

Toxicology Studies

The following articles have been authored or co-authored by 3M scientists:

PEER-REVIEWED PUBLICATIONS

- Chang, S. C., Thibodeaux, J. R., Eastvold, M. L., Ehresman, D. J., Bjork, J. A., Froehlich, J. W., Lau, C. S., Singh, R. J., Wallace, K. B., Butenhoff, J. L. (2007). Negative bias from analog methods used in the analysis of free thyroxine in rat serum containing perfluorooctanesulfonate (PFOS). *Toxicology* 234:21-33 (2007).
- Ehresman, D. J., Froelich, J. W., Olsen, G. W., Chang, S. C., and Butenhoff, J. L. (2007). Comparison of human whole blood, plasma, and serum matrices for the determination of perfluorooctanesulfonate (PFOS), perfluorooctanoate, and other fluorochemicals. *Environ. Res.* 103: 176-184.
- Andersen, M. E., Clewell, H. J., 3rd, Tan, Y. M., Butenhoff, J. L., and Olsen, G. W. (2006). Pharmacokinetic modeling of saturable, renal resorption of perfluoroalkylacids in monkeys-Probing the determinants of long plasma half-lives. *Toxicology* 227: 156-164.
- Hinderliter, P. M., Han, X., Kennedy, G. L., and Butenhoff, J. L. (2006). Age effect on perfluorooctanoate (PFOA) plasma concentration in post-weaning rats following oral gavage with ammonium perfluorooctanoate (APFO). *Toxicology* 225: 195-203.
- Xu, L., Krenitsky, D. M., Seacat, A. M., Butenhoff, J. L., Tephly, T. R., and Anders, M. W. (2006). N-glucuronidation of perfluorooctanesulfonamide by human, rat, dog, and monkey liver microsomes and by expressed rat and human UDP-glucuronosyltransferases. *Drug Metab. Dispos.* 34: 1406-1410.
- Butenhoff, J. L., Gaylor, D. W., Moore, J. A., Olsen, G. W., Rodricks, J., Mandel, J. H., and Zobel, L. R. (2005). Response to Letter to Editor. *Regul. Tox. Pharmacol.* 42:146-147.
- Hinderliter, P. M., Mylchreest, E., Gannon, S. A., Butenhoff, J. L., and Kennedy, G. L., Jr. (2005). Perfluorooctanoate: placental and lactational transport pharmacokinetics in rats. *Toxicology* 211:139-148.
- Luebker, D. J., Case, M. T., York, R.G., Moore, J. A., Hansen, K. J., and Butenhoff, J. L. (2005). Two-generation reproduction and cross-foster studies of perfluorooctanesulfonate (PFOS) in rats. *Toxicology* 215:126-148.
- Luebker, D. J., York, R.G., Hansen, K. J., Moore, J. A., and Butenhoff, J. L. (2005). Neonatal mortality from in utero exposure to perfluorooctanesulfonate (PFOS) in Sprague Dawley rats: Dose-response, and biochemical and pharmacokinetic parameters. *Toxicology* 215:149-169.

