

CURRICULUM VITAE

KIM LEWIS, Ph.D.

University Distinguished Professor
Director, Antimicrobial Discovery Center
Northeastern University
360 Huntington Avenue
Mugar 405
Boston, MA 02115
k.lewis@neu.edu
617-373-8238 FAX 617-373-3724
<http://www.biology.neu.edu/faculty03/lewis03.html>

EDUCATION

| Institution and location | Degree | Year Conferred | Field of Study |
|--------------------------|--------|----------------|----------------|
| Moscow University | BS | 1976 | Biochemistry |
| Moscow University | Ph.D. | 1980 | Biochemistry |

EMPLOYMENT

| <u>From:</u> | <u>To:</u> | <u>Title:</u> | <u>Institution:</u> |
|--------------|------------|---|--|
| 6/01 | present | Professor of Biology | Northeastern University |
| 4/97 | 6/01 | Research Associate Professor | Biotechnology Center, Tufts University |
| 9/94 | 3/31/97 | Associate Professor | Medical & Research Technology, University of Maryland at Baltimore, Medical School |
| 7/88 | 8/94 | Assistant Professor | Department of Biology, MIT |
| 1.1./88 | 1.3./88 | Assistant Professor | Applied Biology, MIT (Department disbanded) |
| 7/87 | 1/88 | Research Associate | University of Wisconsin, Madison |
| 4/84 | 7/87 | Lost academic position upon applying to emigrate to the USA | |
| 6/79 | 3/84 | Senior Researcher | Moscow University |
| 6/76 | 6/79 | Researcher | Moscow University |

Membership : ASM, AAAS, Society for Industrial Microbiology

Awards and Honors:

Lauren Brooks Hope Award, Lyme Research Alliance, 2014

Speaker, National Academy of Sciences meeting "Antimicrobial Resistance and Countermeasures", 2014

Imperial College Leading Scientists Seminar Series Lecture, London, 2013

Lester O. Krampitz Lecture, Case Western Reserve University, Cleveland, 2013

NEU Corporation Lecture, 2012

Keynote Lecture, Belgian Society for Microbiology, Copenhagen, 2011

Fellow, American Academy of Microbiology, 2011

University Distinguished Professor, 2011

Invited Lecture, Institut Pasteur, Paris, 2011

Speaker and Panelist, The National Academies Forum on Microbial Threat, Washington, DC 2011

Speaker and Panelist, the NIAID/FDA/IDSA Public Workshop on Antibacterial Resistance and Diagnostic Device and Drug Development Research for Bacterial Diseases, Washington, DC 2010

Speaker and Panelist, The National Academies Forum on Antibiotic Resistance, Washington, DC 2010

NIH Director's Transformative Award, 2009

Keynote Lecture, ASM Educational Meeting (ASMCUE), Fort Collins, CO 2008

Chair, NIAID-BARDA Application of Platform Technologies for the Development of Therapeutics for Biodefense study section, 2008

Chair, NIH Roadmap study section, High Throughput Screening in the Molecular Libraries Screening Centers Network, 2008

Convener, ICAAC symposium, Antimicrobial Tolerance: Persisters, Biofilms, And Infectious Disease, Washington, DC, 2008

Lecturer, Harvard University Microbial Science Initiative, 2006

Member, Faculty of 1000, Pharmacology & Drug Discovery section, 2006 – present

Division A (Antimicrobial Chemotherapy) Lecture, ASM General Meeting, Atlanta, Georgia, 2005

NIH study section member, Drug Discovery and Mechanisms of Antimicrobial Resistance, 2004 –2006

Distinguished Research Fellow, Northeastern University, 2004

Convener, ASM General Meeting, New Orleans, 2004

Expert Lecture, V European Congress on Chemotherapy and Infections, Rhodes, Greece, 2003

Convener, ASM General Meeting, Washington, DC, 2003

Keynote lecture, Wind River Conference on Prokaryotic Biology, Estes Park, CO, 2001

Convener, Society for Industrial Microbiology Annual Meeting, Saint Louis, 2001

Convener, Society for Industrial Microbiology Annual Meeting, San Diego, 2000

Symposial Lecture at the Society for General Microbiology Meeting, Leeds, 1999

Chair, MDR Colloquium, 9th European Bioenergetics Meeting (EBEC), Louvain, Belgium, 1996

Convener, ASM General Meeting, Washington, DC, 1995

MIT C.E. Reed Faculty Initiative Award for an innovative research project. Competitively awarded to 1 Faculty member among the School of Science and the School of Engineering annually, 1992

Who's Who in America

• PUBLICATIONS

Refereed articles (selected)

Lewis¹, K., and Skulachev, V.P. (1978) The proton pump is a molecular engine of motile bacteria. *Nature* 287: 280-282 .

Glagoleva, T.N., Lewis, K., Gusev, M.V., and Nikitina, K.A. (1980) Proton motive force supports gliding in cyanobacteria. *FEBS Lett.* 117:49-53 .

Lewis, K. (1980) Reception of energy level in bacterial taxis. *J. Theor. Biol.* 82:171-185.

Arshavsky, V.Yu., Baryshev, V.A., Brown, I.I., Lewis, K., and Skulachev, V.P. (1981) Transmembrane gradient of K⁺ and Na⁺ ions as an energy buffer in *Halobacterium halobium* cells. *FEBS Lett.* 133:22-26.

Baryshev, V.A., Lewis, K., and Skulachev, V.P. (1981) Sensing of pmf in phototaxis of *Halobacterium halobium*. *Nature* 292:338-340.

Baryshev, V.A., Lewis, K., and Skulachev, V.P. (1981) Interrelationship between Ca²⁺ and a methionine-requiring step in *Halobacterium halobium* taxis. *FEMS Microbiol. Lett.* 13:47-50.

Murvanidze, G.V., and Lewis, K. (1981) Calcium ions regulate reverse motion in phototactically active *Phormidium uncinatum* and *Halobacterium halobium*.. *FEMS Microbiol. Lett.* 12:3-6.

Chailakhan, L.M., Lewis, K., Glagoleva, T.N., Murvanidze, G.V., Potapova, T.V. and Skulachev, V.P. (1982) Intercellular power transmission along trichomes of cyanobacteria. *Biochim. Biophys. Acta.* 679: 60-67.

Alam, M., and Lewis, K. (1982) $\Delta\mu_{\text{H}^+}$ -sensing in taxis of *Vibrio harveyi*. *FEBS Lett.* 143:144-146.

Murvanidze, G.V., Gabai, V.L. and Lewis, K. (1982) Taxis responses in *Phormidium uncinatum*. *J. Gen. Microbiol.* 128: 1623-1630.

Galperin, M.Yu., Dibrov, P.A., and Lewis, K. (1982) $\Delta\mu_{\text{H}^+}$ is required for flagellar growth in *E. coli*. *FEBS Lett.* 143:319-322.

¹ Name was changed to A.N. Glagolev while living in Russia.

