

BIOGRAPHICAL SKETCH

NAME Mark Everett Shirliff		POSITION TITLE Associate Professor, Department of Microbial Pathogenesis, University of Maryland, Baltimore	
eRA COMMONS USER NAME (credential, e.g., agency login) mshirliff			
EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable.)			
INSTITUTION AND LOCATION	DEGREE (if applicable)	MM/YY	FIELD OF STUDY
University of Alberta, Edmonton, AB, Canada		1987-1990	Biology
University of Houston, Houston, TX	B.S.	1992-1993	Biology
University of Texas - Medical Branch, Galveston, TX	Ph.D	1994-2001	Micro. & Imm.
Montana State University, Bozeman, MT	Postdoc	2000-2002	Biofilm Bacteriology

A. PERSONAL STATEMENT

Mark E. Shirliff, PhD will act as Co-Investigator on this STTR application concerning prevention and resolution of *Staphylococcus aureus* biofilm and planktonic infections. Dr. Shirliff is presently an Associate Professor in the Department of Microbial Pathogenesis in the Dental School and an Adjunct Associate Professor in the School of Medicine. Dr. Shirliff began his animal model infection training at the University of Texas Medical Branch in the Department of Microbiology and Immunology. He received his PhD in 2001 with his thesis titled "*Staphylococcus aureus*: Roles in Osteomyelitis". He then traveled to the Center for Biofilm Engineering in Montana as a postdoctoral fellow to continue his work using animal models to study infection resolution in biofilm-related diseases. Dr. Shirliff became an Assistant Research Professor in 2003 in the Department of Microbiology and later that year accepted a position as Assistant Professor at University of Maryland, Baltimore. Since arriving in Maryland, Dr. Shirliff continues his research and teaching interests in host pathogen interactions, biofilm infections, and treatment of infections using animal models and was promoted to Associate Professor with tenure in 2009. He has published over 80 articles and has greater than 15 years of experience using animal infection models.

B. POSITIONS AND HONORS

POSITIONS:

1993 - 1995 Research Assistant, U of Texas Medical Branch, Galveston, TX
1995 - 2000 Graduate Student and Laboratory Director, U of Texas Medical Branch, Galveston, TX
2000 - 2002 Postdoctoral Fellow, Center for Biofilm Engineering, Montana State University
2002 - 2003 Assistant Research Professor, Center for Biofilm Engineering, Montana State University
2003 - 2009 Assistant Professor, Dept. of Biomedical Sciences, Dental School, U of MD, Baltimore, MD
2003 - 2010 Adjunct Assistant Professor, Dept. of Micro. & Immunol. School of Medicine, U of MD, Baltimore, MD
2009 - present Associate Professor, Dept. of Microbial Pathogenesis, Dental School, U of Maryland, Baltimore, MD
2010 - present Adjunct Associate Professor, Dept. of Micro. & Immunol., School of Medicine, U of MD, Baltimore, MD

AWARDS AND OTHER PROFESSIONAL ACTIVITIES:

1998-present Member, American Society for Microbiology and Sigma Xi (elected)
 1999 Arthur V. Simmang Academic Scholarship
 2000 Christina Fleischmann Award and The Curtis W. Lambert Academic Scholarship
 2002 Outstanding Researcher of the Year, Center Biofilm Engineering
 2002-present Adjunct Reviewer, Molecular Microbiology
 2002 Invited Guest Lecturer, Veterinary Molecular Biology, Montana State University; Department of Environmental Engineering, Washington State University; Dept. of Microbiology and Immunology, New York Medical College
 2002-present Proposal Reviewer, Technology Foundation, Ministries of Science and Education and of Economic Affairs, Government of the Netherlands
 2003 Invited Guest Lecturer, Danish Technological Institute, Copenhagen, Denmark; Dept. of Clinical Microbiology, Copenhagen University Hospital, Copenhagen, Denmark; Dept. of Environmental Engineering and Biotechnology, Aalborg University, Aalborg, Denmark
 2003-present Adjunct Reviewer, Annals of Clinical Microbiology and Antimicrobials, Journal of Bacteriology & FEMS Immunology and Medical Microbiology; Invited Guest Lecturer, Society of Industrial Microbiology, 2003 Annual Meeting, Minneapolis, Minnesota; American Society for Microbiology Biofilms 2003, Victoria,