- Tanaka, S., Thibodeaux, J., Eastvold, M., Bjork, J., Ehresman, D., Singh, R., Wallace, K., Lau, C. and Butenhoff, J. (2005). Measurement of Thyroid Hormones in Rat Sera Containing Perfluorooctanesulfonate (PFOS). *Toxicol. Sci.* 84 (S-1):423.
- Butenhoff, J. L., Gaylor, D. W., Moore, J. A., Olsen, G. W., Rodricks, J., Mandel, J. H., and Zobel, L. R. (2004). Characterization of risk for general population exposure to perfluorooctanoate. *Regul. Tox. Pharmacol.* 39:363-380.
- Butenhoff, J. L., Kennedy, G. L., Frame, S. R., O'Connor, J. C., and York, R. G., (2004). The reproductive toxicity of ammonium perfluorooctanoate (APFO) in the rat. *Toxicology* 196:95-116.
- Butenhoff, J. L., Kennedy, G. L., Jr., Hinderliter, P. M., Lieder, P. H., Jung, R., Hansen, K. J., Gorman, G. S., Noker, P. E., and Thomford, P. J. (2004). Pharmacokinetics of perfluorooctanoate in cynomolgus monkeys. *Toxicol Sci.* 82:394-406.
- Kennedy, G. L., Jr., Butenhoff, J. L., Olsen, G. W., O'Connor, J. C., Seacat, A. M., Perkins, R. G., Biegel, L. B., and Murphy, S. R., and Farrar, D. G. (2004). The toxicology of perfluorooctanoate. *Crit. Rev. Toxicol.* 34:351-384.
- Lau, C., Butenhoff, J. L., Rogers, J. M. (2004). The developmental toxicity of perfluoroalkyl acids and their derivatives. *Toxicol. Appl. Pharmacol.* 198:231-241.
- Perkins, R. G., Butenhoff, J. L., Kennedy, G. L., Jr., and Palazzolo, M. J. (2004). 13-Week dietary toxicity study of ammonium perfluorooctanoate (APFO) in male rats. *Drug Chem. Toxicol.* 27:361-378.
- Shipley, J. M., Hurst, C. H., Tanaka, S., DeRoos, F. L., Butenhoff, J. L., Seacat, A. M., and Waxman, D. J. (2004). Trans-activation of PPAR α and induction of PPAR α target genes by perfluorooctane-based chemicals. *Toxicol. Sci.* 80:151-160.
- Xu, L., Krenitsky, D. M., Seacat, A. M., Butenhoff, J. L., and Anders, M. W. (2004). Biotransformation of N-ethyl-N-(2-hydroxyethyl)perfluorooctanesulfonamide by rat liver microsomes, cytosol, and slices and by expressed rat and human cytochromes P450. *Chem. Res. Toxicol.* 17:767-775.
- Butenhoff, J., Costa, G., Elcombe, C., Farrar, D., Hansen, K., Iwai, H., Jung, R., Kennedy, G., Jr., Lieder, P., Olsen, G., and Thomford, P. (2002). Toxicity of ammonium perfluorooctanoate in male cynomolgus monkeys after oral dosing for 6 months. *Toxicol. Sci.*, 69:244-257.
- Lau, C., Thibodeaux, J. R., Hanson, R. G., Rogers, J. M., Grey, B. E., Stanton, M. E., Butenhoff, J. L., and Stevenson, L. A. (2003). Exposure to perfluorooctane sulfonate during pregnancy in rat and mouse. II: Postnatal evaluation. *Toxicol. Sci.*, 74:382-392.
- Seacat, A. M., Thomford, P. J., Hansen, K. J., Clemen, L. A., Eldridge, S. R., Elcombe, C. R., and Butenhoff, J. L. (2003): Subchronic dietary toxicity of potassium perfluorooctanesulfonate in rats. *Toxicology*, 183:117-131. Erratum in *Toxicology* (2003) 192:263-264.

- Thibodeaux, J. R., Hanson, R. G., Rogers, J. M., Grey, B. E., Barbee, B. D., Richards, J. H., Butenhoff, J. L., Stevenson, L. A., and Lau, C. (2003). Exposure to perfluorooctane sulfonate during pregnancy in rat and mouse. I: Maternal and prenatal evaluations. *Toxicol. Sci.*, 74:369-381. Erratum in: *Toxicol. Sci.* (2004) 82:359.
- Luebker, D. J., Hansen, K. J., Bass, N. M., Butenhoff, J. L., and Seacat, A. M. (2002). Interactions of fluorochemicals with rat liver fatty acid-binding protein. *Toxicology*, 176:175-185.
- Seacat, A. M., Thomford, P. J., Hansen, K. J., Olsen, G. W., Case, M. T., and Butenhoff, J. L. (2002). Subchronic toxicity studies on perfluorooctanesulfonate potassium salt in cynomolgus monkeys. *Toxicol. Sci.*, 68:249-264.
- Griffith, F.D., and Long, J.E. (1980). Animal toxicity studies with ammonium perfluorooctanoate. *Am. Ind. Hyg. Assoc. J.*, 41:576-583.

