

Studium

- 1988-1994
Studium der Biologie (und Chemie) an der Carl von Ossietzky Universität Oldenburg und der Rheinischen Friedrich-Wilhelms-Universität zu Bonn
- 1993-1994
Diplomarbeit (Botanische Zytologie der Universität Bonn)
„Immunzytologische Untersuchungen der Plasmamembran-H⁺-ATPase entlang der Membranflussroute unter Einsatz von Brefeldin A“
(Betreuer: Prof. Volkmann)
- 1994-1998
Doktorarbeit an der Universität Osnabrück (Tierphysiologie)
„Modifikationen des Verhaltens und der elektrischen Eigenschaften von *Euplotes vannus* und *Euplotes raikovi* durch Nahrungssignale und sexuelle Stimuli“
(Betreuer: Prof. Lueken und Priv.-Doz. Krüppel)
- 1998-2002
Postdoc an der University of Hawai'i at Manoa, Pacific Biomedical Research Center und Department of Microbiology
(Mentoren: Prof. R.D. Allen und Prof. Y. Naitoh)
- 2008
Venia legendi für das Fach Physiologie, verliehen durch die Medizinische Fakultät der Westfälischen Wilhelms-Universität Münster
Thema der Habilitationsschrift: „How ion translocation across the plasma membrane modulates cell motility“
(Mentor: Prof. Schwab)
- 2014
Außerplanmäßige Professur, verliehen durch die Medizinische Fakultät der Westfälischen Wilhelms-Universität Münster
- 2017
Anerkennung zum Führen der Bezeichnung „Fachphysiologe“, erteilt durch die Deutsche Physiologische Gesellschaft
- 2017
Umhabilitation an die MHH unter Anerkennung der außerplanmäßigen Professur

Beruflicher Werdegang

- 1994-1998
Doktorand in der Tierphysiologie der Universität Osnabrück als Mitglied des Graduiertenkollegs “Molekulare Zellbiologie mit Schwerpunkt Membranbiologie”

- 1998
Gastwissenschaftler des Graduiertenkollegs “Molekulare Zellbiologie mit Schwerpunkt Membranbiologie” an der Universität Osnabrück

- 1998
Wissenschaftlicher Mitarbeiter in der Zellenlehre der Ruprecht-Karls-Universität Heidelberg

- 1998-2002
Postdoc an der University of Hawai‘i at Manoa, Pacific Biomedical Research Center und Department of Microbiology, als Stipendiat des DAAD und der NSF

- 2002-2003
Wissenschaftlicher Assistent am Physiologischen Institut der Bayerischen Julius-Maximilians-Universität Würzburg

- 2003-2014
Wissenschaftlicher Assistent am Institut für Physiologie II des Universitätsklinikums der Westfälischen-Wilhelms-Universität Münster

- September 2014-heute
Mitglied der AG Seidler

Publikationen

2022

Becker, Y., **Stock, C.** (2022). The ACE inhibitor lisinopril stimulates melanoma cell invasiveness by inducing MMP2 secretion. *Cell. Physiol. Biochem.* **56**, 457-483.

Stock, C. (2022). Circulating tumor cells: Does ion transport contribute to intravascular survival, adhesion, extravasation and metastatic organotropism? *Rev. Physiol. Biochem. Pharmacol.* **182**, 139-175.

Nikolovska, K., Seidler, U.E., **Stock, C.** (2022). The role of plasma membrane sodium/hydrogen exchangers in gastrointestinal functions: proliferation and differentiation, fluid/electrolyte transport and barrier integrity. *Front. Physiol.* **13**, 899286.

2021

Stock, C. (2021). How dysregulated ion channels and transporters take a hand in esophageal, liver and colorectal cancer. *Rev. Physiol. Biochem. Pharmacol.* **181**, 129-222.

2020

Flinck, M., Hagelund, S., Gorbatenko, A., Severin, M., Pedraz-Cuesta, E., Novak, I., **Stock, C.**, Pedersen, S.F. (2020). The Vacuolar H⁺ ATPase α 3 subunit negatively regulates migration and invasion of human pancreatic ductal adenocarcinoma cells. *Cells* **9**, 465.