- Murvanidze, G.V., and Lewis, K. (1982) Electrical nature of the taxis signal in cyanobacteria. *J. Bacteriol.* 50:239-244.
- Bibikov, S.I., Baryshev, V.A., and Lewis, K. (1982) The role of methylation in the taxis of *Halobacterium halobium* to light and chemo-effectors. *FEBS Lett.* 146:255-258.
- Baryshev, V.A., Lewis, K., and Skulachev, V.P. (1983) On the interplay of phototaxis, membrane potential and K^+/Na^+ -gradient in *Halobacterium halobium*. *J. Gen. Microbiol.* 129:367-373.
- Brown, I.I., Galperin, M.Yu., Lewis, K., and Skulachev, V.P. (1983) Utilization of energy stores in the form of Na^+ and K^+ ion gradients by bacterial cells. *Eur. J. Biochem.* 134: 345-349.
- Chernyak, B.V., Dibrov, P.A., Lewis, K., Sherman, M.Y. and Skulachev, V.P. (1983) A novel type of energetics in a marine alkali-tolerant bacterium: Na^+ -driven motility and sodium cycle. *FEBS Lett.* 164: 38-41.
- Lewis, K. (1984) Bacterial $\Delta \mu H^+$ -sensing. *Trends Biochem. Sci.* 9:397-400.
- Dibrova, E. K., Bibikov, S.I., Glagoleva, T.N., and Lewis, K. (1985) The bacterial-type taxis and protein methylation in diatoms. *FEMS Microbiol. Lett.* 26:295-299.
- Lewis, K., and Sherman, M.Yu. (1985) Mechanisms of bacterial taxis: unsuspected forms. *Modern Cell Biol.* 4:129-150.
- Gabai, V.L. and Lewis, K. (1985) Redox-sensing is the basis of photophobic responses in cyanobacteria. *FEMS Microbiol. Lett.* 27: 351-356.
- Lomovskaya, O. and Lewis, K. (1992) EMR, an *Escherichia coli* locus for multidrug resistance. *Proc. Natl. Acad. Sci. USA* 89: 8938-8942.
- Naroditskaya V., Schlosser, M.J., Fang, N.Y., and Lewis, K. (1993) An *E. coli* gene *emrD* is involved in adaptation to low energy shock. *Biochem. Biophys. Res. Comm.* 196: 803-809.
- Lewis, K. (1994) Multidrug resistance pumps in bacteria: variations on a theme. *Trends Biochem. Sci.* 19: 119-123.
- Lewis, K., Naroditskaya, V., Ferrante, A., and Fokina, I. (1994) Bacterial resistance to uncouplers. *J. Bioenerg. Biomembr.* 20: 639-646.
- Lomovskaya, O., Lewis, K., and Matin, A. (1995) EmrR is a negative upstream regulator of the *E coli* multidrug resistance pump EmrAB. *J. Bacteriol.* 177:2328-2334.
- Ferrante, A., Augliera, J., Lewis, K., and Klibanov, M.A. (1995) Cloning of an organic solvent resistance gene in *E. coli*: the unexpected role of alkylhydroperoxide reductase. *Proc. Natl. Acad. Sci. USA* 92:7617-7621.
- Zhang, Y., and Lewis, K. (1997) Fabatins, new antimicrobial peptides from *Vicia faba*. *FEMS Microbiol. Lett.* 149:59-64.
- Hsieh, P.-C., Siegel, S.A., Rogers, B., Davis, D., and Lewis, K. (1998) Bacteria lacking a multidrug pump: a sensitive tool for drug discovery. *Proc. Natl. Acad. Sci. USA.* 95:6602-6606.
- Lewis, K. (1998) Pathogen resistance as the origin of kin altruism. *J. Theor. Biol.* 43:359-363.

- Brooun, A., Tomashek, J.J., and Lewis, K. (1999) Purification and ligand binding of EmrR, a regulator of a multidrug transporter. *J. Bacteriol.* 181:5131-5133.
- Brooun, A., Liu, S., and Lewis, K. (2000) A dose-response study of antibiotic resistance in *Pseudomonas aeruginosa* biofilms. *Antimicrob. Agents Chemother.* 44:640-646.
- Arredondo, A.R., Dorval, B.L., Klibanov, A.M., and Lewis, K. (2000) Rapid immunodetection of *Escherichia coli*. *Biotechnol. Lett.* 22:547-550.
- Stermitz, F.R., P. Lorenz, J.N. Tawara, Zenewicz, L., and Lewis, K. (2000) Synergy in a medicinal plant: antimicrobial action of berberine potentiated by 5'-methoxyhydnocarpin, a multidrug pump inhibitor. *Proc. Natl. Acad. Sci. USA* 97:1433-1437.
- Lewis, K. (2000) Programmed death in bacteria. *Microbiol. Mol. Biol. Rev.* 64:503-514.
- Lewis, K. (2000) Translocases: A bacterial tunnel for drugs and proteins. *Current Biol.* 10:R678-R681.
- Guz, N.R., Stermitz, F.R., Johnson, J.B., Beeson, T.D., Wilen, S., Hsiang, J-F., and Lewis, K. (2001) Flavonolignan and flavone inhibitors of a *Staphylococcus aureus* multidrug resistance (MDR) pump. Structure-activity relationships. *J. Med. Chem.* 44:261-268.
- Lewis, K. (2001) The riddle of biofilm resistance. *Antimicrob. Agents Chemother.* 45:999-1007.
- Tiller, J.C., Liao, C.J., Lewis, K., and Klibanov, A.M. (2001) Designing surfaces that kill bacteria on contact. *Proc. Natl. Acad. Sci. U S A.* 22:5981-5985.
- Stermitz, F.R., Beeson, R.D., Mueller, P.J., Hsiang, J-F., and Lewis, K. (2001) *Staphylococcus aureus* MDR efflux pump inhibitors from a *Berberis* and a *Mahonia* (sensu strictu) species. *Biochem. System. Ecol.* 29:793-798.
- Spoering, A.L., and Lewis, K. (2001) Biofilms and planktonic cells of *Pseudomonas aeruginosa* have similar resistance to killing by antimicrobials. *J. Bacteriol.* 183:6746-6751.
- Severina, I.I., Muntyan, M.S., Lewis, K., and Skulachev, V.P. (2001) Transfer of cationic antibacterial agents berberine, palmatine and benzalkonium through bimolecular planar phospholipid film and *Staphylococcus aureus* membrane. *IUBMB Life* 52:321-324.
- Kaeberlein, T., Lewis*, K., and Epstein*, S.S. (2002) Isolating "uncultivable" microorganisms in pure culture using a simulated natural environment. *Science* 296:1127-1129. (*equal contribution).
- Tiller, J.C., Lee, S.B., Lewis, K., and Klibanov, A.M. (2002) Polymer surfaces derivatized with poly(vinyl-*N*-hexylpyridinium) kill air- and water- borne bacteria. *Biotechnol. Bioengineer.* 79: 465-471.
- Lin, J., Tiller, J.C., Lee, S.B., Lewis, K., and Klibanov, A.M. (2002) Insights into bactericidal action of surface-attached poly(vinyl-*N*-hexylpyridinium) chains. *Biotechnol. Lett.* 24:801-805.
- Tegos, G., Stermitz, F.R., Lomovskaya, O., and Lewis, K. (2002) Multidrug pump inhibitors uncover the remarkable activity of plant antimicrobials. *Antimicrob. Agents Chemother.* 46: 3133-3141.
- Stermitz, F.R., Cashmana, K.K., Halligana, K.M., Morel, C., Tegos, G.P., and, and Lewis, K. (2003) Polyacylated neohesperidosides from *Geranium caespitosum*: bacterial multidrug resistance pump inhibitors. *Bioorg. Med. Chem. Lett.* 13: 1915-1918.
- Kaldalu, N., Mei, R., and Lewis, K. (2004) Killing by ampicillin and ofloxacin induces overlapping changes in *Escherichia coli* transcription profile. *Antimicrob. Agents Chemother.* 48:890-896.

