



**Exponent**<sup>®</sup>  
Engineering & Scientific Consulting

## Marc W. Mittelman, Ph.D.

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### Professional Profile

Dr. Mittelman has over 30 years' experience in academia, industry, and consulting. The majority of his research and consulting work has been in the area of microbiological contamination detection and mitigation for pharmaceutical/biotechnology, clinical, and industrial applications.

Dr. Mittelman has developed test systems and analytical methods for monitoring biofilm development on engineered materials, and has conducted a number of studies on the contamination of critical components from the International Space Station for NASA. He provides consulting services in the fields of biological fouling (biofouling), microbially influenced corrosion (MIC), purified/drinking water system contamination control, medical device-related infections, and antimicrobial coatings development. Dr. Mittelman has conducted contamination control investigations for industrial and biopharmaceutical applications, focusing on process- and product-compatible solutions. He has designed preventative and remedial strategies for controlling microbiological contamination in products and process operations ranging from high purity water systems to marine structures. He has also provided new product development support to large and small medical device companies, with a focus on biofilm prevention and infection control strategies.

Dr. Mittelman was previously an Associate Professor in the Faculties of Medicine and Dentistry, and director of the Centre for Infection and Biomaterials Research (CIBR), at the University of Toronto. He has also worked as a microbiologist in the pharmaceutical industry, directed microbiology and medical device engineering consulting practices, and has served as an expert witness in several legal cases. Dr. Mittelman was co-chair of the Bioburden Task Force Committee for the Parenteral Drug Association. Dr. Mittelman is the author of over 80 scientific papers and books, and has lectured extensively on microbiological contamination control. In addition to his consulting work at Exponent, he is a visiting scientist at Harvard University, School of Engineering and Applied Sciences.

### Academic Credentials & Professional Honors

Ph.D., Life Sciences (Environmental Toxicology), University of Tennessee, Knoxville, 1991

M.S., Microbiology, California State University, Long Beach, 1983

B.S., Microbiology, California State University, Long Beach, 1979

Post-doctoral Research Associate (ONR Fellowship), Oak Ridge National Laboratories/University of Tennessee, 1991-1992

U.S. Coast Guard: OUPV 100 tons, inland waters, mariner credential no. 000148812

## Licenses and Certifications

U.S. Coast Guard: OUPV 100 tons, inland waters, mariner credential no. 000148812

## Academic Appointments

Visiting Scientist, Harvard University School of Engineering and Applied Sciences, 2008-

Professor, Bristol Community College, 2008-2009

Associate Professor, Faculty of Medicine, University of Toronto, 1998-1999

Assistant Professor, Departments of Surgery & Microbiology, Faculty of Medicine, University of Toronto, 1992-1998

Director, Centre for Infection & Biomaterials Research, University of Toronto, Toronto, Ontario, 1992-1998

Member, Centre for Biomaterials, University of Toronto, 1993-1998

Member, Materials Institute, University of Toronto, 1994-1998

Consultant, Hospital for Sick Children Research Institute, Toronto, Ontario, 1994-1998

Member, Graduate Faculty, School of Dentistry, University of Toronto, 1995-1998

## Prior Experience

Principal, Mittelman and Associates, 2002-2009

Director, Biomaterials Development, Altran Corporation, 1998-2002

Associate Professor, University of Toronto, 1998-1999

Assistant Professor, University of Toronto, 1992-1998

President and Founder, Water Micro Associates, 1986-1988

President and Founder, Applied Microbiological Services, Inc., 1982-1986

Process Development Microbiologist, Riker 3M Pharmaceuticals, 1979-1982

Chemistry Technician, Los Angeles County Sanitation Districts, 1977-1979

## Professional Affiliations

American Society for Microbiology

Parenteral Drug Association

## Patents

United States Patent No. 7,190,457: Real-time biofilm monitoring system, 2007 (with M.E. Tabacco and J.A. Schanzie).

United States Patent No. 5,798,115: Bioresponsive, pharmacologically-active co-polymers for the delivery of compounds at a site exhibiting an inflammatory response or an equivalent response with respect to enzymatic activity, 1998 (with J.P. Santerre).