- Canada; Columbia University, New York, NY. Proposal Reviewer, National Science Foundation, USA; Katholieke Universiteit Leuven, Belgium
- 2004 Invited Guest Lecturer, Universidad de Concepción, Concepción, Chile; La Sapienza University, Rome, Italy; Northern Arizona University, Flagstaff, AZ; Management of Battlefield Tissue Injury, Toronto, Canada; Southwestern Association of Clinical Microbiology, San Antonio, TX
- 2005-present
2005 Reviewer, JAMA, Mayo Clinic Reviews, Molecular Microbiology
Invited Guest Lecturer, Philips Oral Healthcare Biofilm Symposium. University of Southern California, Los Angeles, CA; Summer Symposium: Bugs and Biomaterials: Bacteria and the Biointerface. University of Washington • Seattle, WA ; Center for Biofilm Engineering, Montana State University, Bozeman, MT; Winthrop University Hospital, Mineola, NY
- 2006-present
2006 President – American Society for Microbiology – Maryland Division
Invited Guest Lecturer, West Virginia University, Huntington, WV, American Society for Microbiology General Meeting, Orlando, FL; Japan Orthopaedic Society Annual Meeting, Nagasaki, Japan, Center for Genomic Sciences, Allegheny General Hospital, Allegheny-Singer Research Institute, Pittsburgh, Pennsylvania.
- 2007 Invited Guest Lecturer, Johns Hopkins Bayview Medical Center, Baltimore, Maryland; Department of Ophthalmology, Harvard Medical School; The Schepens Eye Research Institute, Boston, Massachusetts; Mayo Clinic, Rochester, Minnesota; University of Missouri Medical School, Columbia, Missouri.
- 2008 Invited Guest Lecturer, Interscience Conference on Antimicrobial Agents and Chemotherapy, Washington, D.C.; General Meeting of the American Society for Microbiology, Boston, Massachusetts. National Institutes of Health, National Institute of Allergy and Infectious Disease, BACP – Bacterial Pathogenesis Study Section and BACP-H (02) S Section.
- 2009 Co-Organizer and Session Chair. Eurobiofilms, Rome, Italy. Session Chair. 5th ASM Conference on Biofilms. Cancun, Mexico; OTA Annual Meeting - 25th Anniversary Meeting. San Diego, CA. Invited Speaker, OTA Annual Meeting - 25th Anniversary Meeting. San Diego, CA; National Institute of Standards and Technology, Bethesda, Maryland; Eurobiofilms, Rome, Italy; Gordon Conference of *Staphylococcus aureus*. New Hampshire; Symposium on Advanced Wound Care/Wound Healing Society. Dallas, TX; Musculoskeletal Infection Society Annual Meeting. San Diego, California; Food and Drug Administration. Bethesda, Maryland; University of Ottawa, Ottawa, Canada. National Research Council of Canada. Ottawa, Canada; 5th ASM Conference on Biofilms. Cancun, Mexico; (SAWC/WHS) Meeting. Dallas, Texas.
- 2010 Adhoc Reviewer, National Institutes of Health, National Institute of Dental and Craniofacial Research. Special Emphasis Panel/Scientific Review Group 2010/08 ZDE1 JH (19). 2010. Invited Guest Editor, FEMS Immunol Med Microbiol. Biofilms Thematic Issue. Invited Guest Lecturer, 2010 Orthopaedic Trauma Association. Baltimore, Maryland; American Biological Safety Association 2010 Meeting. Denver, Colorado; ATACCC 2010 Conference. St. Petes Beach, Florida; AOTrauma CPP Bone Infection workshop. Boston, Massachusetts; NIAID Staphylococcal Vaccine Workshop. Bethesda, Maryland; 8th World Congress on Trauma, Shock, Inflammation, and Sepsis (TSIS), Munich, Germany.

C. PUBLICATIONS (from >80 publications and 1 book)

PEER-REVIEWED PUBLICATIONS (IN CHRONOLOGICAL ORDER):