- Keren, I., Kaldalu, N., Spoering, A., Wang, Y., and Lewis, K. (2004) Persister cells and tolerance to antimicrobials. *FEMS Microbiol. Lett.* 230: 13-18.
- Keren, I., Shah, D., Spoering, A., Kaldalu, N., and Lewis, K. (2004) Specialized persister cells and the mechanism of multidrug tolerance in *Escherichia coli*. *J. Bacteriol.* 186:8172-8180.
- Belofsky, G., Percivill, D., Lewis, K., Tegos, G.P., and Ekart, J. (2004) Phenolic metabolites of *Dalea versicolor* that enhance antibiotic activity against model pathogenic bacteria. *J. Nat. Prod.* 67:481-484.
- Milovic, N.M., Wang, J., Lewis, K., and Klibanov, A.M. (2005) Immobilized N-alkylated polyethylenimine avidly kills bacteria by rupturing cell membranes with no resistance developed. *Biotechnol Bioeng.* 2005. 90:715-722.
- Lewis, K., and Klibanov, A.M. (2005) Surpassing nature: rational design of sterile-surface materials. *Trends Biotechnol.* 23:343-248.
- Samosorn, S., Bremner, J.B., Ball, A., and Lewis, K. (2006) Synthesis of functionalised 2-aryl-5-nitro-1H-indoles and their activity as bacterial NorA efflux pump inhibitors. *Bioorg. Med. Chem.* 14:857-865.
- Shah, D., Zhang, Z., Khodursky, A., Kaldalu, N., Kurg, K., and Lewis, K. (2006) Persisters: a distinct physiological state of *E. coli*. *BMC Microbiol.* 6:53-76.
- Spoering, A.L., Vulić, M., and Lewis, K. (2006) GlpD and PlsB participate in persister cell formation in *Escherichia coli*. *J. Bacteriol.* 186:8172-8180.
- Correia, F.F., D'Onofrio, A., Rejtar, T., Li, L., Karger, B.L., Makarova, K., Koonin, E.V., and Lewis, K. (2006) Kinase activity of overexpressed HipA is required for growth arrest and multidrug tolerance in *Escherichia coli*. *J. Bacteriol.* 188:8360-8367.
- Moy, T.I., Ball, A., Anklesaria, Z., Casadei, G., Lewis, K., Ausubel, F.M. (2006) Identification of novel antimicrobials using a live-animal infection model. *Proc. Natl. Acad. Sci. USA.* 103:10414-10419.
- Lafleur, M.D., Kumamoto, C.A., and Lewis, K. (2006) *Candida albicans* biofilms produce antifungal-tolerant persister cells. *Antimicrob Agents Chemother.* 50:3839-3846.
- Ball, A., Casadei, G., Samosorn, S., Bremner, J.B., Ausubel, F.M., Moy, T.I., and Lewis, K. (2006) Conjugating berberine to an MDR pump inhibitor creates an effective antimicrobial. *ACS Chem. Biol.* 1: 594-600.
- Lewis, K., Ausubel, F.M. (2006) Prospects for plant-derived antibacterials. *Nat. Biotechnol.* 24:1504-1507.
- Lewis, K. (2007) Persister cells, dormancy and infectious disease. *Nature Rev. Microbiol.* 5:48-56.
- Bollmann, A., Lewis, K., and Epstein, S.S. (2007) Incubation of environmental samples in a diffusion chamber increases the diversity of recovered isolates. *Appl. Environ. Microbiol.* 73:6386-6390.
- Gavriš, E., Bollmann, A., Epstein, S., and Lewis, K. (2008) A trap for in situ cultivation of filamentous actinobacteria. *J. Microbiol. Methods.* 72:257-262.
- Ambrus, J.I., Kelso, M.J., Bremner, J.B., Ball, A.R., Casadei, G., and Lewis, K. (2008) Structure-activity relationships of 2-aryl-1H-indole inhibitors of the NorA efflux pump in *Staphylococcus aureus*. *Bioorg. Med. Chem. Lett.* 18:4294-4297.

- Nichols, D., Lewis, K., Orjala, J., Mo, S., Ortenberg, R., O'Connor, P., Zhao, C., Vouros, P., Kaeberlein, T., and Epstein, S.S. (2008) Short peptide induces an "uncultivable" microorganism to grow in vitro. *Appl. Environ. Microbiol.* 74:4889-4897.
- Hansen, S., Lewis, K., and Vulic, M. (2008) Role of global regulators and nucleotide metabolism in antibiotic tolerance in *Escherichia coli*. *Antimicrob. Agents Chemother.* 52:2718-2726.
- Lewis, K., Epstein, S., Godoy, V.G., and Hong, S.H. (2008) Intact DNA in ancient permafrost. *Trends Microbiol.* 2008. 16:92-4.
- Schumacher, M.A., Piro, K.M., Xu, W., Hansen, S., Lewis, K., and Brennan, R.G. (2009) Molecular mechanisms of HipA mediated multidrug tolerance and its neutralization by HipB. *Science* 323:396-401.
- Samosorn, S., Tanwirat, B., Muhamad, N., Casadei, G., Tomkiewicz, D., Lewis, K., Suksamran, A., Prammananan, T., Gornall, K.C., Beck, J.L., and Bremner, J.B. (2009) Antibacterial activity of berberine-NorA pump inhibitor hybrids with a methylene ether linking group. *Bioorg. Med. Chem.* 17:3866-3872.
- Moy, T.I., Conery, A.L., Larkins-Ford, J., Wu, G., Mazitschek, R., Casadei, G., Lewis, K., Carpenter, A.E., and Ausubel, F.M. (2009) High-throughput screen for novel antimicrobials using a whole animal infection model. *ACS Chem. Biol.* 4:527-533.
- Dorr, T., Lewis, K., and Vulic, M. (2009) SOS response induces persistence to fluoroquinolones in *Escherichia coli*. *PLoS Genet* 5: e1000760.
- Lafleur, M.D., Qi, Q., and Lewis, K. (2010) Patients with long-term oral carriage harbor high-persistence mutants of *C. albicans*. *Antimicrob Agents Chemother.* 54:39-44.
- Dörr, T., Vulić, M., and Lewis, K., (2010) Ciprofloxacin causes persister formation by inducing the TisB toxin in *Escherichia coli*. *PLoS Biol* 8(2): e1000317.
- D'Onofrio, A., Crawford, J.M., Stewart, E.J., Witt, K., Gavrish, E., Epstein, S., Clardy, J., and Lewis, K. (2010) Siderophores from neighboring organisms promote the growth of uncultured bacteria. *Chem. & Biol.* 17: 254–264.
- Nichols, D., Cahoon, N., Trakhtenberg, E.M., Pham, L., Mehta, A., Belanger, A., Kanigan, T., Lewis, K., and Epstein, S.S. (2010) Use of ichip for high-throughput in situ cultivation of "uncultivable" microbial species. *Appl. Environ. Microbiol.* 76:2445-2450.
- Tomkiewicz, D., Casadei, G., Larkins-Ford, J., Moy, T.I., Garner, J., Bremner, J.B., Ausubel, F.M., Lewis, K. and Kelso, M.J. (2010) Berberine-INF55 hybrid antimicrobials: effects of varying the relative orientation of the berberine and INF55 components. *Antimicrob. Agents Chemother.* 54:3219-3224.
- Lewis, K., Epstein, S., D'Onofrio, A., and Ling, L.L. (2010) Uncultured microorganisms as a source of secondary metabolites. *J. Antibiot. (Tokyo).* 63:468-476.
- Lewis, K. Persister cells. (2010) *Ann. Rev. Microbiol.* 64:357-372.
- Bollmann, A., Palumbo, A.V., Lewis, K., and Epstein, S. (2010) Isolation and physiology of bacteria from contaminated subsurface sediments. *Appl. Environ. Microbiol.* 76:7413-7419.
- Mulcahy, L.R., Burns, J.L., Lory, S., and Lewis, K. (2010) Emergence of *Pseudomonas aeruginosa* strains producing high levels of persister cells in patients with cystic fibrosis. *J. Bacteriol.* 192:6191–6199.