United States Patent No. 5,059,527: Detection of endotoxins of Gram negative bacteria, 1991 (with D.C. White).

## Publications

Mittelman MW and Steffey D. Comments on duodenoscope reprocessing study. *Gastrointest Endosc* 2019; 89(2):442-443.

Mittelman MW, Jones A. A pure life: the microbial ecology of high purity industrial waters. *Microb Ecol* 2016; 71(2):257-266.

Guezennec J, Herry JM, Bachere E, Mittelman MW, Fontaine MNB. Exopolysaccharides from unusual marine environments inhibit early stages of biofouling. *Int Biodeterior Biodegrad* 2012; 66(1):1-7.

Roman MC, Mittelman MW. Microbiological tests performed during the design of the international space station environmental control and life support systems. Part 1, Bulk phase and wastewater. *NASA Sci Tech Aerospace Rep* 2010; 48:1-15.

Meltzer TH, Livingston RC, Madsen RE, Jornitz MW, Johnson RM, Mittelman MW. Reverse osmosis as a means of water for injection production: a response to the EMEA's position. *PDA J Pharm Sci Technol* 2009; 63:1-7.

Haag AP, Geesey GG, Mittelman MW. Bacterially derived wood adhesive. *Int J Adhes Adhes* 2006; 26:177-183.

Mittelman MW. An updated look at stent encrustation and biofilm formation. *J Endourology* 2003; 17:18-21.

Fung LC, Mittelman MW, Thorner PS, Khoury AE. A novel rabbit model for the evaluation of biomaterial associated urinary tract infection. *Can J Urol* 2003; 10:2007-2012.

Meltzer TH, Collentro WV, Zocolante GV, Jornitz MW, Mittelman MW. In defense of filters in pharmaceutical water systems. *PDA J Pharm Sci Technol* 2002; 56:130-136.

Shah CB, Mittelman MW, Costerton JW, Parenteau S, Pelak M, Arsenault R, Mermel LA. Antimicrobial activity of a novel catheter-lock solution. *J Antimicrob Ag Chemother* 2002; 46:1674-1679.

Mittelman MW, Kawamura K, Jornitz MW, Meltzer TH. Filter validation: Bacterial hydrophobicity, adsorptive sequestration and cell size alteration. *PDA J Pharm Sci Technol* 2001; 55:422-428.

Mittelman MW. Microbially influenced corrosion of sprinkler piping. *PM Engineer* 2001; 7:46-52.

Woo G, Yang ML, Yin HQ, Jaffer F, Mittelman MW, Santerre JP. Biological characterization of a novel biodegradable antimicrobial polymer synthesized with fluoroquinolones. *J Biomed Mat Res* 2001; 59:35-45.

Sodhi RNS, Sahi VP, Mittelman MW. Application of electron spectroscopy and surface modification techniques in the development of anti-microbial coatings for medical devices. *J Electron Spectrosc Relat Phenom* 2001; 121:249-264.

Roman MC, Van der Schijff O, Macuch P, Mittelman MW. Preliminary assessment of microbial adhesion

on the surface of materials from the ISS internal thermal control system: Results of an accelerated 60-d study. *Soc Automotive Eng J* 2001; 2337:1-11.

Woo GL, Mittelman MW, Santerre J. Synthesis and characterization of novel biodegradable antimicrobial polymers. *Biomaterials* 2000; 21:1235-1246.

DiTizzio V, Karlgard C, Lilge L, Khoury AE, Mittelman MW, DiCosmo F. Localized drug delivery using crosslinked gelatin gels containing liposomes: Factors influencing liposome stability and drug release. *J Biomed Mater Res* 2000; 51:96-106.

Pugach JL, DiTizio V, Mittelman MW, Bruce AW, DiCosmo F, Khoury. Antibiotic hydrogel coated Foley catheters for prevention of urinary tract infection in a rabbit model. *J Urol* 1999; 162:883-887.

Mittelman MW. Recovery and characterization of biofilm bacteria associated with medical devices. *Meth Enzymol* 1999; 310:534-551.

Reid G, Soboh F, Bruce AW, Mittelman MW. Effect of nutrient composition on the in vitro growth of urogenital lactobacilli and uropathogens. *Can J Microbiol* 1998; 44:866-871.