1. Davis CP, Shirliff ME, Trieff NM, Hoskins SL, and Warren MM. Quantification, qualification, and microbial killing efficiencies of antimicrobial chlorine-based substances produced by iontophoresis. *Antimicrob Agents Chemother.* 38:2768-74, 1994.
 2. Davis CP, Shirliff ME, Scimeca JM, Hoskins SL, and Warren MM. *In vivo* reduction of bacterial populations in the urinary tract of catheterized sheep by iontophoresis. *J Urol.* 154:1948-53, 1995. Mader JT, Shirliff ME, and Calhoun JH. Staging and staging application in osteomyelitis. *Clin Infect Dis.* 25(6):1303-1309, 1997.
 3. Ali SA, Cesani F, Nusynowitz ML, Briscoe EG, Shirliff ME, Mader JT. Skeletal scintigraphy with technetium-99m-tetraphenyl porphyrin sulfonate for the detection and determination of osteomyelitis in an animal model. *J Nuc Med.* 38(12):1999-2002, 1997.
 4. Mader JT, Shirliff ME, Cripps MW, and Calhoun JH. Cierny-Mader Staging and the Treatment of Long Bone Osteomyelitis. In: *Infectious Diseases. Up To Date Publishing Corporation. Wellesley, MA. 1998.*
 5. Mader JT, Shirliff ME, Cripps MW, and Calhoun JH. Staging Systems for Long Bone Osteomyelitis. In: *Infectious Diseases. Up To Date Publishing Corporation. Wellesley, MA. 1998.*
 6. Mader JT and Shirliff ME. The Rabbit Model of Bacterial Osteomyelitis of the Tibia. In: *Handbook of Animal Models of Infection.* ed. Zak O and Sande MA. Academic Press Ltd. London, England. 581–591, 1999.
 7. Mader JT, Shirliff ME, and Calhoun JH. The Use of Hyperbaric Oxygen in the Treatment of Osteomyelitis. In: *Hyperbaric Medicine Practice.* Best Publishing Co. Flagstaff, Arizona. 603-616, 1999.
 8. Mader JT, Shirliff ME, and Calhoun JH. Practical Guidelines in the Diagnosis and Treatment of Osteomyelitis. In: *Infectious Diseases. Up To Date Publishing Corporation. Wellesley, MA. 1999.*
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9. Mader JT, Shirliff ME, Bergquist S, and Calhoun JH. Principles of Management and Treatment of Osteomyelitis. In: Infectious Diseases. Up To Date Publishing Corporation. Wellesley, MA. 1999.
 10. Mader JT, Shirliff ME, Bergquist S, and Calhoun JH. Antimicrobial treatment of chronic osteomyelitis. Clin Orth Related Res. 360:47-65, 1999.
 11. Mader JT, Shirliff ME, and Calhoun JH. The Host and the Skeletal Infection: Classification and Pathogenesis of Acute Bacterial Bone and Joint Sepsis. In: Baillière's Best Practice & Research. Clinical Rheumatology. ed. Woolf AD. 13(1):1-20, 1999.
 12. Shirliff ME, Calhoun JH, and Mader JT. Rifampin plus azithromycin or clarithromycin to treat osteomyelitis in rabbits. Clin Orth Related Res. 359:229-236, 1999.
 13. Mader JT, Shirliff ME, Bergquist S, and Calhoun JH. Bone and joint infections in the elderly. Practical treatment guidelines. Drugs & Aging. 10(1): 1170-1185, 2000.
 14. Balaban N, Collins LV, Cullor JS, Hume EB, Medina-Acosta E, Vieira da Motta O, O'Callaghan R, Rossitto PV, Shirliff ME, Serafim da Silveira L, Tarkowski A, Torres JV. Prevention of diseases caused by *S. aureus* using the peptide RIP. Peptides. 21(9): 1301-1311, 2000.
 15. Shirliff ME and Mader JT. Osteomyelitis: Clinical Features and Molecular Aspects of Persistence. In: Persistent Bacterial Infections. ed. Nataro JP, Blaser MJ, and Cunningham-Rundles S. ASM Press, Washington DC. 375-395, 2000.
 16. Mader JT, Trevino SG, Galbraith JW, and Shirliff ME. Osteomyelitis. In: Internal Medicine Pearls, 2nd Edition. ed. Heffner JE and Sahn SA. Hanley & Belfus, Inc. Philadelphia, PA. 191-195, 2001.
 17. Shirliff ME, Calhoun JH, and Mader JT. The treatment of experimental methicillin sensitive *S. aureus* osteomyelitis in rabbits with levofloxacin and nafcillin. J Antimicrobial Chemother. 48(2):253-258, 2001.