Cao, L., Yuan, Z., Liu, M., **Stock, C.** (2020). (Patho-)Physiology of Na⁺/H⁺ exchangers (NHEs) in the digestive system. *Front. Physiol.* **10**, 1566.

2019

Keurhorst, D., Liashkovich, I., Frontzek, F., Nitzlaff, S., Dreier, R., **Stock, C.** (2019). MMP3-activity rather than cortical stiffness determines NHE1-dependent invasiveness of melanoma cells. *Cancer Cell Int.* **19**, 285.

2018

Olschewski, D.N., Hofschröder, V., Nielsen, N., Seidler, D.G., Schwab, A., **Stock, C.** (2018). The angiotensin II type 1 receptor antagonist Losartan affects NHE1-dependent melanoma cell behavior. *Cell. Physiol. Biochem.* **45**, 2560-2576.

2017

Nikolovska, K., Spillmann, D., Haier, J., Ladányi, A., **Stock, C.**, Seidler, D.G. (2017). Melanoma cell adhesion and migration is modulated by the Uronyl 2-O Sulfotransferase. *PLoS ONE* **12**, e0170054.

Viola, M., Brüggemann, K., Karousou, E., Caon, I., Caravà, E., Vigetti, D., Greve, B., **Stock, C.**, De Luca, G., Passi, A., Götte, M. (2017). MDA-MB-231 breast cancer cell viability, motility and matrix adhesion are regulated by a complex interplay of heparan sulfate, chondroitin-/dermatan sulfate and hyaluronan biosynthesis. *Glycoconj. J.* **34**, 411-420.

Hofschröer, V., Koch, K.A., Ludwig, F.T., Friedl, P., Oberleithner, H., **Stock C.***, Schwab, A.* (2017). Extracellular protonation modulates cell-cell interaction mechanics and tissue invasion in human melanoma cells. *Sci. Rep.* **7**, 42369. *co-corresponding authors

Stock, C., Pedersen, S.F. (2017). Roles of pH and the Na⁺/H⁺ exchanger NHE1 in cancer: From cell biology and animal models to an emerging translational perspective? *Sem. Cancer Biol.* **43**, 5-16.

Seidler, D.G., **Stock, C.** (2017). Zuckerverbindungen zur unterstützenden Behandlung des metastasierenden Melanoms? *Journal Onkologie Ausgabe 3/2017*, 203-207.

2016

Franz, J., Brinkmann, B.F., König, M., Hüve, J., **Stock, C.**, Ebnet, K., Riethmüller, C. (2016). Nanoscale imaging reveals a tetraspanin-CD9 coordinated elevation of endothelial ICAM-1 clusters. *PLoS ONE* **11**, e0146598.

Riemann, A., Schneider, B., Gündel, D., **Stock, C.**, Gekle, M., Thews, O. (2016). Acidosis promotes metastasis formation by enhancing tumor cell motility. *Adv. Exp. Med. Biol.* **876**, 215-220.

2015

Schwickert, A., Weghake, E., Brüggemann, K., Engbers, A., Brinkmann, B.F., Kemper, B., Seggewiß, J., **Stock, C.**, Ebnet, K., Kiesel, L., Riethmüller, C., Götte, M. (2015). microRNA miR-142-3p inhibits breast cancer cell invasiveness by synchronous targeting of WASL, integrin alpha v, and additional cytoskeletal elements. *PLoS ONE* **10**, e0143993.

Spugnigni, E., Sonveaux, P., **Stock, C.**, Perez-Sayans, M., De Milito, A., Avnet, S., García García, A., Harguindey, S., Fais, S. (2015). Implication of proton channels and exchangers in cancer. *Biochim. Biophys. Acta* **1848**, 2715-2726.

Stock, C., Schwab, A. (2015). Ion channels and transporters in metastasis. *Biochim. Biophys. Acta* **1848**, 2638-2646.

Alfarouk, K.O., **Stock, C.M.**, Taylor, S., Walsh, M., Muddathir, A.K., Verduzco, D., Bashir, A.H., Mohammed, O.Y., Elhassan, G.O., Harguindey, S., Reshkin, S.J., Ibrahim, M.E., Rauch, C. (2015). Resistance to cancer therapy: failure in drug response from ADME to P-gp. *Cancer Cell Int.* **15**, 71.