Mittelman MW, Jornitz MW, Meltzer TH. Surrogate solution attributes and use conditions: Effects on bacterial cell size and surface charges relevant to filter validation studies. *PDA J Pharm Sci Technol* 1998; 52:37-42.

Mittelman MW. Bacterial biofilm structure-function relationships. *J Dairy Sci* 1998; 81:2760-2764.

Shek PN, Tikuisis P, Zamecnik J, Soltes S, Mustard RA, Mittelman MW. Distribution of free and liposomal cefoxitin in plasma and peritoneal fluid in a porcine intra-abdominal sepsis model. *J Drug Targeting* 1998; 5:353-364.

DiTizio V, Ferguson GW, Mittelman MW, Khoury AE, Bruce AW, DiCosmo F. A liposomal hydrogel for the prevention of bacterial adhesion to catheters. *Biomaterials* 1998; 19:1877-1884.

Suci PA, Vransy JD, Mittelman MW. Investigation of interactions between antimicrobial agents and bacterial biofilms using attenuated total reflection Fourier transform infrared spectroscopy. *Biomaterials* 1998; 19: 327-339.

Khoury AE, Pugach JL, DiTizio V, Mittelman MW, Bruce AW, DiCosmo F. Antibiotic hydrogel-coated Foley catheters for prevention of urinary tract infections. *Pediatrics* 1998; 102:844-845.

Ackerley CA, Tilups A, Khoury AE, Becker LE, Mittelman MW. Changes in the elemental composition of bladder mucus in stone and non-stone forming patients following augmentation cystoplasty. *J Microsc Microanal* 1997; 3:71-72.

Heritz DM, Lacroix JM, Batra SD, Jarvi KA, Beheshti B, Mittelman MW. Detection of eubacteria in interstitial cystitis by 16S rDNA amplification. *J Urol* 1997; 158:2291-2295.

Khoury AE, Salomon M, Doche R, Jayanthi R, Soboh F, McLorie GA, Mittelman MW. Stone formation following augmentation cystoplasty: The role of urinary components. *J Urol* 1997; 158:1133-1137.

Mittelman MW, Habash M, Lacroix JM, Khoury AE, Krajden M. Rapid detection of Enterobacteriaceae in urine by fluorescent 16S rRNA in situ hybridization on membrane filters. *J Microbiol Meth* 1997; 30:153-160.

Wright TL, Ellen RP, Lacroix JM, Sinnadurai S, Mittelman MW. Effects of metronidazole on *Porphyromonas gingivalis* biofilms. *J Periodont Res* 1997 32:473-477.

Davidson D, Beheshti B, Mittelman MW. Effects of *Arthrobacter* sp., *Acidovorax delafieldii*, and *Bacillus megaterium* colonisation on copper solvency in a laboratory reactor. *Biofouling* 1996; 9:279-292.

Fung HC, Khoury AE, Oreopoulos D, Vas S, Mittelman MW. Biocompatibility of silver-coated peritoneal dialysis catheters in a porcine model. *Peritoneal Dial Int* 1996; 16:380-388.

Jarvi K, Heritz DM, Mittelman MW, Bruce AW. Cryptic bacteria in IC and nonbacterial prostatitis? *Contemp Urol* 1996; 8:53-56.

Jarvi K, Lacroix JM, Jain A, Dimitro I, Heritz D, Mittelman MW. PCR based detection of bacteria in semen of infertile men. *Fertil Steril* 1996; 66:463-467.

Khoury AE, Salomon M, Jayanthi R, Ackerley C, McLorie GA, Mittelman MW. The role of intestinal mucous in lithogenesis following augmentation cystoplasty. *Pediatrics* 1996; 98:78.

Saloman MM Jayanthi R, Doche R, Mittelman MW, McLorie GA, Khoury AE. Stone formation following augmentation cystoplasty: The role of urinary constituents. *Pediatrics* 1996; 98:78.

Lacroix JM, Jarvi K, Batra SD, Heritz DM, Mittelman MW. PCR-based technique for the detection of bacteria in semen and urine. *J Microbiol Meth* 1996; 26:61-71.