SCIENTIFIC PRESENTATIONS (POSTERS AND PLATFORM) – PUBLISHED ABSTRACTS

- Chang, S., Hart, J. A., Ehresman, D. J., Das, K., Lau, C. S., Noker, P. E., Gorman, G. S., Tan, Y., and Butenhoff, J. L. (2007). Comparative Pharmacokinetics of Perfluorobutyrate (PFBA) in Rats, Mice, and Monkeys. *The Toxicologist* 96:194 (abstract 937).
- Das, K. P., Grey, B., Butenhoff, J., Tanaka, S., Ehresman, D., Zehr, D. and Lau, C. (2007). Effects of Perfluorobutyrate Exposure in Mice During Pregnancy. *The Toxicologist* 96:313 (abstract 1514).
- Ehresman, D. J., Chang, S., Bjork, J. A., Hart, J. A., Lieder, P. H., Wallace, K. B., and Butenhoff, J. L. (2007). Increased Acyl Coa Oxidase Activity in Rats After Five Consecutive Daily Doses of Perfluorobutanesulfonate, Perfluorohexanesulfonate, and Perfluorooctanesulfonate. *The Toxicologist* 96:179 (abstract 865).
- Gordon, S. C., Schurch, S., Amrein, M. and Schoel, M. (2007). Effects of Perfluorinated Acids on Pulmonary Surfactant Properties *In Vitro*. *The Toxicologist* 96:91 (abstract 437).
- Lieder, P.H., Chang, S., Ehresman, D. J., Roy, R. R., van Otterdijk, F. M., and Butenhoff, J. L. (2007). Twenty-Eight-Day Oral Toxicity Study of Perfluorobutyrate in Rats. *The Toxicologist* 96:193 (abstract 931).
- Tan, Y., Clewell, H., Butenhoff, J., Olsen, G., and Andersen, M. (2007). Physiologically-Motivated Pharmacokinetic Modeling of Saturable, Renal Resorption of Perfluoroalkylacids in Monkeys and Rats. *The Toxicologist* 96:81 (abstract 386).
- Butenhoff, J. L., and Lieder, P. H. (2006). A two-generation reproduction study with perfluorobutanesulfonate in rats. *The Toxicologist* 90.