2014

Vahle, A.-K., Domikowsky, B., Schwöppe, C., Krähling, H., Mally, S., Schäfers, M., Hermann, S., Shahin, V., Haier, J., Schwab, A., **Stock, C.** (2014). Extracellular matrix composition and interstitial pH modulate NHE1-mediated melanoma cell motility. *Int. J. Oncol.* **44**, 78-90.

Riemann, A., Schneider, B., Gündel, D., **Stock, C.**, Thews, O., Gekle, M. (2014). Acidic priming enhances metastatic potential of cancer cells. *Eur. J. Physiol.* **466**, 2127-2138.

Kumar, A.V., Salem Gassar, E., Spillmann, D., **Stock, C.**, Sen, Y.P., Zhang, T., Van Kuppevelt, T.H., Hülsewig, C., Koszłowski, E., Pavao, M.S., Ibrahim, S.A., Poeter, M., Rescher, U., Kiesel, L., Koduru, S., Yip, G.W., Götte, M. (2014). HS3ST2 modulates breast cancer cell invasiveness via MAP kinase- and Tcf4 (Tcf712)-dependent regulation of protease and cadherin expression. *Int. J. Cancer* **135**, 2579-2592.

Lindner, K., Borchardt, C., Schöpp, M., Bürgers, A., **Stock, C.**, Hussey, D.J., Haier, J., Hummel, R. (2014). Proton pump inhibitors (PPIs) impact on tumour cell survival, metastatic potential and chemotherapy resistance, and affect expression of resistance-relevant miRNAs in esophageal cancer. *J. Exp. Clin. Cancer Res.* **33**, 73.

Frontzek, F., Nitzlaff, S., Horstmann, M., Schwab, A., **Stock, C.** (2014). Functional interdependence of NHE1 and merlin in human melanoma cells. *Biochem. Cell Biol.* **92**, 430-540.

Schwab, A. and **Stock, C.** (2014). Ion channels and transporters in tumour cell migration and invasion. *Philosophical Transactions of the Royal Society B*, **369**, 1638.

2013

Ludwig, F.T., Schwab, A., **Stock, C.** (2013). The Na⁺/H⁺ exchanger (NHE1) generates pH nanodomains at focal adhesions. *J. Cell. Physiol.* **228**, 1351-1358.

Di Marco, G.S., König, M., **Stock, C.**, Wiesinger, A., Hillebrand, U., Reiermann, S., Reuter, S., Amler, S., Köhler, G., Buck, F., Fobker, M., Kümpers, P., Oberleithner, H., Hausberg, M., Lang, D., Pavenstädt, H., Brand, M. (2013). High phosphate directly affects endothelial function by downregulating annexin II. *Kidney Int.* **83**, 213-222.

Clement, D. L., Mally, S., **Stock, C.**, Lethan, M., Satir, P., Schwab, A., Pedersen S.F., Christensen, S.T. (2013). PDGFR α signaling in the primary cilium regulates NHE1-dependent fibroblast migration via coordinated differential activity of MEK1/2-ERK1/2-p90^{RSK} and AKT signaling pathways. *J. Cell Sci.* **126**, 953-965.

Van Horssen, R., Willemsse, M., Haeger, A., Attanasio, F., Günen, T., Schwab, A., **Stock, C.**, Buccione, R., Fransen, J.A.M., Wieringa, B. (2013). Intracellular NAD(H) levels control motility and invasion of glioma cells. *Cell Mol. Life Sci.* **70**, 2175-2190.

Stock, C., Ludwig, F.T., Hanley, P.J., Schwab, A. (2013). Roles of ion transport in cell motility. *Compr. Physiol.* **3**, 59-119.

Pedersen S.F. and **Stock C.** (2013). Ion channels and transporters in cancer: pathophysiology, regulation and clinical potential. Meeting Report. *Cancer Res.* **73**, 1-4.

2012

Schwab, A., Nechyporuk-Zloy, V., Gassner, B., Schulz, C., Kessler, W., Mally, S., Römer, M., **Stock, C.** (2012). Dynamic redistribution of calcium sensitive potassium channels (hKCa3.1) in migrating cells. *J. Cell. Physiol.* **227**, 686-696.

