regulation of size and distribution of lipid droplets* Mol. Biol. Cell, **23**, 896-909

Notch signalling

Tagami, S., Okochi, M., Yanagida, K., Ikuta, A., et al (2008) *Regulation of Notch signaling by dynamic changes in the precision of S3 cleavage of Notch-1* Mol. Cell. Biol., **28**, 165-76

Rab GTPase

Meyers, J.M. and Prekeris, R. (2002) *Formation of mutually exclusive Rab11 complexes with members of the family of Rab11-interacting proteins regulates Rab11 endocytic targeting and function* J. Biol. Chem., **277**, 49003-49010

Proikas-Cezanne, T., Gaugel, A., Frickey, T. and Nordheim, A. (2006) *Rab14 is part of the early endosomal clathrin-coated TGN microdomain* FEBS Lett., **580**, 5241-5246

Urbanska, A., Sadowski, L., Kalaidzidis, Y. and Miaczynska, M. (2011) *Biochemical characterization of APPL endosomes: the role of annexin A2 in APPL membrane recruitment* Traffic, **12**, 1227–1241

ROS

Mumbengegwi, D.R., Li, Q., Li, C., Bear, C.E., et al (2008) *Evidence for a superoxide permeability in endosomal membranes* Mol. Cell. Biol., **28**, 3700-3712

Salmonella-containing vacuole

Santos, J.C., Duchateau, M., Fredlund, J., Weiner, A., Mallet, A., Schmitt, C., Matondo, M., Hourdel, V., Chamot-Rooke, J. and Enninga, J. (2015) *The COPII complex and lysosomal VAMP7 determine intracellular Salmonella localization and growth* Cell. Microbiol., **17**, 1699–1720

Syntaxins

Neto, H., Kaupisch, A., Collins, L.L. and Gould, G.W. (2013) *Syntaxin 16 is a master recruitment factor for cytokinesis* Mol. Biol. Cell, **24**, 3663-3674

Virus internalization and interactions

Ding, W., Zhang, L.N., Yeaman, C. and Engelhardt, J.F. (2006) *rAAV2 traffics through both the late and the recycling endosomes in a dose-dependent fashion* Mol. Ther., **13**, 671-682

Ganti, K., Massimi, P., Manzo-Merino, J., Tomaić, V., Pim, D., Playford, M.P., Lizano, M., Roberts, S., Kranjec, C., Doorbar, J. and Banks, L. (2016) *Interaction of the human papillomavirus E6 oncoprotein with sorting nexin 27 modulates endocytic cargo transport pathways* PLoS Pathog., **12**: e1005854

Su, W-C., Chen, Y-C., Tseng, C-H., Hsu, P.W-C., et al (2013) *Pooled RNAi screen identifies ubiquitin ligase Itch as crucial for influenza A virus release from the endosome during virus entry* Proc. Natl. Acad. Sci. USA, **110**, 17516–17521

Cardiac tissue

Hund, T.J. and Mohler, P.J. (2011) *Differential roles for SUR subunits in KATP channel membrane targeting and regulation* Am. J. Physiol. Heart Circ. Physiol., **300**, H33–H35

Yang, H.Q., Foster, M.N., Jana, K., Ho, J., Rindler, M.J. and Coetzee, W.A. (2016) *Plasticity of sarcolemmal KATP channel surface expression: relevance during ischemia and ischemic preconditioning*. Am. J. Physiol. Heart Circ. Physiol., **310**, H1558–H1566

CHO cells

β-amyloid precursor protein

Huttunen, H.J., Puglielli, L., Ellis, B.C., MacKenzie Ingano, L.A. and Kovacs, D.M. (2009) *Novel N-terminal cleavage of APP precludes Aβ generation in ACAT-defective AC29 cells* J. Mol. Neurosci., **37**, 6-15

Coatamer COPI protein

Daro, E., Sheff, D., Gomez, M., Kreis, T., et al (1997) *Inhibition of endosome function in CHO cells bearing a temperature-sensitive defect in the coatamer (COPI) component ε-COP* J. Cell Biol., **139**, 1747-1759

GLUT8 transporter

Augustin, R., Riley, J. and Moley, K.H. (2005) *GLUT8 contains a [DE]XXXL[LI] sorting motif and localizes to a late endosomal/lysosomal compartment* Traffic, **6**, 1196-1212

LDL receptor

Sugii, S., Reid, P.C., Ohgami, N., Du, H. et al (2003) *Distinct endosomal compartments in early trafficking of low density lipoprotein-derived cholesterol* J. Biol. Chem., **278**, 27180-27189