- LaFleur, M.D., Lucumi, E., Napper, A.D., Diamond, S.L., and Lewis, K. (2011) Novel high-throughput screen against *Candida albicans* identifies antifungal potentiators and agents effective against biofilms. *J. Antimicrob. Chemother.* 66:820-826.
- Keren, I., Minami, S., Rubin, E., and Lewis, K. (2011) Characterization and transcriptome analysis of *Mycobacterium tuberculosis* persisters. *mBIO* 2: e00100-11.
- Hansen, S., Vulić, M., Min, J., Yen, T-J., Schumacher, M.A., Brennan, R.G., and Lewis, K. (2012) Regulation of the *Escherichia coli* HipBA toxin-antitoxin system by proteolysis. *PLoS ONE* 7: e39185. doi:10.1371.
- Wu, Y., Vulic, M., Keren, I., and Lewis, K. (2012) Role of oxidative stress in persister tolerance. *Antimicrob Agents Chemother.* 56:4922-4926.
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- Schumacher, M.A., Min, J., Link, T.M., Guan, Z., Xu, W., Ahn, Y.H., Soderblom, E.J., Kurie, J.M., Evdokimov, A., Moseley, M.A., Lewis, K., and Brennan, R.G. (2012) Role of unusual P loop ejection and autophosphorylation in HipA-mediated persistence and multidrug tolerance. *Cell Rep.* 27:518-525
- Lechner, S., Lewis, K., and Bertram, R. (2012) *Staphylococcus aureus* persisters tolerant to bactericidal antibiotics. *J. Mol. Microbiol. Biotechnol.* 22:235-244.
- Lewis, K. (2012) Recover the lost art of drug discovery. *Nature* (485): 439-440.
- Keren, I., Wu, Y., Innocencio, J., Mulcahy, L., and Lewis, K. (2013) Killing by bactericidal antibiotics does not depend on reactive oxygen species. *Science* 339: 1213-1216.
- Lewis, K. (2013) Platforms for antibiotic discovery. *Nat. Rev. Drug Disc.* 12: 371–387.
- LaFleur, M., Sun, L., Lister, I., Keating, J., Nantel, A., Long, L., Ghannoum, M., North, J., Lee, R., Coleman, K., Dahl, T., and Lewis, K. (2013) Potentiation of azole antifungals by 2-adamantanamine. *Antimicrob. Agents Chemother.* 57:3585-3592.
- Mulcahy, L., Isabella V.M., Lewis, K. (2013) *Pseudomonas aeruginosa* biofilms in disease. *Microbial ecology* 10/6/13: 1-12.
- Theodore, A., K. Lewis, and Vulic, M. (2013) Tolerance of *Escherichia coli* to fluoroquinolones antibiotics depends on specific components of the SOS response pathway. *Genetics* 195(4): 1265-76.
- Conlon, B.P., Nakayasu, E.S., Fleck, L.E., LaFleur, M.D., Isabella, V.M., Coleman, K., Leonard, S.N., Smith, R.D., Adkins, J.N. and Lewis, K. (2013) Activated ClpP kills persisters and eradicates a chronic biofilm infection. *Nature* 503(7476): 365-70.
- Balaban N.Q., Gerdes, K., Lewis, K., McKinney, J.D. (2013) A problem of persistence: still more questions than answers? *Nat. Rev. Microbiol.* 11(8): 587-91.
- Fleck, L.E., North, E.J., Lee, R.E., Mulchay, L.R., Casadei, G., Lewis, K. (2014) A Screen and validation of prodrug antimicrobials. *Antimicrob. Agents Chemother.* [epub ahead of print]

Chen, C., Dolla, N.K., Casdei, G., Bremner, J.B., Lewis, K., Kelso, M.J. (2014) Diarylacylhydrazones *Clostridium*-selective antibacterials with activity against stationary-phase cells. *Bioorg. Med. Chem. Lett.* 24(2): 595-600.

Gavriš, E., Sit, C.S., Cao, S., Kandrór, O., Spoering, A., Peoples, A., Ling, L., Fetterman, A., Hughes, D., Bissell, A., Torrey, H., Akopian, T., Mueller, A., Epstein, S., Goldberg, A., Clardy, J., and Lewis, K. (2014) Lassomycin, a ribosomally synthesized peptide, kills *Mycobacterium tuberculosis* by targeting the ATP-dependent protease ClpC1P1P2. *Chem. and Biology* (in press).

Non-refereed articles

Lewis, K., Hooper, D., and Ouellette, M. (1997). Microbial Multidrug Resistance Pumps: New Developments and Clinical Significance. *ASM News* 63:605-610.

Oulette, M., Lewis, K., and Hooper, D. (1997). Eukaryotic microbial multidrug resistance pumps. *ASM News* 63:664-667.

Lewis, K. (1999). Multidrug resistance: versatile drug sensors of bacterial cells. *Current Biol.* 9:R403-R407.

Lewis, K. (2001). In search of natural substrates and inhibitors of MDR pumps. *J. Mol. Microbiol. Biotechnol.* 3:247-254.

Lewis, K. Persister Cells and the Paradox of Chronic Infections. *Microbe*, October 2010.

Books

Lewis, K. (1984) *Motility and Taxis in Prokaryotes*. Harwood Acad. Pub. New York. pp. 279.

K. Lewis, A. Salyers, H. Taber, R. Wax, eds. *Bacterial Resistance to Antimicrobials: Mechanisms, Genetics, Medical Practice and Public Health*. 2001. Marcel Dekker, New York.

Book chapters

Lewis, K. (1981). Proton circuits of bacterial flagella. In: *Chemiosmotic Proton Circuits in Biological Membranes*. In Honor of Peter Mitchell. (V.P. Skulachev and P.C. Hinkle, eds.), Addison-Wesley, Reading, MA 577-600.

Lewis, K. (1999). Multidrug Resistance Efflux. In: *Transport of Molecules Across Microbial Membranes*. Broome-Smith, J.K., Baumberg, S., Stirling, C.J., Ward, F.B., eds., 58:15-40, Cambridge University Press, Cambridge.

Lewis, K., and Lomovskaya, O. (2001). Drug Efflux. In: "Bacterial Resistance to Antimicrobials: Mechanisms, Genetics, Medical Practice and Public Health", K. Lewis, A. Salyers, H. Taber, R. Wax, eds. Marcel Dekker, New York.