Soltes S, Mustard RA, Shek PN, Soric I, Bohnen J, Mittelman MW. Liposomal cefoxitin in a porcine model of intra-abdominal sepsis: Hemodynamic changes. *Shock* 1996; 6:43-49.

Landau EH, Khoury AE, Thorner PS, Mittelman MW, Steckler RE, McLorie GA, Jayanthi R, Churchill BM. Histologic studies of intravesical oxybutynin in the rabbit. *J Urol* 1995; 153:2022-2024.

Reid G, Busscher HJ, Sharma S, Mittelman MW, McIntyre S. Utilization of surface science techniques to examine biomedical device-related problems. *Surf Sci Rep* 1995; 7:251-274.

Soboh F, Zamboni AC, Davidson D, Khoury AE, Mittelman MW. Interaction of *Pseudomonas aeruginosa* biofilm with ciprofloxacin and protamine sulfate. *Antimicrob Ag Chemother* 1995; 39:1281-1286.

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Kohring LL, Ringelberg DB, Devereux R, Stahl DA, Mittelman MW, White DC. Comparison of phylogenetic relationships based on phospholipid fatty acid profiles and ribosomal RNA sequence similarities among dissimilatory sulfate-reducing bacteria. *FEMS Microb Ecol* 1994; 119:303-308.

Suci PA, Mittelman MW, Yu FP, Geesey GG. Investigation of ciprofloxacin penetration into *Pseudomonas aeruginosa* biofilms. *Antimicrob Agents Chemother* 1994; 38:2125-2133.

Angell P, Arrage AA, Mittelman MW, White DC. On-line, non-destructive biomass determination of bacterial biofilms by fluorometry. *J Microbiol Meth* 1993; 18:317-327.

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Luo JS, Campaignolle X, Bullen J, Mittelman MW, White DC. Influence of molybdate concentration on microbiologically influenced corrosion of mild steel. *Corrosion* 1992.

Mittelman MW, King HC, Sayler GS, White DC. On-line detection of bacterial adhesion in a shear gradient

with bioluminescence by a *Pseudomonas fluorescens* (lux) strain. *J Microbiol Meth* 1992; 15:53-60.

Mittelman MW, Kohring LL, White DC. Multipurpose laminar-flow adhesion cells for the study of bacterial colonization and biofilm formation. *Biofouling* 1992; 6:39-51.

Crane GA, Mittelman MW, Stephen M. Total organic carbon measurement as a substitute for the U.S.P. oxidizable substances test. *J Parenteral Sci Technol* 1991; 45:20-28.

Guezennec J, Mittelman MW. From biofouling to biocorrosion. *Biofutur* 1991; 106:42.

Franklin MJ, Nivens DE, Vass AA, Mittelman MW, Jack RF, Dowling NJE, White DC. Effect of chlorine and chlorine/bromine biocide treatments on the number and activity of biofilm bacteria and on carbon steel corrosion. *Corrosion* 1990; 47:128-134.

Mittelman MW, Nivens DE, Low C, White DC. Differential adhesion, activity, and carbohydrate: Protein ratios of *Pseudomonas atlantica* monocultures attaching to stainless steel in a linear shear gradient. *Microb Ecol* 1990; 19:269-278.

Mittelman MW, Bruen R. Rapid enumeration of bacteria in electronics-grade purified water systems by direct-count epifluorescence microscopy. *ASTM F1095-88*, 1988.

Geesey GG, Mittelman MW, Lieu VT. Evaluation of slime-producing bacteria in oilfield core experiments. *Appl Environ Microbiol* 1987; 53:278-283.

Mittelman MW, Islander R, Platt RM. Biofilm formation in a closed-loop purified water system. *Med Device Diagn Ind* 1987; 10:50-55, 75.

Mittelman MW. Biological fouling of purified water systems: part III, treatment. *Microcontamination* 1986; 4:30-40, 70.

Mittelman MW. Trends in the detection and control of biological fouling in purified water systems. *Ultrapure Wat* 1986; 3(6):22-23.

Geesey GG, Mittelman MW, Iwaoka T, Griffiths PR. Role of bacterial exopolymers in the deterioration of metallic copper surfaces. *Mater Perform* 1986; 25:37-40.