Lauritzen, G., **Stock, C.**, Lemaire, J., Lund, S.F., Jensen, M.F., Damsgaard, B., Petersen, K.S., Wiwel, M., Rønnow-Jessen, L., Schwab A., Pedersen, S.F. (2012). The Na⁺/H⁺ exchanger NHE1, but not the Na⁺,HCO₃⁻ cotransporter NBCn1, regulates motility of MCF7 breast cancer cells expressing constitutively active ErbB2. *Cancer Letters* **317**, 172-183.

Ibrahim, S.A., Yip, G.W., **Stock, C.**, Pan, J.-W., Neubauer, C., Poeter, M., Pupjalis, D., Koo, C.Y., Kelsch, R., Schüle, R., Rescher, U., Kiesel, L., Götte, M. (2012). Targeting of Syndecan-1 by microRNA miR-10b promotes breast cancer cell motility and invasiveness via a Rho-GTPase- and E-cadherin-dependent mechanism. *Int. J. Cancer* **131**, E884-E896.

Jungmann, O., Nikolovska, K., **Stock, C.**, Schulz, J.-N., Eckes, B., Riethmüller, C., Owens, R.T., Iozzo, R.V., Seidler, D.G. (2012). The dermatan sulfate proteoglycan decorin modulates $\alpha 2\beta 1$ integrin and the vimentin intermediate filament system in a collagen-rich matrix. *PLoS ONE* **7**, e50809.

Stock, C., Ludwig, F.T., Schwab, A. (2012). Is the multifunctional Na⁺/H⁺ exchanger isoform 1 a potential therapeutic target in cancer? *Curr. Med. Chem.* **19**, 647-660.

Schwab, A., Fabian, A., Hanley, P.J., **Stock, C.** (2012). Role of ion channels and transporters in cell migration. *Physiol. Rev.* **92**, 1865-1913.

2011

Martin, C., Pedersen, S.F., Schwab, A., **Stock, C.** (2011). Intracellular pH gradients in migrating cells. *Am. J. Physiol.* **300**, C490-C495.

Stock, C., Jungmann, O., Seidler, D.G. (2011). Decorin and chondroitin-6 sulfate inhibit B16V melanoma cell migration and invasion by cellular acidification. *J. Cell. Physiol.* **226**, 2641-2650.

Stock, C., Riethmüller, C. (2011). Endothelial activation drives lateral migration and diapedesis of leukocytes. *Cell. Immunol.* **271**, 180-183.

2010

Schneider, L., Cammer, M., Lehman, J., Nielsen, S.K., Guerra, C.F., Veland, I.R., **Stock, C.**, Hoffmann, E.K., Yoder, B.K., Schwab, A., Satir, P., Christensen, S.T. (2010). Directional cell migration and chemotaxis in wound healing response to PDGF-AA are coordinated by the primary cilium in fibroblasts. *Cell. Physiol. Biochem.* **25**, 279-292.

Götte, M., Mohr, C., Koo, C.-Y., **Stock, C.**, Vaske, A.-K., Viola, M., Ibrahim, S.A., Peddibhotla, S., Teng, Y. H.-F., Low, J.-Y., Ebnet, K., Kiesel, L., Yip, G.W. (2010). miR-145-dependent targeting of junctional adhesion molecule A and modulation of fascin expression are associated with reduced breast cancer cell motility and invasiveness. *Oncogene* **29**, 6569-6580.

2009

Hillebrand, U., Lang, D., Telgmann, R.G., Hagedorn, C., Reuter, S., Kliche, K., **Stock, C.**, Oberleithner, H., Pavenstädt, H., Büsemaker, E., Hausberg, M. (2009). Nebivolol decreases endothelial cell stiffness via the estrogen receptor beta: a nano-imaging study. *J. Hypertens.* **27**, 517-526.

Schneider, L., **Stock, C.**, Dieterich, P., Satir, P., Schwab, A., Christensen, S.T., Pedersen, S.F. (2009). The Na⁺/H⁺ exchanger NHE1 plays a central role in directional migration stimulated via PDGFR α in the primary cilium. *J. Cell Biol.* **185**, 163-176.

