Legionella

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Granular activated carbon (GAC) filters are final polishing step in the drinking water treatment systems for removal of dissolved organic carbon fractions. Generally filters are colonized by bacterial communities and their activity reduces biodegradable solutes allowing partial regeneration of GAC's adsorptive capacity. When the bacteria pass into the filtrate due to increased growth, microbiological quality of drinking water is compromised and regrowth in the distribution system occurs. Bacteria attached to carbon particles as biofilms or in conjugation with other bacteria were observed to be highly resistant to post filtration microbial mitigation techniques. Some of these bacteria were identified as pathogenic. This study focuses on one such pathogen Legionella pneumophila which is resistant to environmental stressors and treatment conditions. It is also responsible for Legionnaires' disease outbreak through drinking water thus attracting attention of regulatory agencies. The work assessed the attachment and colonization of Legionella and heterotrophic bacteria in lab scale GAC media column filters. Quantification of Legionella and HPC in the influent, effluent, column's biofilms and on the GAC particles was performed over time using fluorescent microscopy and culture based techniques. The results indicated gradual increase in the colonization of the GAC particles with HPC bacteria. Initially high number of Legionella cells were detected in the column effluent and were not detected on GAC suggesting low attachment of the cells to the particles potentially due to lack of any previous biofilms. With the initial colonization of the filter media by other bacteria the number of Legionella cells on the GAC particles and biofilms also increased. Presence of Legionella was confirmed in all the samples collected from the columns spiked with Legionella. Significant increase in the Legionella was observed in column's inner surface biofilm (0.25 logs up to 0.52 logs) and on GAC particles (0.42 logs up to 0.63 logs) after 2 months. Legionella and HPC attached to column's biofilm were higher than that on GAC particles indicating the strong association with biofilms. The bacterial concentration slowly increased in the effluent. This may be due to column's wall effect decreasing filter efficiency, possible exhaustion of GAC capacity over time and potential bacterial growth.

Legionellosis is a disease of significant medical and public interest. Legionella is commonly found in aquatic habitats where its ability to survive and to multiply within different protozoa equips the bacterium to be transmissible and pathogenic to humans. In addition, Legionella has become a favored model system to analyze the mechanisms of bacterial survival, acquisition of nutrients, and intracellular replication. Following the recent publication of the genome sequences of four L. pneumophila strains, it is now feasible to investigate the whole genome in silico, the transcriptome via micro arrays, and the proteome by two-dimensional gel electrophoresis. Research in the fields of clinical features, diagnosis, treatment, and epidemiology continues to generate new data. The topics covered by this volume range from the history of the identification of Legionella and clinical disease treatment, to the microbe's gene expression and secretion systems, as well as its strategies for intracellular multiplication and nutrient acquisition. The main focus of the book is the current state of many of the most critical features of Legionella. Internationally renowned authors have contributed chapters describing and discussing the latest research findings with an emphasis on molecular aspects. The editors and authors have produced an excellent book that will be an extremely useful reference source. This comprehensive publication is aimed at readers with teaching or research interests in microbiology, genetics, genomics, infectious diseases, or clinical research.

Legionnaires' disease, a pneumonia caused by the Legionella bacterium, is the leading cause of reported waterborne disease outbreaks in the United States. Legionella occur naturally in water from many different environmental sources, but grow rapidly in the warm, stagnant conditions that can be found in engineered water systems such as cooling towers, building plumbing, and hot tubs. Humans are primarily exposed to Legionella through inhalation of contaminated aerosols into the respiratory system. Legionnaires' disease can be fatal, with between 3 and 33 percent of Legionella infections leading to death, and studies show the incidence of Legionnaires' disease in the United States increased five-fold from 2000 to 2017. Management of Legionella in Water Systems reviews the state of science on Legionella contamination of water systems, specifically the ecology and diagnosis. This report explores the process of transmission via water systems, quantification, prevention and control, and policy and training issues that affect the incidence of Legionnaires' disease. It also analyzes existing knowledge gaps and recommends research priorities moving forward.