 18. Chen JJ, Huang JC, Shirliff M, Briscoe E, Ali S, Cesani F, Paar D, Cloyd MW. CD4 lymphocytes in the blood of HIV(+) individuals migrate rapidly to lymph nodes and bone marrow: support for homing theory of CD4 cell depletion. J Leukoc Biol. 72(2):271-8, 2002
 19. Shirliff ME, Leid J, and Costerton JW. Basic science of musculoskeletal infections. In: Musculoskeletal Infections. ed. Mader JT and Calhoun JH. Marcel Dekker, Inc. New York, NY. 1-61, 2002.
 20. Shirliff ME and Lefrock J. Septic Arthritis. In: Musculoskeletal Infections. ed. Mader JT and Calhoun JH. Marcel Dekker, Inc. New York, NY. 183-209, 2002.
 21. Leid JG, Costerton JW, Shirliff ME, Gilmore MS, and Engelbert M. Immunology of staphylococcal biofilm infections in the eye: New tools to study endophthalmitis. J DNA Cell Biol. 21(5):405-413, 2002.
 22. Shirliff ME, Calhoun JH, and Mader JT. Experimental osteomyelitis treatment with antibiotic-impregnated hydroxyapatite. Clin Orth Related Res. 401:239-247, 2002.
 23. Mader JT and Shirliff ME. Osteomyelitis. In: Conn's Current Therapy, 2002 Edition. ed. Rakel RE and Bope ET. WB Saunders Co. Philadelphia, PA. 1010-1016, 2002.
 24. Leid JG, Shirliff ME, Costerton JW, and Stoodley P. Human leukocytes adhere to, penetrate, and respond to *S. aureus* biofilms. Infect Immun. 70(11): 6339-6345, 2002.
 25. Shirliff ME, Mader JT, and Camper AK. Molecular interactions in biofilms. Chem and Biol. 9(8):859-865, 2002.
 26. Shirliff ME, Calhoun JH, and Mader JT. Evaluation of gatifloxacin in the treatment of methicillin sensitive *S. aureus* osteomyelitis in a rabbit model. Antimicrob Agents Chemother. 46(1):231-233, 2002.
 27. Mader JT, Wang J, Shirliff ME, and Calhoun J. Osteomyelitis. Expert Guide to Infectious Diseases. ed. Tan JS. American College of Physicians-American Society of Internal Medicine. Philadelphia, PA. 585-604, 2002.
 28. Shirliff ME and Mader JT. Acute septic arthritis. Clin Micro Rev. 15(4):527-544, 2002.
 29. Costerton JW, Veeh R, Shirliff ME, Pasmore M, Post C, and Ehrlich G. The application of biofilm science to the study and control of chronic bacterial infections. J Clin Invest. 112(10):1466-1477, 2003.
 30. Worley SD, Li F, Wu R, Wei C-I, Williams JF, Owens J, Wander JD, Bargmeyer AM, and Shirliff ME. A novel N-halamine monomer for preparing biocidal polyurethane coatings. Surface Coatings Int. Part B: Coat. Trans. 86(B4): 273-277, 2003.
 31. Shirliff ME and Mader JT. Imaging in osteomyelitis. Curr Treat Options Infect Dis 5(4):323-335, 2003.
 32. Veeh RH, Shirliff ME, Petik JR, Flood JA, Davis CC, Seymour JL, Hannsmen MA, Kerr KM, Costerton JW, and Pasmore, M. Detection of *S. aureus* Biofilm on Tampons and Menses. J Infect Dis. 188(4):519-530, 2003.
 33. Costerton JW, Stoodley P, Shirliff ME, Pasmore M, Cook G. Biofilms, Biomaterials, and device-related infections. In: Biomaterials Science: An Introduction to Materials in Medicine. ed. Ratner BD, Hoffman AS, Schoen FJ, and Lemons JE., Elsevier Academic Press. 345-354, 2004.
 34. Shirliff ME, Cripps MW, and Calhoun JH. Staging Systems for Long Bone Osteomyelitis. In: Infectious Diseases. Up To Date Publishing Corporation. Wellesley, MA. 2005.
 35. Fux CA, Shirliff ME, Stoodley P, and Costerton JW. Can laboratory strains mirror "real world" pathogenesis? *Trends Micro.* 13(2):2005.
 36. Shirliff ME, Cripps MW, and Calhoun JH. Cierny-Mader Staging and the Treatment of Long Bone Osteomyelitis. In: Infectious Diseases. Up To Date Publishing Corporation. Wellesley, MA. 2005.
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37. Leid JG, Carey JW, Shirliff ME, Hassett DJ, Parsek MR, and Jeffers AK. The exopolysaccharide alginate protects *Pseudomonas aeruginosa* biofilm bacteria from IFN- γ -mediated macrophage killing. *J. Imm.* 175(11):7512-8, 2005.