Lewis, K. (2008). Multidrug Tolerance of Biofilms and Persister Cells. *Current Topics in Microbiology and Immunology*. 322:108-129.

Lewis, K. (2009). Persisters, Biofilms, and the Problem of Cultivability 184-194. In: *Uncultivated Microorganisms* (Epstein, S., ed.). Springer.

Epstein, S.S., K. Lewis, D. Nichols and E. Gavrish (2010). New Approaches to Microbial Isolation. Manual of Industrial Microbiology and Biotechnology. R.H. Baltz, J.E. Davies and A. Demain. Washington, DC, ASM.

Lewis, K., Hansen, S. (2013) Type II Toxin-Antitoxin Loci, hipBA and Persisters. In: Prokaryotic Toxin-Antitoxins. Springer.

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National Geographic online (Nov 13, 2013) "Killing Sleeper Cells and Superbugs with Assassin Janitors" by Ed Yong.

<http://phenomena.nationalgeographic.com/2013/11/13/killing-sleeper-cells-and-superbugs-with-assassin-janitors/>

Science Daily, (Nov 13, 2013) "New treatment discovered to cure MRSA infection."

<http://www.sciencedaily.com/releases/2013/11/131113144109.htm>

Boston Magazine online, (Nov 13, 2013) "Northeastern University Researchers Cured A Mouse With the 'Superbug'" by Melissa Malamut

<http://www.bostonmagazine.com/health/blog/2013/11/13/northeastern-university-researchers-develop-superbug-cure/>

The Independent, (Nov 13, 2013) "A valuable weapon in war against drug-resistant superbugs: Antibiotic offers hope" by Steve Connor

<http://www.independent.co.uk/news/science/a-valuable-weapon-in-war-against-drugresistant-superbugs-antibiotic-offers-hope-8937737.html>

Keren, I., Wu, Y., Innocencio, J., Mulcahy, L., and Lewis, K. (2013) Killing by bactericidal antibiotics does not depend on reactive oxygen species. Science 339: 1213-1216.

Chemical & Engineering News (Mar 11, 2013) "Antibiotics Don't Kill with Reactive Oxygen Species" by Celia Henry Arnaud.

Mulcahy, L.R., Burns, J.L., Lory, S., and Lewis, K. (2010). Emergence of *Pseudomonas aeruginosa* strains producing high levels of persister cells in patients with cystic fibrosis. J. Bacteriol. 192:6191–6199.

Microbe (2011) Persister Cells Fingered in Chronic CF. (Feature).

Anthony D'Onofrio, Jason M. Crawford, Eric J. Stewart, Kathrin Witt, Ekaterina Gavrish, Slava Epstein, Jon Clardy, Kim Lewis (2010) Siderophores from Neighboring Organisms Promote the Growth of Uncultured Bacteria. Chemistry & Biology 17(3)256-264.

Discover Magazine (2010) Luring Out the Missing Biosphere. Carl Zimmer.

Faculty of 1000 Biology (2010), A "Must read" by Harald Labischinski.

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Dörr T, Vulic M, Lewis K (2010) Ciprofloxacin causes persister formation by inducing the TisB toxin in *Escherichia coli*. PLoS Biol 8(2): e1000317.

Faculty of 1000 Biology (2010) Review. Daniel Madar and Uri Alon.

Boston Globe (2010) Outwitting germs that never say die. Carolyn Y. Johnson.

Schumacher, M.A., Piro, K.M., Xu, W., Hansen, S., Lewis, K., and Brennan, R.G. 2009. Molecular mechanisms of HipA mediated multidrug tolerance and its neutralization by HipB. *Science* 323:396-401.

Educational video: <http://www.3dciencia.com/>.

Hansen, S. Lewis, K. Vulic, M. (2008) Role of global regulators and nucleotide metabolism in antibiotic tolerance in *Escherichia coli*. *Antimicrob Agents Chemother.* 52(9):2716-26.

Microbe, Current Topics. (2008) Genes Underlying Bacterial "Persister Cells" Identified. 3:399-400.

Belofsky, G., Carreno, R., Lewis, K., Ball, A., Casadei, G., and Tegos, G.P. (2006) Metabolites of the 'Smoke Tree' *Dalea spinosa* Potentiate Antibiotic Activity against Multi-Drug Resistant (MDR) *Staphylococcus aureus*. *J. Nat. Prod. Chem.* 69:261-4.

American Society of Pharmacognosy (ASP) Newsletter, Clearing the Air on the Smoke Tree, Vol. 42(2) 2006.

Moy, T.I., Ball, A.R., Anklesaria, Z., Casadei, G., Lewis, K., and Ausubel F.M. (2006) From the Cover: Identification of novel antimicrobials using a live-animal infection model. *Proc. Natl. Acad. Sci. U S A.* 103:10414-9.

PNAS In the News. Identification of novel antimicrobials using a live-animal infection model, July 2006.

Nature Reviews: Microbiology, Research Highlights. Anti-infectives Worming a way to better drugs August 2006.

Nature Biotechnology, Research Highlights. The worm turns for antimicrobial discovery. September 2006.

Kaeberlin, T., Lewis, K., and Epstein, S. S. (2002) Isolating "uncultivable" microorganisms in pure culture using a simulated natural environment. *Science* 296:1127-1129.

Science (News) 296:550 (2002)

Lin, J., Tiller, J.C., Lee, S.B., Lewis, K., and Klibanov, A.M. (2002) Insights into bactericidal action of surface-attached poly(vinyl-N-hexylpyridinium) chains. *Biotechnol. Lett.* 24:801-805.

Chem. Engineer. News (2002) 80:22. Surface Designed to Kill Bacteria.

Spoering, A. L. and Lewis, K. (2001) Biofilms and Planktonic Cells of *Pseudomonas aeruginosa* Have Similar Resistance to Killing by Antimicrobials. *Journal of Bacteriology* 183:6746-6751

ASM News Journal Highlights. Persister Cells Responsible for Biofilms' Antimicrobial Resistance. January 2002.

Tiller, J.C., Liao, C.J., Lewis, K., and Klibanov, A.M. (2001). Designing surfaces that kill bacteria on contact. *Proc. Natl. Acad. Sci. U S A.* 22:5981-5985.

Chem. Engineer. News (2001) 79:13. Designed Surface Kills Bacteria.

Chem. Engineer. News (2001) 79:50. Chemistry highlights 2001. *Science (News)* 159(21):325 (2001)

Technology Review (MIT) 104:19 (2001)

Lewis interview with NPR: <http://www.npr.org/templates/story/story.php?storyId=1123328>

Stermitz, F.R., Lorenz, P., Tawar, J.N., Zenewicz, L., and Lewis, K. (2000). Synergy in a medicinal plant: antimicrobial action of berberine potentiated by 5'-methoxyhydrnocarpin, a multidrug pump inhibitor. *Proc. Natl. Acad. Sci. USA* 97:1433-1437.

Chem. Engineer. News (2000). 78 (8):6-7. Plant may hold key to ultimate antibiotic.

Chem. Engineer. News (2000). 78 (51):24-31. Chemistry highlights 2000.