Corneal epithelial cells

Clathrin-mediated

Argueso, P., Guzman-Aranguéz, A., Woodward, A. and Pintor, J.J. (2011) *Inhibition of mucin O-glycosylation promotes endocytosis and nanoparticle uptake in corneal epithelial cells* Invest. Ophthalmol. Vis. Sci., **52**, E-Abstr. 4394

COS cells

Sialidase

Lukong, K.E., Seyrantepe, V., Landry, K., Trudel, S., et al (2001) *Intracellular distribution of lysosomal sialidase is controlled by the internalisation signal in its cytoplasmic tail* J. Biol. Chem., **276**, 46172-46181

Transferrin receptor

Shen, X., Xu, K-F., Fan, Q., Pacheco-Rodriguez, G., et al (2006) *Association of brefeldin A-inhibited guanine nucleotide-exchange protein 2 (BIG2) with recycling endosomes during transferrin uptake* Proc. Natl. Acad. Sci. USA, **103**, 2635-2640

Cytokinesis

Chen, X-W., Inoue, M., Hsu, S. and Saltiel, A.R. (2006) *RalA-exocyst-dependent recycling endosome trafficking is required for the completion of cytokinesis* J. Biol. Chem., **281**, 38609-38616

Drosophila

Epithelial septate junction

Tiklová, K., Senti, K-A., Wang, S., Gräslund, A., et al (2010) *Epithelial septate junction assembly relies on melanotransferrin iron binding and endocytosis in Drosophila* Nature Cell. Biol., **12**, 1071-1078

Photoreceptor cells

Lee, J., Song, M. and Hong, S. (2013) *Negative regulation of the novel norpAP24 suppressor, diehard4, in the endo-lysosomal trafficking underlies photoreceptor cell degeneration* PLoS Genet., **9**: e1003559

sRNA

Lee, Y.S., Pressman, S., Andress, A.P., Kim, K., et al (2009) *Silencing by small RNAs is linked to endosomal trafficking* Nat. Cell Biol., **11**, 1150-1157

Endothelial cells

Growth factor receptors

Lampugnani, M.G., Orsenigo, F., Gagliani, M.C., Tacchetti, C. et al (2006) *Vascular endothelial cadherin controls VEGFR-2 internalization and signaling from intracellular compartments* J. Cell Biol., **174**, 593-604

Enterocytes

Intestinal chylomicron output

Siddiqi, S. and Mansbach II, C.M. (2015) *Dietary and biliary phosphatidylcholine activates PKC ξ in rat intestine* J. Lipid Res., **56**, 859–870

Glia/glioma cells

Proteoglycans

Podyma-Inoue, K.A., Moriwaki, T, Rajapakshe, A.R., Terasawa, K. and Hara-Yokoyama, M. (2016) *Characterization of heparan sulfate proteoglycan-positive recycling endosomes isolated from glioma cells* Canc. Genom. Proteom., **13**, 443-452

Virus processing

Querbes, W., O'Hara, B.A., Williams, G. and Atwood, W.J. (2006) *Invasion of host cells by JC virus identifies a novel role for caveolae in endosomal sorting of noncaveolar ligands* J. Virol., **80**, 9402-9413

Green monkey kidney (Vero) cells

Toxins

McKenzie, J., Johannes, L., Taguchi, T. and Sheff, D. (2009) *Passage through the Golgi is necessary for Shiga toxin B subunit to reach the endoplasmic reticulum* FEBS J., **276**, 1581–1595

Majoul, I.V., Bastiaens, P.I.H. and Soling H-D (1996) *Transport of an external Lys-Asp-Glu-Leu (KDEL) protein from the plasma membrane to the endoplasmic reticulum: studies with cholera toxin in Vero cells* J. Cell Biol., **133**, 777-789

HEK cells

Rab GTPase

Urbanska, A., Sadowski, L., Kalaidzidis, Y. and Miaczynska, M. (2011) *Biochemical characterization of APPL endosomes: the role of annexin A2 in APPL membrane recruitment* Traffic, **12**, 1227–1241

Stotmatin

Mairhofer, M., Steiner, M., Salzer, U. and Prohaska, R. (2009) *Stomatatin-like protein-1 interacts with stomatin and is targeted to late endosomes* J. Biol. Chem., **284**, 29218-29229

β -Catenin

Layton, M.J., Faux, M.C., Church, N.L., Catimel, B., et al (2012) *Identification of a Wnt-induced protein complex by affinity proteomics using an antibody that recognizes a sub-population of β -catenin* Biochim. Biophys. Acta, **1824**, 925–937