 38. Shirliff ME, Bargmeyer A, and Camper AK. Assessment of the bioelectric effect to eliminate mixed water species biofilms. *Appl Environ Micro.* 71(10):6379-82, 2005.
 39. Brady RA, Leid JG, Costerton JW, and Shirliff ME. Identification of *Staphylococcus aureus* proteins recognized by the antibody mediated immune response to a biofilm infection. *Infect. Immun.* 74(6):3415-3426, 2006.
 40. Jabra-Rizk MA, Meiller T, James CE, and Shirliff ME. Effect of farnesol on *Staphylococcus aureus* biofilm formation and antimicrobial susceptibility. *Antimicrob Agents Chemother.* 50(4):1463-9, 2006.
 41. Brady RA, Leid JG, Costerton JW, and Shirliff ME. Osteomyelitis. *Clin. Micro. News.* 28(9):65-72, 2006.
 42. Jabra-Rizk MA, Shirliff ME, and Meiller T. Farnesol effect on *Candida albicans* and *Candida dubliensis*. *FEMS Yeast Research.* 6(7):1063-73, 2006.
 43. Lazzarini L, Overgaard KA, Conti E, and Shirliff ME. Experimental osteomyelitis: what have we learned from animal studies about the systemic treatment of osteomyelitis? *J. Chemother.* 18(5): 451-460, 2006.
 44. Shirliff ME, Singh Bal B, Yin L, and Calhoun JH. Staging systems for long bone osteomyelitis. In: Infectious Diseases. Up To Date Publishing Corporation. Wellesley, MA. 2006.
 45. Calhoun JH, Sexton DJ, and Shirliff ME. Hematogenous osteomyelitis in adults. In: Infectious Diseases. Up To Date Publishing Corporation. Wellesley, MA. 2007.
 46. Brady RA, Leid JG, Kofonow J, Costerton JW, and Shirliff ME. Immunoglobulins to surface-associated biofilm immunogens provide a novel means of visualization of methicillin-resistant *Staphylococcus aureus* biofilms. *Appl Env Micro.* 73(20): 6612-9, 2007
 47. Calhoun J, Christensen G, Brady RA, Shirliff ME. Osteomyelitis. In: Expert Guide to Infectious Diseases. ed. Tan JS. American College of Physicians-American Society of Internal Medicine. Philadelphia, PA. 2007.
 48. Jacobsen SM, Lane MC, Harro JM, Shirliff ME, and Mobley HLT. The high-affinity phosphate transporter Pst is a virulence factor for *Proteus mirabilis* during complicated urinary tract infection. *FEMS Immun Med Micro.* Jan. 2008.
 49. Jacobsen SM, Stickler D, Brady RA, Mobley H, and Shirliff ME. The role of *Escherichia coli* and *Proteus mirabilis* in catheter-related urinary tract infections. *Clin Micro Rev.* 21(1):26-59, 2008.
 50. Brady R, Leid JG, Calhoun JH, and Shirliff ME. Osteomyelitis and the role of biofilms in chronic infection. *FEMS Immun Med Micro.* 52:13-22, 2008.
 51. Scheper MA, Shirliff ME, Meiller TF, Peters B, and Jabra-Rizk MA. Farnesol a fungal quorum sensing molecule triggers apoptosis in human oral squamous carcinoma cells. *Neoplasia.* 10(9):954-63, 2008.
 52. Fux CA, Stoodley P, Shirliff ME, and Costerton JW. Biofilms. In: Antimicrobial Drug Resistance: Principles and Practice for the Clinic and Bench. ed Mayers DL. Infectious Disease Series. ed Georgiev VS. Humana Press. March, 2008.
 53. Shirliff ME, Peters B, Jabra-Rizk MA. Cross-kingdom interactions: *Candida albicans* and Bacteria. *FEMS Microbiol Lett.* 299(1): 1-8, 2009.
 54. Unnanuntana A, Bonsignore L, Shirliff ME, and Greenfield EM. The effects of farnesol on *Staphylococcus aureus* biofilms and osteoblasts. An *in vitro* study. *J Bone Joint Surg Am.*;(91):2683-92, 2009.
 55. Leid JG, Kerr M, Selgado C, Johnson C, Moreno G, Shirliff ME, O'Toole GA, and Cope EK. Flagellar-mediated biofilm defense mechanisms of *Pseudomonas aeruginosa* against host derived lactoferrin. *J of Immunology.* 77(10):4559-66, 2009.
 56. Shirliff ME, Krom BP, Peters B, Zhu J, and Jabra-Rizk MA. Farnesol-induced modifications in *Candida albicans* proteome. *Antimicrob Agents Chemother.* 53(6):2392-401, 2009.