• INVENTIONS

1. Solvent-resistant microorganisms. Klibanov, A. M., Lewis, K., Ferrante, A., Coyle, C. L., Zylstra, G., Logan, M. S. P., Grossman, M. J. US Patent #5,807,735. Awarded 9.15.98.
2. Culturing cells in presence of amphipathic weak bases and/or cations and multiple drug resistance inhibitor containing reserpine. Lewis, K., Hsieh, P-C. US Patent #6,410,041. Awarded 6.25.02.
3. Isolation and cultivation of microorganisms from natural environments and drug discovery based thereon. Lewis, K., Epstein, S.S., and Kaeberlein, T. US Patent #7,011,957. Awarded March 14, 2006. Licensed to NovoBiotic Pharmaceuticals, LLC.
4. Antimicrobial polymeric surfaces. Klibanov, A.M., Lewis, K., Tiller, J., Liao, C-J. US 10/123,860 (Patent pending). Licensed to Pulmatrix, Inc.

Funding (last 10 years)

Current Support:

| Source of Funding, Role, Title | Duration, Annual Direct Costs to ADC | Total Award Funding |
|--|--------------------------------------|---------------------|
| NIH Director's Transformative Award T-R01AI085585-04 (K. Lewis, P.I.) Super-persistent cells and the paradox of untreatable infections | 9/25/09 - 8/31/2014 \$673,396 | \$5,538,557 |
| Lyme Research Alliance (K. Lewis, P.I.) Persister Cells and Antibiotic Tolerance in <i>B. burgdorferi</i> | 07/01/13-06/30/14 \$151,000 | \$151,000 |
| NIH (K. Lewis, Co-PI) Developing therapeutics to treat chronic infections | 03/01/14-02/28/19 \$206,952 | \$1,780,943 |
| Institut Merieux (K. Lewis, PI) Die Hard: How <i>M. tuberculosis</i> survives antibiotic treatment | 02/01/14-01/31/16 \$137,500 | \$275,000 |
| Total Amount | \$1,168,848 | \$7,745,500 |

| Resource Grants 2009-2012 |
|---|
| NIH/Broad Institute whole genome sequencing for 400 genomes and transcriptome analysis |
| NIH/Harvard/ICCB, High-throughput screening, 250,000 compound screen for <i>C. difficile</i> therapeutics |
| NIH/NCI, 140,000 compound library |

Past Support (last 10 years):

| | | |
|---|--------------------------------------|-------------|
| 1R01HG005824-03 (K. Lewis, P.I.) Culturing uncultivable gut microorganisms | 07/01/2010 - 06/31/2013 \$173,378 | \$1,233,692 |
|---|--------------------------------------|-------------|

| | | |
|--|---|-------------|
| 1 R01 AI076372-04 (K. Lewis, P.I.) NIH A synergy-based therapy against <i>C. difficile</i> | 2/2/2009- 2/1/2014 \$224,108 | \$2,721,560 |
| 1R01AI085005-03 (K. Lewis, P.I.) NIH A High-Throughput screen for specific anti- <i>M. tuberculosis</i> compounds | 07/01/2010 - 04/30/2013 \$250,000 (scored in top 1%) | \$1,170,000 |
| W9911NF-09-1-0265 (K. Lewis, P.I.) ARO Genetics of persister formation in <i>Pseudomonas aeruginosa</i> | 6/1/2009-5/31/2012 \$48,750 | \$315,057 |
| 3R01 GM061162 -05A1 (K. Lewis, P.I.) NIH A genomics approach to drug tolerance | 4/1/2008- 3/31/2012 \$241,294 | \$1,163,292 |
| 3R01GM061162-10S1 (K. Lewis, P.I.) NIH A genomics approach to drug tolerance (ARRA Competitive Revision) | 9/30/2009 - 8/31/2011 \$210,950 | \$641,368 |
| (L. Mulcahy, PI, K. Lewis, Sponsor) Cystic Fibrosis Foundation Antibiotic Tolerance in <i>Pseudomonas aeruginosa</i> | 5/1/2008-4/30/2011 \$42,500 | \$127,500 |
| (K. Lewis, P.I.; E. Rubin, Harvard Medical School, Co-PI.) Bill & Melinda Gates Foundation. Isolation and properties of <i>M. tuberculosis</i> persisters | 11/01/2007 – 3/31/2011 \$243,515 | \$1,119,604 |
| 1R01AI070863-01A1 (K. Lewis, P.I.) NIH Screen development for antimicrobial prodrugs | 12/15/2006 - 11/03/2009 \$250,000 | \$1,170,000 |
| RO1 AI072508-01 (F. Ausubel, PI; K. Lewis, co-investigator) NIH Novel whole-animal screens for anti-microbials | 12/15/2006 - 11/03/2009 \$80,000 | \$1,170,000 |
| 1R43 AI072895 - 01 (C. Moore, P.I.; K. Lewis, Co-Investigator)NIH Isolating novel fungi for antibiotic discovery | 1/07 – 1/09 \$63,600 | \$600,000 |
| 1 R21 DE018026-01A1 (S. Epstein, P.I.; K. Lewis, Co-Investigator) NIH Cultivating the 'uncultivable' oral microflora | 08/01/07 – 07/30/09 \$60,000 | \$431,750 |
| 2 R01 GM061162-05A1 (K. Lewis, P.I.) NIH A genomics approach to biofilms | 3/1/04-2/28/08 \$170,000 | \$1,067,600 |
| R21 AI059483-01 (K. Lewis, P.I.) NIH Novel methods for discovery of anti-microbials | 3/1/04 – 3/1/06 \$200,000 | \$628,000 |
| R21 AI059489-01 (K. Lewis, P.I.; S. Epstein, Co-PI) NIH Biodefense therapeutics from uncultured microorganisms | 3/1/04 – 3/1/06 \$200,000 | \$628,000 |

| | | |
|---|----------------------------------|-------------|
| R01 GM61162 (K. Lewis, P.I.) NIH A genomics approach to <i>P. aeruginosa</i> biofilms | 08/10/00 – 09/01/04 \$190,000 | \$1,191,920 |
| NIH RO1GM59903 (K. Lewis, P.I.; F. Stermitz, Co-PI) NIH Natural substrates and inhibitors of microbial MDR pumps | 3.1.01 – 2.28.03 \$118,000 | \$373,267 |
| SGER 0132889 (K. Lewis, P.I.) NSF Apoptosis in bacteria | 9.1.01 – 8.30.02 \$50,000 | \$78,500 |

Administrative responsibilities:

Director, Antimicrobial Discovery Center (ADC), 2006 – present.

Supervise a team of 25 researchers, including 2 Research Assistant Professors supervising research teams (Persisters cells in infectious diseases; Uncultured bacteria; and Drug discovery), 3 Senior Scientists, 6 Postdoctoral Associates, 2 Research Assistants, 2 Visiting Scientists, and 10 Graduate Students.

A full-time Operations Coordinator assists the Director.