- Lau, C., Thibodeaux, J., Das, K. P., Ehresman, D., Tanaka, S., Froehlich, J., and Butenhoff, J. L. (2006). Evaluation of perfluorooctane sulfonate in the rat brain. *The Toxicologist* 90.
- Lieder, P., and Butenhoff, J. L. (2006). Ninety-Day oral gavage toxicity study of perfluorobutanesulfonate (PFBS) in rats. *The Toxicologist* 90.
- Olsen, G. W., Lieder, P., Noker, P., Gorman, G., and Butenhoff, J. L. (2006). The pharmacokinetics of perfluorobutanesulfonate (PFBS) in monkeys and humans. *The Toxicologist* 90.
- Tanaka, S., Eastvold, M., Foshay, E., Hart, J., and Butenhoff, J. L. (2006). Effects of perfluorooctanesulfonate on 125I elimination in rats after a single intravenous dose of 125I-labeled thyroxine. *The Toxicologist* 90.
- Bjork, J. A., Berthiaume, J. M., Lau, C., Butenhoff, J. L., Wallace, K. B. (2005). Hepatic gene expression profiles of rats exposed to perfluorooctanesulfonate (PFOS) in utero. *Toxicol. Sci.* 84 (S-1):389-390.
- Butenhoff, J., Eastvold, M., Bjork, J., Ehresman, D., Singh, R., Wallace, K., and Tanaka, S. (2005). Thyroid Hormone Status in Adult Rats After an Oral Dose of Perfluorooctanesulfonate (PFOS). *Toxicol. Sci.* 84 (S-1):354-355.
- Ehresman, D., Olsen, G., Burris, J., Froehlich, J., Seacat, A., Butenhoff, J. (2005). Evaluation of the half-life (T_{1/2}) of elimination of perfluorooctanoate (PFOA) from human serum. *Toxicol. Sci.* 84 (S-1):253.
- Ehresman, D., Olsen, G., Tanaka, S., Butenhoff, J. and Froehlich, J. (2005). A Comparison of Whole Blood, Plasma and Serum Evaluations for the Determination of PFOA, PFOS, and PFHS In Human Subjects. FLUOROS, University of Toronto, ANA037.
- Ehresman, D., Olsen, G. W., Burris, J. M., Froehlich, J., Seacat, A. M., and Butenhoff, J. L. (2005). Evaluation of the half-life (T_{1/2}) of elimination of perfluorooctanoate (PFOA) from human serum. *The Toxicologist* 84.
- Frame, S. R., Butenhoff, J. L., Kennedy, G. L. and Hardisty, J. F. (2005). Pathology Working Group Review Of Mammary Glands From Chronic Feeding Study In Rats With APFO. FLUOROS, University of Toronto, TOX021.
- Lau, C., Thibodeaux, J., Ehresman, D., Tanaka, S., Froehlich, J. and Butenhoff, J. (2005). Evaluation of Perfluorooctane Sulfonate (PFOS) in the rat brain. FLUOROS, University of Toronto, TOX020.
- Olsen, G., Ehresman, D., Froehlich, J., Burris, J. and Butenhoff, J. (2005). Evaluation of the half-life (T_{1/2}) of elimination of perfluorooctanesulfonate (PFOS), Perfluorohexanesulfonate (PFHS) and perfluorooctanoate (PFOA) from human serum. FLUOROS, University of Toronto, TOX017.
- Tanaka, S., Thibodeaux, J., Eastvold, M., Singh, R., Lau, C. and Butenhoff, J. (2005). Thyroid hormone status in adult rats given oral doses of perfluorooctanesulfonate. FLUOROS, University of Toronto, TOX018.

- Xu, F., Seacat, A. M., Butenhoff, J. L., and Anders, M. W. (2004a). N-Dealkylation of N-ethyl-N-(2-hydroxyethyl) perfluorooctanesulfonamide (N-ETFOSE) by rat liver microsomes and by expressed rat and human cytochromes P450 (CYPS). *The Toxicologist* 78.
- Butenhoff, J. L., Kennedy, G. L., Jr., O'Connor, J. C., and York, R. G. (2003). Multi-generation reproduction study of ammonium perfluorooctanoate in rats (abstract). *Toxicol. Sci.*, 72 (S-1):76.
- Gaylor, G. W., Moore, J. A., and Butenhoff, J. L. (2003). The concept of benchmark internal concentration (BMIC) in risk assessment (abstract). *Toxicol. Sci.*, 72 (S-1):140-141.
- Kuklennyik, Z., Reich, J. A., Needham, L. L., Calafat, A. M., and Butenhoff, J. L. (2003). Quantitative detection in serum and breast milk of perfluorochemical surfactants. 13th Annual Conference of the International Society of Exposure Analysis, Stresa, Italy, Abstract WS-11-01.
- Thibodeaux, J., Hanson, R. G., Grey, B. E., Barbee, B. D., Richards, J. H., Butenhoff, J. L., Rogers, J. M., and Lau, C. (2003). Maternal and developmental toxicity of perfluorooctane sulfonate (PFOS) in the mouse (abstract). *Toxicol. Sci.*, 72 (S-1):342.
- Xu, L., Seacat, A. M., Butenhoff, J. L., and Anders, M. W. (2003). Biotransformation of N-Ethyl-N-(2-hydroxyethyl)perfluorooctanesulfonamide (N-EtFOSE) by rat liver microsomes, cytosol, and slices (abstract). *Toxicol. Sci.*, 72 (S-1):314.
- Butenhoff, J. L., York, R., Seacat, A. M., and Luebker, D. J. (2002). Perfluorooctanesulfonate-induced perinatal mortality in rat pups is associated with a steep dose-response (abstract). *Toxicol. Sci.*, 66 (S-1), 25.
- Lau, C., Rogers, J. M., Thibodeaux, J. R., Hanson, R. G., Grey, B. E., Barbee, B. D., Richards, J. H., and Butenhoff, J. L. (2002). Maternal and developmental toxicity of perfluorooctane sulfonate (PFOS) in the rat (abstract). *Toxicol. Sci.*, 66 (S-1), 25.
- Luebker, D. J., York, R., Seacat, A. M., and Butenhoff, J. L. (2002). Perfluorooctanesulfonate-induced perinatal mortality in rat pups is not a result of reduced serum lipids (abstract). *Toxicol. Sci.*, 66 (S-1), 26.
- Roy, R., Olsen, G. W., Lieder, P. H., Mandel, J., and Butenhoff, J. L. (2002). A biological limit value for occupational exposure to perfluorooctanoate (abstract). *Toxicol. Sci.*, 66 (S-1), 284.
- Seacat, A. M., Thomford, P. J., and Butenhoff, J. L. (2002). Terminal observations in Sprague Dawley rats after lifetime dietary exposure to potassium perfluorooctanesulfonate (abstract). *Toxicol. Sci.*, 66 (S-1), 185.
- Thomford, P. J., Seacat, A. M., and Butenhoff, J. L. (2002). Terminal observations in Sprague Dawley rats after lifetime dietary exposure to N-ethyl perfluorooctanesulfonamido ethanol (abstract). *Toxicol. Sci.*, 66 (S-1), 185-186.