Clathrin-mediated

Idkowiak-Baldys, J., Becker, K.P., Kitatani, K. and Hannun, Y.A. (2006) *Dynamic sequestration of the recycling compartment by classical protein kinase C* J. Biol. Chem., **281**, 22321-22331

Neel, N.F., Lapierre, L.A., Goldenring, J.R. and Richmond, A. (2007) *RhoB plays an essential role in CXCR2 sorting decisions* J. Cell Sci., **120**, 1559-1571

Dopamine transporter

Keith, D.J., Wolfrum, K., Eshleman, A.J. and Janowsky, A. (2012) *Melittin initiates dopamine transporter internalization and recycling in transfected HEK-293 cells* Eur. J. Pharmacol., **690**, 13–21

GLUT8 transporter

Augustin, R., Riley, J. and Moley, K.H. (2005) *GLUT8 contains a [DE]XXXL[LI] sorting motif and localizes to a late endosomal/lysosomal compartment* Traffic, **6**, 1196-1212

Immune receptors

Qi, R., Singh, D. and Kao, C.C. (2012) *Proteolytic processing regulates toll-like receptor 3 stability and endosomal localization* J. Biol. Chem., **287**, 32617–32629

Notch signalling

Tagami, S., Okochi, M., Yanagida, K., Ikuta, A., et al (2008) *Regulation of Notch signaling by dynamic changes in the precision of S3 cleavage of Notch-1* Mol. Cell Biol., **28**, 165-76

Pericentriion

El-Osta, M.A., Idkowiak-Baldys, J. and Hannun, Y.A. (2011) *Delayed phosphorylation of classical protein kinase C (PKC) substrates requires PKC internalization and formation of the pericentriion in a phospholipase D (PLD)-dependent manner* J. Biol. Chem., **286**, 19340–19353

Phosphatidylinositol

Sbrissa, D., Ikononov, O.C., Fu, Z., Ijuin, T., et al (2007) *Core protein machinery for mammalian phosphatidylinositol 3,5-bisphosphate synthesis and turnover that regulates the progression of endosomal transport* J. Biol. Chem., **282**, 23878-23891

Tau protein

Simón, D., García-García, E., Royo, F., Falcón-Pérez, J.M. et al (2012) *Proteostasis of tau. Tau overexpression results in its secretion via membrane vesicles* FEBS Lett., **586**, 47–54

Virus internalization

Su, W-C., Chen, Y-C., Tseng, C-H., Hsu, P.W-C., et al (2013) *Pooled RNAi screen identifies ubiquitin ligase Itch as crucial for influenza A virus release from the endosome during virus entry* Proc. Natl. Acad. Sci. USA, **110**, 17516–17521

HeLa cells (see “Carcinoma cells”)

Hepatocytes

Autophagosomes

Berg, T.O., Fengsrud, M., Stromhaug, P.E., Berg, T., et al (1998) *Isolation and characterization of rat liver amphisomes* J. Biol. Chem., **273**, 21883-21892

Fengsrud, M., Erichsen, E.S., Berg, T.O., Raiborg, C. et al (2000) *Ultrastructural characterization of the delimiting membranes of isolated autophagosomes and amphisomes by freeze-fracture electron microscopy* Eur. J. Cell Biol., **79**, 871-882

Strømhaug, P.E., Berg, T.O. and Seglen, P.O. (1998) *Purification and characterization of autophagosomes from rat hepatocytes* Biochem. J., **335**, 217-224

Lipid droplets

Schulze, R.J., Weller, S.G., Schroeder, B., Krueger, E.W., et al (2013) *Lipid droplet breakdown requires Dynamin 2 for vesiculation of autolysosomal tubules in hepatocytes* J. Cell Biol., **203**, 315–326

siRNA

Xu, Y., Ou, M., Keough, E., Roberts, J., et al (2014) *Quantitation of physiological and biochemical barriers to siRNA liver delivery via lipid nanoparticle platform* Mol. Pharmaceutics, **11**, 1424-434

Hepatoma cells

Lipid droplets

Li, Z., Schulze, R.J., Weller, S.G., Krueger, E.W., Schott, M.B., Zhang, X., Casey, C.A., Liu, J., Stöckli, J., James, D.E. and McNiven, M.A. (2016) *A novel Rab10-EHBP1-EHD2 complex essential for the autophagic engulfment of lipid droplets* Sci. Adv., **2**: e1601470

Transferrin receptor

Manunta, M., Izzo, L., Duncan, R. and Jones, A.T. (2007) *Establishment of subcellular fractionation techniques to monitor the intracellular fate of polymer therapeutics II: Identification of endosomal and lysosomal compartments in HepG2 cells combining single-step subcellular fractionation and fluorescent imaging* J. Drug Target., **15**, 37-50