NEU Faculty affiliated with the Center:

Slava Epstein, Biology (Microbial ecology)

Michael Pollastri, Chemistry (Medicinal chemistry)

Vladimir Torchilin, Pharmaceutical sciences (Nanotechnology and drug delivery)

April Gu, Civil and Environmental Engineering

External collaborators of the Center:

Frederick Ausubel, MGH (*C. elegans* model of infection for drug discovery)

Eric Rubin, Harvard School of Public Health (*M. tuberculosis* latency)

Sarah Fortune, HHMI/ Harvard School of Public Health (*M. tuberculosis* latency)

Clifton Barry, NIAID (*M. tuberculosis* latency)

Sang Jae Kim, International Tuberculosis Research Center, Korea (*M. tuberculosis* latency)

Steven Lory, HMS (*P. aeruginosa* molecular biology)

Jon Clardy, HMS (Natural product chemistry)

Richard Brennan, University of Texas M.D. Anderson Cancer Center (Crystallography)

Wayne Anderson, Northwestern University/NIH Center for Structural Genomics (Protein NMR)

James Galagan, BU/Broad Institute (Whole genome sequencing)

George Weinstock, Director, Genome Sequencing Center, Washington University School of Medicine (Microbiome sequencing)

David Relman, Stanford University Medical Center (Microbiome analysis)

Sergey Bezrukov, NICHD (Membrane channels)

Richard Lee, St. Jude Hospital (Medicinal chemistry)

Michael Kelso, University of Wollongong (Medicinal chemistry)

Ralph Bertram, University of Tubingen (*S. aureus* tolerance)

Founder:

NovoBiotic Pharmaceuticals, Cambridge, MA (co-owned by NEU)

Arietis Corporation, Boston, MA (co-owned by NEU)

Consulting for the Industry:

Pfizer, Merck, Pharmacia-Upjohn; Procter & Gamble; Phytera; Microcide; PathoGenesis; Chiron; Genome Therapeutics; Lytex; Energy Biosystems; Combinatorix; Cubist; Genzyme; Novartis.

Teaching (NEU):

Supervised 20 Graduate students

Courses taught:
General Microbiology, undergraduate
Microbial Biotechnology, graduate/undergraduate

SERVICE

Co-Chair of the University Academic Planning Committee. The committee formulated a strategic plan for the University development for the next decade, 2008-2009.

Chair, search committee for Department Chair, 2008-2009; 2012-2013.

Chair, search committees for Faculty in Bioinformatics and Microbiology 2002-20012.

Chair, Department equipment committee 2009 - present.

Member, NEU Research Policy Oversight Committee 2008 – 2009.

Mentor for 4 Junior Faculty.

Grant reviewing

Chair, NIAID-BARDA Application of Platform Technologies for the Development of Therapeutics for Biodefense study section, 2008.

Chair, NIH Roadmap study section, High Throughput Screening in the Molecular Libraries Screening, 2008.

NIH study section member, Drug Discovery and Mechanisms of Antimicrobial Resistance, 2004 –2006.

Ad hoc on numerous NIH study sections.

Ad hoc Reviewer for NSF, DOE, ARO, The Bill & Melinda Gates Foundation, The Wellcome Trust, EU Funding Agencies, National Funding Agencies (Singapore, New Zealand, Spain).

Reviewer, Nature, Science, Cell, Proceedings of the National Academy of Sciences, USA; Journal of Biological Chemistry; Journal of Biochemistry; Microbiological Reviews; Molecular Microbiology; Journal of Bacteriology; Antimicrobial Agents and Chemotherapy; Journal of Molecular Microbiology and Biotechnology; Canadian Journal of Microbiology; Applied and Environmental Microbiology.

Invited Talks At Meetings (selected, last 5 years)

Nobel Conference “Biofilm formation, its clinical impact and potential treatment”, Karolinska Institutet, Stockholm, 2013

International Academy of Endodontics. January 21, 2012. “Uncultivable Organisms and Bacterial Persistence”.

ASM General Meeting in San Francisco. June 16-19, 2012. “Persister cells and infectious diseases”.

Lyme Disease Association/Columbia University Scientific Conference. September 30, 2012. “Antibiotic Tolerance & Microbial Persistence”.

Harvard-wide Program on Antibiotic Resistance. November 6, 2012, PPG Workshop. “Platforms for Antimicrobial Drug Discovery”.

Computational Biology Training & Workshop UC-Berkeley. August 11, 2011, Berkeley. "Growth Factors for Uncultured Microorganisms".

Workshop "Antibacterial Resistance and Diagnostic Device and Drug Development Research for Bacterial Diseases" Co-Sponsored by FDA, NIAID, and the Infectious Diseases Society of America (IDSA). July 26, 2011. Silver Spring, MD. "Antimicrobial tolerance of persister cells and drug discovery".

22nd Annual Buffalo Conference on Microbial Pathogenesis (Graduate students invited speaker). April 28th, 2010. "Persister Cells, Biofilms, and the Paradox of Relapsing Infections".

National Academies Forum on Microbial Threats Antimicrobial Resistance Workshop. Washington, DC. April 7th, 2010. "Novel Approaches for Drug Discovery".

Biofilms workshop, Mathematical Biosciences Institute, Ohio State University, Columbus. March 23rd, 2010. "Persisters and The Paradox of Relapsing Infections".

Leopoldina Symposium, Evolution of Programmed Cell Death in Infection & Immunity. Wuerzburg, September 18th, 2009. "Death and Survival in Bacterial Populations".

ICAAC Annual Meeting, San Francisco. September 13th, 2009. "Bacterial Death or Survival: Mechanisms of Antibiotic Killing and Tolerance".

Society of Industrial Microbiology and Biotechnology Annual Meeting, Toronto. July 28th, 2009. "Uncultured Microorganisms: From in Situ Cultivation To Drug Discovery".

Keynote Lecture, Bacterial Adhesion in Environmental Systems, American Chemical Society's Colloids Meeting, Columbia University, NY. June 15, 2009. "Adhesion and the Mechanism of Biofilm Tolerance to Antimicrobial Agents".

Keynote Lecture, 16th Annual Conference for Undergraduate Educators Colorado State University, Ft. Collins. May 30th, 2009. "Biofilms Opposites: Pathogenesis and Drug Discovery from Uncultured Species".

American Society For Microbiology, Philadelphia. May 19th 2009. "Dormant Persisters: Mechanisms of Formation and Role in Disease".

48th ICAAC/IDSA Annual Meeting, Washington, DC. Oct 26th, 2008. "Antimicrobial Tolerance: Persisters, Biofilms, and Infectious Diseases."

The Rockefeller Foundation Workshop, Evolution of Microbial Heterogeneity and Complexity. Bellagio, Italy. October 22nd, 2008. "Molecular Mechanism of Persister Cell Development".

International Conference on Gram-Positive Pathogens, University of Nebraska Medical Center. October 8th 2008. "Persister Cells: Role in Pathogenesis and Mechanisms of Drug Tolerance".

The Life Sciences Division of the Army Research Office: Bacterial Structure and Composition as a Function of Growth Conditions. Arlington, Virginia. September 30th, 2008 "Bacterial Dormancy: Persister Cells and Unculturable Species".

Arrowhead Microbial Genomics Conference, Arrowhead, CA. September 16th, 2008. "Persister Cells and Biofilm Resistance".

Practical application of Permeant Ions, Karolinska Institute, Stockholm, July 7th, 2008. "Phenoptosis In Bacteria- Current State of The Art".

2008 Banff Conference on Infectious Diseases, Alberta. May 29th, 2008. “Multidrug Tolerance of Persister Cells and Approaches to Infection Eradication”.

Stress, Stress Responses and Mechanisms of Evolvability, Baeza, Spain. October 22nd, 2007. “Persister Cells and Multidrug Tolerance of Biofilm Producing Pathogens”.