Mittelman MW. Bacteria and TOC monitoring. *Ultrapure Wat* 1986; 2:51-52.

Mittelman MW. Biological fouling of purified water systems: Part I: Bacterial growth and replication. *Microcontamination* 1985; 3:51-55.

Mittelman MW. The need for acceptance specifications for high-purity water. *Microcontamination* 1985; 3:30-35.

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Mittelman MW, Geesey GG. Copper-binding characteristics of exopolymers from a freshwater-sediment bacterium. *Appl Environ Microbiol* 1985; 49:846-851.

Mittelman MW, Geesey GG, Platt RM. Rapid enumeration of bacteria in purified water systems. *Med Dev Diagn Ind* 1985; 7:144-149.

Mittelman MW, Geesey GG, Hite R. Epifluorescence microscopy: A rapid method for enumerating bacteria in ultrapure water systems. *Microcontamination* 1983; 1:32-37.

### **Book Chapters**

Mittelman MW. Bacterial biofilms in pharmaceutical water systems. pp 581-601. In: *Filtration and Purification in the Biopharmaceutical Industry*, 3rd ed. Jornitz M (ed.) Informa Healthcare, New York. 2019.

Mittelman MW. The importance of microbial biofilms in the deterioration of heritage materials. pp. 3-15. In: *Biodeterioration and preservation in art, archaeology and architecture*. Mitchell R and Clifford J (eds.) Archetype, London. 2018.

Mittelman MW, Mukherjee N. Antimicrobial coatings and other surface modifications for infection prevention. pp.29-74. In: *Biomedical Coatings Handbook*. Glocker D and Renade S. (eds.). Scrivener, Beverly, MA, 2016.

Mukherjee N, Mittelman MW. Antimicrobial coatings efficacy evaluation. pp. 583-604. In: *Biomedical Coatings Handbook*. Glocker D and Renade S. (eds.). Scrivener, Beverly, MA, 2016.

Mittelman MW. Bacterial biofilms in pharmaceutical water systems. pp. 699-715. In: *Filtration and Purification in the Biopharmaceutical Industry*. Meltzer TH and Jornitz MW (eds), Taylor and Francis, London, 2008.

Haberer K, Mittelman MW. Growth and recovery of microorganisms from pharmaceutical manufacturing environments. pp. 19-40. In: *Rapid Microbiological Methods in Pharmaceutical Industry*. Easter MC (ed), Interpharm Press, Buffalo Grove, IL, 2003.

Mittelman MW, Macuch P, Van der Schijff O. Genesis and control of MIC in wet and dry type fire protection systems. pp. 21-31. In: *MIC Research Technical Symposium*. B. Little., NACE International, Houston, TX, 2002.

Mittelman MW. Bacterial biofilms and biofouling: translational research in marine biotechnology. pp. 3-7. In: *Environmental applications of Marine Biotechnology*. National Academy of Sciences Press, Washington, DC, 2000.

Jarvi K and Mittelman MW. Prostatitis and infertility. pp. 234-240. In: *Textbook of Prostatitis*. Nickel JC (ed), Isis Medical, Oxford, 1999.

Mittelman MW. Bacterial biofilms in pharmaceutical water systems. pp. 245-258. In: *Filtration in the Biopharmaceutical Industry*. Meltzer TH and Jornitz M (eds), Marcel Dekker, New York, 1998.

Mittelman MW. Laboratory studies of bacterial biofilms. pp. 337-353. In: *Techniques in Microbial Ecology*. Burlage R (ed), Oxford University Press, London, 1998.

Mittelman MW. Adhesion to biomaterials. pp. 89-127. In: *The Molecular and Ecological Diversity of Bacterial Adhesion*. Fletcher M(ed), Wiley, New York, 1997.

Mittelman MW. Biofilm development in purified water systems. pp. 133-147. In: *Microbial Biofilms*. Lappin-Scott HL, and Costerton JW, Cambridge Univ. Press London, 1995.

Mittelman MW. Emerging techniques for the evaluation of bacterial biofilm formation and metabolic activity in marine and freshwater environments. pp. 49-56. In: *Recent Developments in the Control of Biodeterioration*. Morse D (ed), Oxford Univ. Press, London, 1994.