Since its first report in 1976, many outbreaks of Legionella have been reported in the world. These outbreaks are a public health concern because of legionellosis, which cause Pontiac fever and Legionnaires disease. Legionnaires disease is a type of pneumonia responsible for the majority of the illness in the reported outbreaks. This study consists of an extensive literature review and experimental work on the aerosolization of Legionella and a bacterial surrogate under laboratory conditions. The literature review summarizes Legionella characteristics, legionellosis, potential sources of Legionella, disease outbreaks, collection and detection methodologies, environmental conditions for growth and survival of Legionella, Gaussian plume dispersion modeling, and recommendations for reducing potential Legionella outbreaks. The aerosolization and airborne dispersion of Legionella and E. coli was conducted separately inside of a closed environment. First, the bacterial cells were sprayed inside of an airtight box and then samples were collected using a microbial air sampler to measure the number of bacterial cells aerosolized and transported in air.

Furthermore, a Gaussian plume dispersion model was used to estimate the dispersion under the experimental conditions and parameters. The concentration of Legionella was estimated for a person inhaling the air at three different distances away from the spray. The concentration of Legionella at distances of 0.1 km, 1 km, and 10 km away from the source was predicted to be 1.7x10-1, 2.2x10-3, and 2.6x10-5 CFU/m3, respectively.

Methods and Protocols

Puzzled by Legionella: a Guide to Understanding Detection, Prevention, and Water Management

The Control of Legionella Bacteria in Water Systems: Approved Code of Practice and Guidance on Regulations

Legionella: Infections and Pathology

Isolation of Legionella

Legionella spp. are ubiquitous microorganisms that are widely distributed in aquatic environments. Water systems of large buildings, such as hospitals, hotels, and rental units are often contaminated by legionellae and various parameters such as physical, chemical, and microbial building water system characteristics can influence Legionella occurrence. A range of physical and chemical disinfection methods have been proposed to control Legionella contamination; however, to date, the most effective procedures have not been defined. There is a need to survey legionellae in water systems to prevent legionellosis. Although the assessment of L. pneumophila in water is typically performed by culture isolation on selective media, it has several limits. For this reason, alternative tools for rapid, sensitive, and specific detection of Legionella in water samples have been proposed. In order to increase knowledge on different aspects of Legionella contamination in the water environment, this book gathers research studies related to the occurrence of Legionella in water systems of different environments; the role of different factors that can influence the Legionella contamination, as well as the advantages and disadvantages of different methodological approaches.

Legionella refers to a genus of pathogenic bacteria which can cause diseases such as legionellosis, Pontiac fever and Legionnaires' disease. Their symptoms are similar to pneumonia. Complicated cases might also lead to issues related to the gastrointestinal tract and nervous system. The infections generally spread by the inhalation of water droplets from a source in which the bacteria has spread. It has not been observed to spread from person-to-person. The incubation period of these bacteria inside a host organism is up to two weeks. It usually causes severe complications in individuals who are aged or immunocompromised. This book contains some path-breaking studies in the research of legionella. Also included herein is a detailed explanation of the various infections and pathology of these bacteria. The extensive content of this book provides the readers with a thorough understanding of the subject.

Legionella ssp. are the causative agents of severe inflammatory pneumonia, known as Legionnaires' Disease, which is fatal in up to 30 % of cases. Legionella replicate within alveolar macrophages by hijacking host cell pathways to establish a unique vacuolar niche. This includes the regulation of programmed host cell death factors, as Legionella must first prevent, and then induce, host cell death to promote bacterial growth and egress, respectively. However, the molecular mechanisms involved in toggling "off" and "on" host cell death signalling pathways remain undetermined. The major focus of the work described in this thesis was the delineation of the role that programmed host cell death pathways play in Legionella infection. To do this, a novel live-cell imaging technique was employed to visualise the intracellular life-cycle of Legionella and to monitor macrophage health in real-time. Using this method, I was able to confirm that wild-type Legionella induce a rapid form of cell death, termed pyroptosis, which is dependent on bacterial flagellin and the host protease, caspase-1. While flagellin/caspase-1-mediated pyroptosis prevents bacterial replication, I have identified that aflagellated Legionella also induce caspase-11-dependent pyroptosis. In contrast to caspase-1, caspase-11-mediated pyroptosis is induced in the late stages of infection, concomitant with Legionella egress, and does not interfere with intracellular bacterial replication. Legionella are also thought to induce other forms of host cell death, however, genetic ablation of mitochondrial apoptosis (BAX and BAK deletion), caspase-independent necroptotic cell death (RIPK3 and MLKL deletion), or BNIP3 and BCL-RAMBO, the putative targets of the effector protein SidF, did not affect Legionella replication or the killing of host macrophages.Legionella must prevent the activation of host cell death signalling to allow for efficient replication. While down-regulation of flagellin enables intracellular growth in the presence of caspase-1, little is known about how Legionella might evade apoptotic cell death. Using live-cell imaging, I have now shown that Legionella-infected macrophages depend critically upon the anti-apoptotic activity of host cell BCL-XL, but not other BCL-2 family members, for viability. In the absence of BCL-XL, Legionella-infected cells underwent apoptosis, which abolished bacterial replication and dissemination. Legionella infection could be fully restored by inhibiting mitochondrial apoptosis, either via BAX/BAK deletion or caspase inhibition. A single dose of BCL-XL-targeted BH3-mimetic therapy significantly reduced Legionella burden in the lungs of mice and prevented lethal bacterial infection. Mechanistically, I identified that Legionella infection inhibits host protein synthesis, which sensitises macrophages to BCL-XL loss or inhibition, via depletion of another anti-apoptotic BCL-2 family protein, MCL-1. Together, these results demonstrate that Legionella- infected macrophages are specifically and acutely sensitive to apoptotic cell death following the loss, or inhibition, of BCL-XL. Thus, the re-purposing of existing drugs, such as chemotherapeutic BH3-mimetics, to target host, rather than bacterial, pathways represents a novel and promising strategy for the treatment of intracellular pathogens that show increased, and often rapidly acquired, antibiotic resistance.