Callies, C., Schön, P., Liashkovich, I., **Stock, C.**, Kusche-Vihrog, K., Fels, J., Sträter, A.S., Oberleithner, H. (2009). Simultaneous mechanical stiffness and electrical potential measurements of living vascular endothelial cells using combined atomic force and epifluorescence microscopy. *Nanotechnology* **20**, 175104.

Krähling, H., Mally, S., Eble, J.A., Noël, J., Schwab, A., **Stock, C.** (2009). The glycocalyx maintains a cell surface pH nanoenvironment crucial for integrin-mediated migration of human melanoma cells. *Eur. J. Physiol.* **458**, 1069-1083.

Stock, C. and Schwab, A. (2009). Protons make tumor cells move like clockwork. *Eur. J. Physiol.* **458**, 981-992.

2008

Schneider, L., Klausen, T., **Stock, C.**, Mally, S., Christensen, S., Pedersen, S., Hoffmann, E., Schwab, A. (2008). H-ras transformation sensitizes volume-activated anion channels and increases migratory activity of NIH3T3 fibroblasts. *Eur. J. Physiol.* **455**, 1055-1062.

Nechyporuk-Zloy, V., Dieterich, P., Oberleithner, H., **Stock, C.**, Schwab, A. (2008). Dynamics of single potassium channel proteins in the plasma membrane of migrating cells. *Am. J. Physiol.* **294**, C1096-1102.

Hillebrand, U., Hausberg, M., Lang, D., **Stock, C.**, Riethmüller, C., Callies, C., Büsemaker, E. (2008). How steroid hormones act on the endothelium-insights by atomic force microscopy. *Eur. J. Physiol.* **456**, 51-60.

Stock, C., Cardone, R.A., Busco, G., Krähling, H., Schwab, A., Reshkin, S.J. (2008). Protons extruded by NHE1: Digestive or glue? *Eur. J. Cell Biol.* **87**, 591-599.

Schwab, A., Hanley, P., Fabian, A., **Stock, C.** (2008). Potassium channels keep mobile cells on the go. *Physiology* **23**, 212-220.

2007

Hillebrand, U., Schillers, H., Riethmüller, C., **Stock, C.**, Wilhelmi, M., Oberleithner, H. and Hausberg, M. (2007). Dose-dependent endothelial cell growth and stiffening by aldosterone: endothelial protection by eplerenone. *J. Hypertens.* **25**, 639-647.

Stock, C., Mueller, M., Kraehling, H., Mally, S., Noël, J., Eder, C., Schwab, A. (2007). pH nanoenvironment at the surface of single melanoma cells. *Cell. Physiol. Biochem.* **20**, 679-686.

Stüwe, L., Müller, M., Fabian, A., Waning, J., Mally, S., Noël, J., Schwab, A., **Stock, C.** (2007). pH dependence of melanoma cell migration: Protons extruded by NHE1 dominate protons of the bulk solution. *J. Physiol.* **585**, 351-360.

Schwab, A., Nechyporuk-Zloy, V., Fabian, A. and **Stock, C.** (2007). Cells move when ions and water flow. *Eur. J. Physiol.* **453**, 421-432.

2006

Schwab, A., Wulf, A., Schulz, C., Kessler, W., Nechyporuk-Zloy, V., Römer M., Reinhardt J., Weinhold, D., Dieterich, P., **Stock, C.**, and Hebert, S.C. (2006). Subcellular distribution of calcium-sensitive potassium channels (IK1) in migrating cells. *J. Cell. Physiol.* **206**, 86-94.

Hillebrand, U., Hausberg, M., **Stock, C.**, Shahin, V., Nikova, D., Riethmüller, C., Kliche, K., Ludwig, T., Schillers, H., Schneider, S.W., and Oberleithner H. (2006). 17 β -estradiol increases volume, apical surface and elasticity of human endothelium mediated by Na⁺/H⁺ exchange. *Cardiovasc. Res.* **69**, 916-924.

Oberleithner, H., Riethmüller, C., Ludwig, T., Shahin, V., **Stock, C.**, Schwab, A., Hausberg, M., Kusche, K., Schillers, H. (2006). Differential action of steroid hormones on human endothelium. *J. Cell Sci.* **119**, 1926-1932.

Nechyporuk-Zloy, V., **Stock, C.**, Schillers H., Oberleithner, H. and Schwab A. (2006). Single plasma membrane potassium channel detection by using dual-colour quantum dot labeling. *Am. J. Physiol.* **291**, C266-C269.