Dowling NJE, Mittelman MW, White DC. The role of consortia in microbially influenced corrosion. pp. 341-372. In: Mixed Cultures in biotechnology. Zeikus G and Johnson EA (eds), McGraw-Hill, New York, 1991.

Mittelman MW. Bacterial growth and biofouling control in purified water systems. pp. 133-154. In: Biofouling and Biocorrosion in Industrial Water Systems. Flemming HG and Geesey GG (eds), Springer-Verlag, Berlin, 1991.

Mittelman MW, White DC. The role of biofilms in contamination of process fluids by biological particulates. Vol. 2, pp. 33-50. In: Particles in Gases and Liquids. Mittal KL (ed), Plenum Press, New York, 1990.

White DC, Nivens DE, Mittelman MW. The application of novel approaches for characterizing organic acids from aqueous matrices focusing biological systems on environmental problems. pp. 25-42. In: Organic Acids in Aquatic Ecosystems. Perdue EM and Gjessing ET (eds), John Wiley & Sons, New York, 1990.

Mittelman MW. Biological fouling of purified water systems. In: Biological Fouling of Industrial Water Systems: A Problem Solving Approach. Mittelman MW and Geesey GG (eds), WMA, San Diego, 1987.

### **Books Edited**

Dowling NJE, Mittelman MW, Danko JC. Microbially Influenced Corrosion and Biodeterioration. University of Tennessee Press, Knoxville, 1991. 540 pp.

Mittelman MW, Geesey GG. Biological Fouling of Industrial Water Systems: A Problem Solving Approach. WMA, San Diego, 1987. 357 pp.

### **Recent Presentations**

Mittelman MW. Life detection and long term space travel. NASA Life Detection Workshop; Houston, TX, December 19-20, 2018.

Mittelman MW. Antimicrobial coating technologies for medical devices. Biointerface 2017; San Diego, CA, October 1-3.

Mittelman MW. Biofilms and biological fouling in occupational settings. George Washington University School of Public Health (invited departmental lecture), Washington, DC, March 31, 2015.

Mittelman MW. Bioburden and biofilm management in pharmaceutical drug substance manufacturing. Parenteral Drug Association Annual Meeting, Las Vegas, NV, March 16-18, 2015.

Mittelman MW. Device-related infections: challenges and opportunities for biomedical engineers. Graduate Program Research Day (plenary speaker), Dalhousie University, Halifax, Nova Scotia, Canada, May 10, 2013.

Mittelman MW. Genesis and detection of biofilms. Parenteral Drug Association Annual Meeting, Phoenix, AZ, April 16-18, 2012.

Mittelman MW. Biofilms in compendial water and other fluid handling systems. Parenteral Drug Association Global Microbiology Conference, Bethesda, MD, October 17-19, 2011.

Roman MC, Mittelman MW. Overview of microbiological tests performed during the design of the international space station environmental control and life support systems. AIAA International Conference on Environmental Systems, Barcelona, Spain, July 11-15, 2010.



Mittelman MW. Microbial biofilms and bioburden generation in compendial water systems. Ultrapure Water Pharma, New Brunswick, NJ, May 20-21, 2010.

Mittelman MW. Bacterial biofilms and bioburden generation. Parenteral Drug Association, Frankfurt, Germany, April 20-21, 2010.

Mittelman MW. Prevention and control of biofilm formation. Parenteral Drug Association, Frankfurt, Germany, April 20-21, 2010.

## Editorships & Editorial Review Boards

*Biofouling* (North American editor), 1994-1999

*Journal of Microbiological Methods*, 1989-1998

*Microcontamination*, 1985-1997

*Standard Methods for the Examination of Water & Wastewater*, 17th ed., 1988-1989

## Peer Reviewer

*Biofouling*

*Environ. Sci. Technol.*

*J. Adhes. Sci. Technol.*

*J. Biomed. Mater. Res.*

*J. Concrete Research*

*J. Ind. Microbiol. Biotechnol.*

*J. Microbiol. Meth.*

*J. Parenteral Sci. Technol.*

*Med. Dev. Diagnos.*