"Legionella are aquatic bacteria capable of inhabiting man-made water systems. Inhaling water droplets carrying Legionella can cause Legionnaires' disease, a rapidly progressing pneumonia. From 2000-2016 the number of Legionnaires' cases increased 5-fold. Detecting Legionella in water systems can be challenging. Legionella have complex growth requirements, requiring expensive specialized media to grow. It can take 10 days to grow Legionella colonies on agar plates. There are few rapid assays available that can identify multiple Legionella species. This project aims to develop a Loop Mediated Isothermal Amplification (LAMP) assay that can detect multiple species of Legionella in less than one hour. LAMP utilizes four primers, a strand displacing DNA polymerase, and a single incubation temperature to amplify DNA from a target specimen. Four primers were designed that amplify a unique Legionella 16S rDNA sequence. We have demonstrated that a Legionella specific LAMP assay amplified only DNA from Legionella. When DNA from Legionella was amplified the pH in the reaction decreased. The pH drop triggered a color change of a pH indicator present in the reaction. Some LAMP assays have been shown to detect as few as 10-12 copies of DNA in food or water samples. Colorimetric Legionella LAMP can detect as few as two copies of DNA in under 90 minutes. The colorimetric LAMP assay can be used as a fast and accurate method for detecting Legionella in water samples and for monitoring purposes, as well as for tracing sources of outbreaks."--Abstract.

Current Status and Emerging Perspectives

Legionella Contamination in Water Environment

Legionella Pneumophila: Pathogenesis and Immunity

Transformed Legionella for Application in Engineering Process Validation in the Built Environment

Legionella: from protozoa to humans

Legionella species are Gram negative aerobic bacilli which stain poorly with most aniline dyes. They are non-sporing, and are usually motile by means of one or more subpolar flagella. Most Legionella species are short rods but some strains have filamentous forms. They do not grow on ordinary media but will grow on media supplemented with L-cysteine and ferric salts. Legionella was isolated from four different samples. The samples from which isolation occurred were called Legionella-positive samples. The most common habitats from which Legionella was isolated were cooling towers and water tanks. 20% of the water tanks/tap water and 60% of the cooling towers were Legionella-positive samples. The species, most commonly found in the isolates was Legionella pneumophila serogroup 1. Both the Legionella counts (DFA) and the microorganisms counts (FITC) were found to be statistically significant (p