- Lieder, P., Butenhoff, J., Costa, G., Elcombe, C., Farrar, D., Hansen, K., Iwai, H., Jung, R., Kennedy, G., Jr., Olsen, G., and Thomford, P. (2001). Toxicity of ammonium perfluorooctanoate (APFO) in cynomolgus monkeys after 26 weeks of oral dosing. (abstract). *Toxicol. Sci.*, 60 (S-1), 348.
- Seacat, A. M., Butenhoff, J. L., Hansen, K. J., Olsen, G. W., and Thomford, P. J. (2001). Toxicity of potassium perfluorooctanesulfonate in cynomolgus monkeys after twenty-six weeks of oral dosing and one year of recovery (abstract). *Toxicol. Sci.*, 60 (S-1), 348.
- Starkov, A., Butenhoff, J. L., Seacat, A. M., and Wallace, K. B. (2001). Structural determinants of mitochondrial dysfunction caused by *in vitro* exposure to selected perfluorooctanyl compounds. *Toxicol. Sci.*, 60 (S-1), 348-349.
- Butenhoff, J. L. and Seacat, A. M. (2001). Comparative sub-chronic toxicity of perfluorooctane sulfonate (PFOS) and N-ethyl perfluorooctane-sulfonamidoethanol (N-EtFOSE) in the rat (abstract). *Toxicol. Sci.*, 60 (S-1), 348.
- Case, M. C., York, R., and Butenhoff, J. L. (2001). Oral (gavage) cross-fostering study of potassium perfluorooctanesulfonate (PFOS) in rats (abstract). *Toxicol. Sci.*, 60 (S-1), 221-222.
- Butenhoff, J. L. and Luebker, D. J. (2001). Use of toxicokinetic data to assess risk to wildlife from exposure to perfluorooctanesulfonate. Society of Environmental Toxicology and Chemistry, Annual Meeting, Presentation 56, Baltimore, Maryland, November 13, 2001.
- Luebker, D. J., Hansen, K. J., Clemen, L. A., Butenhoff, J. L., and Case, M. T. (2001). Background perfluorooctanesulfonate in experimental rats (abstract). *Toxicol. Sci.*, 60 (S-1), 232.
- Wallace, K. B., Luebker, D. J., Butenhoff, J. L., and Seacat, A. M. (2001). Perfluorooctane sulfonate and 2-(N-ethylperfluorooctanesulfonamido)-ethyl alcohol are peroxisome proliferators in rats, but not guinea pigs (abstract). *Toxicol. Sci.*, 60 (S-1), 348.
- Nabbefeld, D., Butenhoff, J., Bass, N., and Seacat, A. (1998). Displacement of a fluorescently labeled fatty acid analog from fatty acid carrier proteins by Wyeth-14,643, ammonium perfluorooctanoate, potassium perfluorooctane sulfonate and other known peroxisome proliferators. *Toxicol. Sci.*, 42 (S-1), 395-396.