 57. O'May G, Jacobsen SM, Mobley H, and Shirliff ME. The high-affinity phosphate transporter Pst in *Proteus mirabilis* HI4320 and its importance in biofilm formation. *Microbiology.* 155(5):1547-1557, 2009.
 58. Meiller TF, Hube B, Schild L, Shirliff ME, Scheper MA, Ton A, and Jabra-Rizk MA. A novel immune evasion strategy of *Candida albicans*: proteolytic cleavage of a salivary antimicrobial peptide. *PLoS ONE.* 4(4):e5039, 1-9, 2009.
 59. Xu Z, Li L, Shirliff ME, Alam MJ, Yamasaki S, Shi L. Occurrence and characteristics of class 1 and 2 integrons in *Pseudomonas aeruginosa* isolates from patients in southern China. *J Clin Microbiol.* 47(1):230-4, 2009.
 60. Brady RA, Calhoun JH, Leid JG, and Shirliff ME. Infections of orthopaedic implants and devices. In: Biofilms and Device-Related Infections. Springer, New York, NY. ed. Shirliff ME and Leid JG. 15-56, 2009.
 61. Costerton JW, Veeh R, Shirliff ME, Pasmore M, Post C, and Ehlich G. The application of biofilm science to the study and control of chronic bacterial infections. In: Science in Medicine: The JCI Textbook of Molecular Medicine. ed Marks AR. American Society for Clinical Investigation. Jones and Bartlett, Boston, MA. 121-131, 2009.
 62. Calhoun JH, Manning M, and Shirliff ME. Osteomyelitis of the long bones. *Sem. Plastic Surg.* 23(2):59-72. 2009.
 63. O'May G, Jacobsen SM, Mobley H, and Shirliff ME. Catheter-related urinary tract infections. In: Biofilms and Device-Related Infections. Springer, New York, NY. ed. Shirliff ME and Leid JG. 123-166, 2009.
 64. M. Nymer M, Cope E, Brady R, Shirliff ME, and Leid JG. Immune responses to indwelling medical devices. In: Biofilms and Device-Related Infections. Springer, New York, NY. ed. Shirliff ME and Leid JG. 239-264, 2009.
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65. Peters BM, Shirtliff ME, Jabra-Rizk MA. Antimicrobial peptides: primeval molecules or future drugs? PLoS Pathog. 2010 Oct 28;6(10):e1001067.
 66. Xu Z, Li L, Shirtliff ME, Peters BM, Peng Y, Alam MJ, Yamasaki S, Shi L. First report of class 2 integron in clinical *Enterococcus faecalis* and class 1 integron in *Enterococcus faecium* in South China. Diagn Microbiol Infect Dis. Nov;68(3):315-7, 2010.
 67. Miclau T, Schmidt AH, Wenke JC, Webb LX, Harro JM, Prabhakara R, Shirtliff ME. Infection. J Orthop Trauma. Sep;24(9):583-6, 2010.
 68. Donelli G, Bayston R, Costerton WB, Shirtliff ME. The first European congress on microbial biofilms: EUROBIOFILMS 2009, Rome, Italy, September 2-5, 2009. FEMS Immunol Med Microbiol. 59(3):223-6, 2010.
 69. Peters BM, Jabra-Rizk MA, Scheper MA, Leid JG, Costerton JW, Shirtliff ME. Microbial interactions and differential protein expression in *Staphylococcus aureus* -*Candida albicans* dual-species biofilms. FEMS Immunol Med Microbiol. 59(3):493-503, 2010
 70. Harro JM, Peters BM, O'May GA, Archer N, Kerns P, Prabhakara R, Shirtliff ME. Vaccine development in *Staphylococcus aureus*: taking the biofilm phenotype into consideration. FEMS Immunol Med Microbiol. 59(3):306-23, 2010.
 71. Zhao X, Wang L, Chu J, Li Y, Li Y, Xu Z, Li L, Shirtliff ME, He X, Liu Y, Wang J, and Yang L. Rapid detection of *Vibrio parahaemolyticus* strains and virulent factors by loop-mediated isothermal amplification assays. Food Sci. Biotechnol. 19(5): 1191-1197. 2010.
 72. Leid JG, Cope EK, Parmenter S, Shirtliff ME, Dowd S, Wolcott R, Basaraba R, Hunsaker H, Palmer J, and Cohen N. The importance of biofilms in chronic rhinosinusitis. Biofilm Infections. Springer Inc. New York, New York. 139-160, 2011.
 73. O'May GA, Brady RA, Leid JG, Calhoun JH, and Shirtliff ME. Osteomyelitis. Biofilm Infections. Springer Inc. New York, New York. 111-138, 2011.
 74. Prabhakara R, Harro JM, Leid JG, Harris ML, and Shirtliff ME. Murine immune response to a chronic *Staphylococcus aureus* biofilm infection. Infect Immun. 79(4): 1789-1796, 2011.