Host Pathogen Co-Evaluation: A Tale of Struggle and Affection, Wurzburg. May 11th, 2007. “Biofilm Infections and Multidrug Tolerant Persister Cells”.

Society for General Microbiology, Biofilm: A Systems of Microbiology Analysis Meeting, Limerick. April 19th, 2007. “Persister Cells in Bacterial and Yeast Infections”.

ASM Biofilm Conference, Quebec. March 29th, 2007. “Persister Cells and Multidrug Tolerance in Biofilms”.

Keynote Lecture, University of Wollongong Antimicrobials Workshop, New South Wales. November 9th, 2006. “The Challenge of Antibiotic Discovery and Emerging Solutions”.

American Society for Microbiology 106th General Meeting. Orlando. May 24th, 2006. “The Promise of Uncultivated Microorganisms”.

SIM Natural Products Discovery and Production Conference, Santa Fe. June 6th, 2006. “Growing Unculturable Bacteria for Natural Product Drug Discovery”.

ICAAC/ISME Meeting, San Francisco. July 28th, 2005. “Persisters and The Molecular Mechanism of Multidrug Tolerance”.

ICAAC/ISME Meeting, San Francisco. July 27th, 2005. “Domesticated Unculturable Bacteria: A New Source of Bioactive Models”.

Gordon Research Conference on Tuberculosis Drug Development. July 5th, 2005. “Molecular Mechanisms of Bacterial Dormancy”.

Division A Lecture, American Society For Microbiology 105th General Meeting, Atlanta. June 6th 2005. “Persister cells and Unculturable Bacteria – One Mechanism For Two Puzzling Phenomena”.

Biology of Tuberculosis Persistence, The Gates Foundation/GlaxoSmithKline Meeting, Tres Cantos, Spain. May 17, 2005. “Counterpoint Discussion of Persistence as a Deterministic Phenomenon”.

Society for Industrial Microbiology Conference on Biofilms. Microbial Adhesion to Surfaces: Mechanisms and Prevention. Arlington, Virginia. April 11th, 2005. “Molecular Mechanism of Biofilm Multidrug Tolerance”.

50th Anniversary of Russian Bioenergetics: The Way From Single Molecules To Cell Physiology, Moscow State University. February 21st, 2005. “Bioenergetics, Multidrug Resistance, and Cell Fate”.

Invited Seminars (selected, last 5 years)

Leading Scientists Seminar Series, Imperial College London, 2013. “Persister Cells and the Paradox of Chronic Infections”.

Lester O. Krampitz Lecture, Case Western Reserve University, 2013. “Specialized survivor cells and the quest for a sterilizing antibiotic”.

Marine Biological Laboratory. January 27, 2012. "Dormancy Rules: Persister Cells and Uncultured Microorganisms".

University of Maryland Baltimore. February 15, 2012. "Microbial dormancy: a common cause of drug tolerance and "uncultivability".

Biochemistry Seminar Series at Boston University. February 21, 2012. "Dormant Persister Cells and the Challenge of Drug Tolerance".

University of Massachusetts Amherst Marine Biological Laboratory. January 27, 2012. "Dormancy Rules: Persister Cells and Uncultured Microorganisms".

University of Maryland Baltimore. February 15, 2012. "Microbial dormancy: a common cause of drug tolerance and "uncultivability".

St. John's University, New York. April 18, 2012. "Antibiotic Tolerance in Persisters, Specialized Survivor Cells".

Department of Microbiology at NYU School of Medicine. January 5, 2012. "Persister Cells and the Paradox of Chronic Infections".

Rutgers University. February 25th, 2011. " Drug Discovery and The Paradox of Chronic Infections".

St. Jude Children's Research Hospital. May 6, 2011. "E1003- New Antibiotics from Old Sources".

New England BioLabs. Ipswich, Massachusetts. October 20, 2011. "Uncultured Bacteria and Persister Cells: Dormancy in The World of Microbes".

University of Texas Houston Medical School. December 2^d, 2010. "Bacterial Dormancy, a Common Cause for Persistence and Uncultivability".

University of Illinois at Urbana-Champaign. November 3rd, 2010. "Bacterial Dormancy: Common Cause of Drug Tolerance and "Uncultivability".

Forsyth Institute, Boston. December 3rd, 2009. "Microbial Dormancy: Role in Disease and Uncultivability".

Novartis Institutes for BioMedical Research, Cambridge. November 3rd, 2009. "Persister cells and the Paradox of Untreatable Infections".

Florida International University, Miami, Department of Molecular Biology & Infectious Disease. October 9th, 2009. "Persister Cells: Mechanis of Formation and Role in Relapsing Infections".

Cubist Pharmaceuticals, Lexington. August 12th, 2009. "Multidrug Tolerant Persisters in Bacteria and Fungi".

University of Florida Gainesville, Department of Molecular Microbiology & Infectious Disease. February 16th 2009. "Dormancy, A Common Cause of Antibiotic Tolerance and Unculturability".

University of Rochester, Department of Microbiology & Immunology. February 10th, 2009. "Microbial Persisters".

Waksman Foundation for Microbiology Board of Trustees Annual Meeting, Woods Hole. June 6th, 2008. "Unsolved Problems in Microbiology".

Brandeis University, Biochemistry/Biophysics Friday Journal Club (Graduate Student invitation). April 4th, 2008. "Antibiotic Tolerance of Invincible Persister Cells".

University of North Carolina, Chapel Hill, Department of Microbiology. January 24th, 2008. "Persister Cells: The Perfect Defense Against Antibiotics".

Board of Trustees Meeting, Northeastern University, Boston. October 26th 2007. "New Ideas for New Antibiotics".

Johns Hopkins University, School of Medicine. Baltimore. October, 8th, 2007. "Antibiotic Tolerant Persister Cells and Approaches to Their Eradication".

City University of New York, Department of Biochemistry. October 3rd, 2007. "Persister Cells and Antibiotic Discovery".

3M, September 26th, 2007. "Persister Cells: The Ultimate Challenge for Antimicrobial Chemotherapy".

The Sloan Foundation, presentation for program directors. New York. May 7th, 2007. "In What Form Do Bacteria Travel?".

University of Medicine & Denistry of New Jersey, Department of Microbiology & Molecular Genetics. February 13th, 2007. "Microbial Persister Cells, Biofilms, and Multidrug Tolerance".

Harvard Medical School, Department of Microbiology & Molecular Genetics. January 9th, 2007. "Persister Cells, Biofilms, and Multidrug Tolerance".

Harvard University, Microbial Sciences Initiative. December 14th, 2006. "The Puzzle of Uncultured Bacteria".

University of Massachusetts Medical School, Department of Molecular Genetics & Microbiology. September 29th, 2006. "Multidrug Tolerance of Microbial Persister Cells".

Massachusetts Institute of Technology, Broad Institute. May 19th, 2006. "Bacterial Persisters: The Role of Dormancy in Infection And Unculturability".

US Army Soldier Systems Center Seminar. Natick, Massachusetts. January 12th, 2006. "Biofilm Multidrug Tolerance and Eradication Strategies".

University of Missouri-Columbia, Department of Molecular Microbiology & Immunology. November 3rd, 2005. "Persister Cells and Unsolved Puzzles in Microbiology".

Marine Biological Laboratory, Woods Hole. October 11, 2005. "Unculturable Bacteria and Unsolved Puzzles in Microbiology".