Virus interactions

Abdul, F., Ndeboko, B., Buronfosse, T., Zoulim, F., et al (2012) *Potent inhibition of late stages of hepadnavirus replication by a modified cell penetrating peptide* PLoS One, **7**: e48721

Shaikh F.Y., Utley, T.J., Craven, R.E., Rogers, M.C., et al (2012) *Respiratory syncytial virus assembles into structured filamentous virion particles independently of host cytoskeleton and related proteins* PLoS One, **7**: e40826

Human skin fibroblasts

Niemann-Pick C1

Nakasone, N., Nakamura, Y.S., Higaki, K., Oumi, N., Ohno, K. and Ninomiya, H. (2014) *Endoplasmic reticulum-associated degradation of Niemann-Pick C1: evidence for the role of heat shock proteins and identification of lysine residues that accept ubiquitin* J. Biol. Chem., **289**, 9714–19725

Ileal brush border

Na⁺-H⁺ exchanger

Li, X. and Donowitz, M. (2008) *Fractionation of subcellular membrane vesicles of epithelial and nonepithelial cells by OptiPrep™ density gradient ultracentrifugation* In Methods Mol. Biol., **440**, Exocytosis and Endocytosis (ed. Ivanov, A.I.) Humana Press, Totowa, NJ, pp 97-110

Li, X., Zhang, H., Cheong, A., Leu, S., et al (2004) *Carbachol regulation of rabbit ileal brush border Na⁺-H⁺ exchanger 3 (NHE3) occurs through changes in NHE3 trafficking and complex formation and is Src dependent* J. Physiol., **3**, 791-804

Li, X. and Donowitz, M. (2014) *Fractionation of subcellular membrane vesicles of epithelial and non-epithelial cells by OptiPrep™ density gradient ultracentrifugation* In *Exocytosis and Endocytosis, Methods in Molecular Biology*, **1174** (ed. Ivanov, A.I.) Springer Science+Business Media New York 2014, pp 85-99

Jurkat cells

Transferrin receptor

Shakor, A.B.A., Atia, M.M., Kwiatkowska, K. and Sobota, A. (2012) *Cell surface ceramide controls translocation of transferrin receptor to clathrin-coated pits* *Cell. Signal.*, **24**, 677–684

Keratinocytes

Clathrin-mediated

Guzman-Aranguéz, A., Woodward, A.M., Pintor, J. and Argüeso, P. (2012) *Targeted disruption of core 1 β 1,3-galactosyltransferase (C1galt1) induces apical endocytic trafficking in human corneal keratinocytes* *PLoS One*, **7**: e36628

Kidney

Aquaporin

Procino, G., Barbieri, C., Carmosino, M., Rizzo, F., et al M. (2010) *Lovastatin-induced cholesterol depletion affects both apical sorting and endocytosis of aquaporin-2 in renal cells* *Am. J. Physiol. Renal Physiol.*, **298**, F266–F278

Megalin (LDL receptor gene family)

Zou, Z., Chung, B., Nguyen, T., Mentone, S., Thomson, B. and Biemesderfer, D. (2004) *Linking receptor-mediated endocytosis and cell signaling* *J. Biol. Chem.*, **279**, 34302-34310

Myosin VI

Biemesderfer, D., Mentone, S.A., Mooseker, M. and Hasson, T. (2002) *Expression of myosin VI within the early endocytic pathway in adult and developing proximal tubules* *Am. J. Physiol., Ren. Physiol.*, **282**, F785-F794

LD9 cells

Prion protein

Graham, J.F., Agarwal, S., Kurian, D., Kirby, L., et al (2010) *Low density subcellular fractions enhance disease-specific prion protein misfolding* *J. Biol. Chem.*, **285**, 9868–9880

Liver (rodent)

Late endosomal/lysosomal sorting

Pribasniq, M.A., Mrak I., Grabner, G.F., Taschler, U., Knittelfelder, O., Scherz, B., Eichmann, T.O., Heier, C., Grumet, L. et al (2015) *α/β Hydrolase domain-containing 6 (ABHD6) degrades the late endosomal/ lysosomal lipid bis(monoacylglycero)phosphate* *J. Biol. Chem.*, **290**, 29869–29881

Neogalactosylalbumin uptake

Billington, D., Maltby, P.J. Jackson, A.P. and Graham, J.M. (1998) *Dissection of hepatic receptor-mediated endocytic pathways using self-generated gradients of iodixanol (OptiPrep)* *Anal. Biochem.*, **258**, 251-258

Sialidase

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