 75. Brady RA, O'May G, Leid JG, and Shirtliff ME. Resolution of *Staphylococcus aureus* biofilm infection using vaccination and antibiotic treatment. Infect Immun. 79(4): 1797-1803, 2011.
 76. Xu Z, Lin Li L, Shirtliff ME, Peters BM, Li B, Peng Y, Alam MJ, Yamasaki S, Shi L. Resistance Class 1 Integron in clinical methicillin-resistant *Staphylococcus aureus* strains in Southern China, 2001-2006. Clin Microbiol Infect. 17(5):714-8, 2011.
 77. Xu Z, Li L, Shi L, Shirtliff ME. Class 1 integron in staphylococci. Mol Biol Rep. Published online: Jan 22, 2011.
 78. Prabhakara R, Harro J, Harris M, Leid JG, and Shirtliff ME. Prevention and resolution of *Staphylococcus aureus* biofilm infections via host immune response modulation. Infect Immun. Epub: Sept 26, 2011.
 79. Xu Z, Lin L, Chu J, Peters BP, Harris ML, Li B, Shi L, and Shirtliff ME. Development and application of loop-mediated isothermal amplification assays on rapid detection of various types of staphylococcal strains. Food Res Int. – in press.
 80. Jacobsen SM, Shirtliff ME. *Proteus mirabilis* biofilms and catheter-associated urinary tract infections. Virulence. Sep 1;2(5). 2011.
 81. Archer NK, Mazaitis MJ, Costerton JW, Leid JG, Powers ME, Shirtliff ME. *Staphylococcus aureus* biofilms: Properties, regulation, and roles in human disease. Virulence. Sep 1;2(5), 2011.
 82. Conti S, Sotereanos N, Altman G, Altman D, Post JC, Ehrlich GD, Gorur A, Schaudinn C, Sedghizadeh P, Shirtliff ME, Costerton JW, Stoodley P, Kathju S, and DeMeo P. Significance of the biofilm mode-of-growth in orthopaedic infections. JBJS. 2011. – in press.
 83. Cope E, Cohen N, Dowd SE, Palmer J, Chiu A, Wolcott R, Neeling L, Gmerek A, Smith A, Shirtliff ME, and Leid JG. Primary exposure to cigarette smoke influences microbial community composition in chronic rhinosinusitis determined by next generation pyrosequencing. PLoS One. 2011. – in press.
 84. O'May GA, Macfarlane S, Macfarlane GT, and Shirtliff ME. Biofilms in the human gastrointestinal tract. 2011 – in press.
 85. Stoodley P, Hall-Stoodley L, Costerton JW, DeMeo P, Shirtliff ME, Gawalt E, and Kathju S. Biofilms, Biomaterials, and Device-Related Infections. In Biomaterials. 2011. – in press.
 86. McLean JS, Fansler SJ, Majors PD, McAteer K, Ziegler L, Lux R, Shirtliff ME, Costerton JW, and Shi W. Revealing species identity and their functional contribution in the development of cariogenic conditions within oral plaque by combining in-vivo metabolomics with stable isotope probing. NMR. 2011. – in press.
 87. Peters BM, O'May GA, Jabra-Rizk MA, Costerton JW, and Shirtliff ME. Polymicrobial interactions in biofilms: impact on pathogenesis and human disease. Clin Micro Rev. 2011. – in press.
 88. Zhu J, Krom B, Peters B, Shirtliff ME, Scheper M, Intapa C, Jabra-Rizk MA. Farnesol-induced apoptosis in *Candida albicans* is mediated by Cdr1-p extrusion and depletion of intracellular glutathione. J Euk Cell. 2011. – accepted with revisions.
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89. Han A, Zenilman JM, Melendez JH, Shirtliff ME, Agostinho A, James G, Stewart PS, Mongodin EF, Rao DL, Rickard AH, Lazarus GS. A systematic, multi-faceted approach using novel molecular methods to characterize the microbial flora in chronic wounds. 2011. – submitted to Wound Rep. Regen.
90. Peters BM, Ovchinnikova E., Jabra-Rizk MA, Hoyer L, van der Mei HC, Busscher HJ, Krom BP, and Shirtliff ME. *Candida albicans* hyphal adhesin Als3p mediates interspecies interactions with *Staphylococcus aureus* during polymicrobial biofilm growth. 2011. – submitted to PLoS One.
- Also >80 Abstracts at national and international scientific meetings