INVITED PRESENTATIONS – JOHN L. BUTENHOFF

- Perfluorooctanesulfonate and Perfluorooctanoate: Does Presence Equal Harm?
Symposium on Biomonitoring and Risk Assessment, American College of Toxicology, November 7, 2006. Palm Springs, California.
- Perfluorooctanesulfonate and Perfluorooctanoate: Does Presence Equal Harm?
Seminar, Institutet Miljomedicine, Karolinska Institute, November 23, 2006, Stockholm, Sweden.

Perfluorooctane Sulfonate and Perfluorooctanoate: Toxicology, Human Health, and Risk. Fachgespräch Perfluorierte Verbindungen in Lebensmitteln und Muttermilch, November 27, 2006. Bundesinstitut für Riskobewertung (BfR), Berlin, Germany.

The descriptive toxicology of perfluorooctanesulfonate and perfluorooctanoate. FLUOROS International Symposium on Fluorinated Alkyl Organics in the Environment, University of Toronto, Toronto, Ont., Canada, August 20, 2005.

Influence of PFOS on thyroid hormones and thyroid hormone status in rats. Thyroid Hormone Seminar, Northland SOT, EPA ORD, Duluth, MN September 30, 2005.

Perfluorinated alkyl acids in the environment: challenges to risk characterization. University of Kansas, Department of Pharmacology, Toxicology, and Therapeutics, Kansas City, KS, April 5, 2005.

The toxicology of perfluorooctanesulfonate. PERFORCE Summer School, University of Antwerp, June 28, 2005.

Perfluorooctanesulfonate (PFOS): biomonitoring case study. Biomonitoring Seminar, Toxicology Forum, Aspen Colorado, July 14, 2005.

Perfluorinated alkyl acids in blood: challenges to risk characterization. Calculation to Communication, University of Michigan Center for Risk Science and Communication, Ann Arbor, MI, September 16, 2005.

The use of population bio-monitoring exposure data in the human-health risk assessment of perfluorooctane sulfonate. 13th Annual Conference of the International Society of Exposure Analysis, Stresa, Italy, Abstract WS-11-06.

ILSI/HESI Workshop on the Use of Biomonitoring Data in the Risk Assessment Process, NIEHS, RTP, NC, September 21.

Response to perfluorooctanoate: role of differential expression of organic anion transporters – sex and species differences in response. Use of Genomics in Risk Assessment. National Academy of Sciences, NRC, Washington, DC, August 12, 2004.

OTHER

- Co-chair (with John A. Moore, D.V.M.) of 2002 Society of Toxicology Annual Meeting Symposium "Perfluorooctanesulfonate: Risk characterization of a persistent and pervasive fluorochemical." Nashville, Tennessee, March 19, 2002.
- Co-chair (with Dr. Antonia Calafat, U. S. Center for Disease Control), workshop on use of bio-monitoring data in the risk assessment of perfluorooctane sulfonate at the 2003 meeting of the International Society for Exposure Analysis, Stresa, Italy.
- Member of Planning Committee for OECD-sponsored workshop on perfluorinated alkyl acids and their derivatives in the environment, November 20-22, 2006, Stockholm, Sweden.

- Co-Chair (with Christopher S. Lau, Ph.D., USEPA) of Organizing Committee for SOT Contemporary Concepts in Toxicology meeting entitled, “Perfluoroalkyl Acids and Related Chemistries: Toxicokinetics and Modes of Action,” held February 14-16, 2007, Arlington, Virginia.

7/06/07