Kliche, K., Kuhn, M., Hillebrand, U., Ludwig, Y., **Stock, C.** and Oberleithner, H. (2006). Direct aldosterone action on mouse cardiomyocytes detected with atomic force microscopy. *Cell. Physiol. Biochem.* **18**, 265-274.

Stock, C., Schilling, T., Schwab, A., and Eder, C. (2006). Lysophosphatidylcholine stimulates IL-1 β release from microglia via a P2X₇ receptor-independent mechanism. *J. Immunol.* **177**, 8560-8568.

Stock, C. and Schwab, A. (2006). The role of the Na⁺/H⁺ exchanger NHE1 in cell migration. *Acta Physiol.* **187**, 149-157.

Stock, C. and Schwab, A. (2006). How ion channels and transporters affect metastasis. *PN (Physiology News, Quarterly Newsletter of the Physiological Society, UK)*, spring edition, number 62, 19-20.

2005

Shahin, V., Albermann, L., Schillers, H., Kastrup, L., Ludwig, Y., Schäfer, C., **Stock, C.**, Oberleithner, H. (2005). Steroids dilate nuclear pores imaged with atomic force microscopy. *J. Cell. Physiol* **202**, 591-601.

Dreval, V., Dieterich, P., **Stock, C.**, Schwab, A. (2005). The role of Ca²⁺ transport across the plasma membrane for cell migration. *Cell. Physiol. Biochem.* **16**, 119-126.

Stock, C., Gassner, B., Hauck, C.R., Arnold, H., Mally, S., Dieterich, P., and Schwab, A. (2005). Migration of human melanoma cells depends on extracellular pH and Na⁺/H⁺ exchange. *J. Physiol.* **567**, 225-238.

Schwab, A., Rossmann, H., Klein, M., Dieterich, P., Gassner, Neff, B.C., **Stock, C.**, and Seidler, U. (2005). Functional role of Na⁺-HCO₃⁻ cotransport in migration of transformed renal epithelial cells. *J. Physiol.* **568**, 445-458.

1997-2004

Schilling, T., **Stock, C.**, Schwab, A., and Eder, C. (2004). Functional importance of Ca²⁺-activated K⁺ channels for lysophosphatidic acid-induced microglial migration. *Eur. J. Neurosci.* **19**, 1469-1474.

Stock, C., Grønlien, H.K., Allen, R.D., and Naitoh, Y. (2002). Osmoregulation in *Paramecium*: in situ ion gradients permit water to cascade through the cytosol to the contractile vacuole. *J. Cell Sci.* **115**, 2339-2348.

Grønlien, H.K., **Stock, C.**, Aihara, M.S., Allen, R.D. and Naitoh, Y. (2002). Relationship between the membrane potential of the contractile vacuole complex and its osmoregulatory activity in *Paramecium multimicronucleatum*. *J. Exp. Biol.* **205**, 3261-3270.

Stock, C., Grønlien, H.K., and Allen, R.D. (2002). The ionic composition of the contractile vacuole fluid of *Paramecium* mirrors ion transport across the plasma membrane. *Eur. J. Cell Biol.* **81**, 505-512.

Stock, C., Allen, R. D., and Naitoh, Y. (2001). How external osmolarity affects the activity of the contractile vacuole complex, the cytosolic osmolarity and the water permeability of the plasma membrane in *Paramecium multimicronucleatum*. *J. Exp. Biol.* **204**, 291-304.

Stock, C., Krüppel, T., Key, G., and Lueken, W. (1999). Sexual behaviour in *Euplotes raikovi* is accompanied by pheromone-induced modifications of ionic currents. *J. Exp. Biol.* **202**, 475-483.

Stock, C., Krüppel, T., Lueken, W., and Key, G. (1998). Congruence of electrical properties in two Antarctic and two middle-latitude marine species of *Euplotes* (Ciliata, Hypotrichida). *Polar Biol* **20**, 127-133.

Stock, C., Krüppel, T., and Lueken, W. (1997). Kinesis in *Euplotes vannus* - ethological and electrophysiological characteristics of chemosensory behavior. *J. Euk. Microbiol.* **44**, 427-433.