D. RESEARCH SUPPORT

Ongoing Research Support:

- Department of Defense. – W81XWH-07-1-0210. PI – ME Shirtliff 2008 – present
 Vaccine development for recurrent musculoskeletal infections. Summary: This is a subcontract from the University of Missouri to explore vaccine development in problematic pathogens causing recurrent musculoskeletal infections due to battlefield injuries.
 Role: Principal Investigator
- National Institutes of Health (Agency NIAID) – R01-AI069568-02. PI – ME Shirtliff 2007 – present
Staphylococcus aureus biofilms: *in vitro* and *in vivo* studies. Summary: This study tests vaccine candidates in two models of biofilm infection.
 Role: Principal Investigator
- National Institutes of Health (Agency NIAID) – R01-ARRA Supplement. PI – ME Shirtliff. 2007 – present
Staphylococcus aureus biofilms: *in vitro* and *in vivo* studies. Summary: This study tests vaccine candidates in two models of biofilm infection.
 Role: Principal Investigator
- National Institutes of Health/Pathogen Functional Genomics Resource Center. PI – ME Shirtliff 2004 – present
 Transcriptomic and proteomic evaluation of *Streptococcus mutans* biofilms/Determination of differential gene expression in *S. aureus* biofilms through microarray analysis. Summary: This study is a materials grant that provides DNA microarrays (no direct or indirect costs) for the evaluation of *S. mutans* and *S. aureus* gene expression grown as a biofilm under *in vitro* conditions.
 Role: P
- National Institutes of Health (Agency NIAID) – 1R01DE020939-01A2. PI – MA Jabra-Rizk 2010 – present
Candida albicans and *Staphylococcus aureus* biofilms: *in vitro* and *in vivo* studies. Summary: This study endeavors to explore the interactions between a fungal and bacterial pathogen.
 Role: Co-PI.

Completed Research Support - Previous 3 years

- University of Maryland. PI – ME Shirtliff and KS McIver 2008 – 2009
 Identification of determinants essential for biofilm formation and virulence in methicillin-resistant *Staphylococcus aureus* (MRSA) using a global genetic approach. Summary: This study will utilize novel molecular techniques in order to find those genes necessary for biofilm formation.
 Role: PI
- National Institutes of Health – SBIR. PI - Tim Opperman. Co-Investigator – ME Shirtliff 2005 - 2007
 Detection and evaluation of antimicrobial agent targets against *Staphylococcus epidermidis* in models of biofilm infection. Summary: This study tests mutant defective in biofilm formation in two models of biofilm infection.
 Role: Co-Investigator
- Philips. PI's – JW Costerton and ME Shirtliff 2005 - 2007
 Modern Molecular Methods for the Analysis of Supragingival and Subgingival Biofilm Populations: Location of the Aerobic/Anaerobic Boundary. Summary: This study will test the change in microbial populations and distribution following Sonicare cleaning system.
 Role: PI
- Howard Hughes Fellowship Program. PI – ME Shirtliff 2006 - 2007
 Determination of the phenotypic effect of mutation in genes shown to be up-regulated in *Staphylococcus aureus* biofilms. Summary: This fellowship provides funds for a student to perform research in PI's laboratory.
 Role: PI
- Maryland Technology Development Corporation. PI – S Kramer 2005 - 2007
 Combinatorial Method to Combat Antimicrobial Resistance. Summary: The purpose of this research project is to identify synergistic antimicrobial agents against biofilm-mediated infections and contamination.
 Role: Co-Investigator
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