Legionnaire's Disease: Control of Legionella Bacteria in Water Sys

Advances in Legionella Research and Application: 2013 Edition is a ScholarlyPaper™ that delivers timely, authoritative, and intensively focused information about ZZZAdditional Research in a compact format. The editors have built Advances in Legionella Research and Application: 2013 Edition

on the vast information databases of ScholarlyNews.™ You can expect the information about ZZZAdditional Research in this book to be deeper than what you can access anywhere else, as well as consistently reliable, authoritative, informed, and relevant. The content of Advances in Legionella Research and Application: 2013 Edition has been produced by the world ' s leading scientists, engineers, analysts, research institutions, and companies. All of the content is from peer-reviewed sources, and all of it is written, assembled, and edited by the editors at ScholarlyEditions™ and available exclusively from us. You now have a source you can cite with authority, confidence, and credibility. More information is available at http://www.ScholarlyEditions.com/. GoalsLegionnaires' disease is a severe infection caused by Legionella bacteria that affects more than 10,000 people in the United States every year, with 10% of those people dying from the disease. The goal of this guide is to educate professionals involved with water safety and management programs, including infection preventionists, risk management professionals, public health professionals, safety officers, facility managers, engineering and maintenance staff, water treatment professionals, and consultants. Through the education and training provided in this guide, we hope to reduce the risk of Legionnaires' disease in facilities. The information in this guide will complement in-person training programs on Legionnaires' disease and water safety and management. By working together, we can end Legionnaires' disease!

Proceedings of the 2nd International Symposium

Legionella and the Prevention of Legionellosis

Comparison of the Virulence of the Philadelphia and Pontiac Isolates of Legionella Pneumophila

Legionella in the environment

Molecular Mechanisms in Legionella Pathogenesis

A comprehensive laboratory manual on the range of techniques used to identify, isolate, and culture the bacterium legionella, causative organism of Legionnaires' disease. Provides researchers and lab workers with the methods for serological diagnostic of legionellosis in patients. Describes phenotypic characteristics of the bacterium, culture of the organism from clinical and environmental samples, and modern hospital and laboratory practice.

This publication outlines the principles involved in design, installation and testing of hot and cold water supply, storage and distribution systems for health care premises It is apllicable to both new and existing sites. A companion volume, Part B, Operational management (ISBN 0113227450) is also available. HTM 04-01 supersedes HTM 2027 (1995) and HTM 2040 (1994)

Water is the major natural reservoir for legionellae, and the bacteria are found worldwide in many different natural and artificial aquatic environments, such as cooling towers, water systems in hotels homes, ships and factories, respiratory therapy equipment, fountains misting devices and spa pools. This book provides a comprehensive overview on the sources, ecology and laboratory diagnosis of legionella. Guidance is provided on risk assessment and risk management of susceptible environments. The necessary measures to prevent, or adequately control, the risk from exposure to legionella bacteria are identified for each identified environment. Outbreaks of legionellosis generally cause a high level of morbidity and mortality in the people affected and as such the suspicion of an outbreak warrants immediate action. The policies and practice for outbreak management and the institutional roles and responsibilities of an outbreak control team are reviewed. This book will be useful to all those concerned with legionella and health, including environmental and public health officers, health care workers, the travel industry, researchers and special interest groups. The volume brings together all of the latest research on this pathogen, the interest in which is rapidly growing. Legionella pneumophila is an emerging human pathogen that resides in natural environments as a parasite of freshwater. There have been major new developments in this field, including the publication of three whole genome sequences and the discovery of a developmental cycle and novel cyst-like highly infectious form.

A Laboratory Manual for Legionella

Molecular Microbiology

Advances in Legionella Research and Application: 2013 Edition

(the cause of legionnaires disease); a review of current knowledge

Occurrence of Pathogenic Legionella and Amoebae Spp. from Source (groundwater) to Exposure (taps and Cooling Towers) in a Complex Water System

"Illness caused by the gram-negative bacteria in the genus Legionella is referred to as legionellosis. Legionellosis consists of two distinct clinical syndromes, Legionnaires' disease and Pontiac fever. Legionnaires' disease is characterized by pneumonia wherase Pontiac fever is a self-limiting, nonpneumonic, influenza-like illness. Inhalation of aerosols containing the bacterium is presumed to be the primary means of acquiring legionellosis. Aerosolized waters from cooling towers, evaporative condensers, showers, and humidifiers have been identified as sources of infection. Legionella species have been recovered from a wide variety of domestic water systems and are ubiquitous in freshwater environments. Although once considered transient contaminants of natural and domestic waters, legionellae are now known to be free-living organisms surviving as natural components of freshwater ecosystems. Domestic systems are complex environments in which concentrations of legionellae can fluctuate considerably depending upon water temperature, biocide levels, and presence of natural hosts (i.e. protozoa) for legionellae to parasitize. The choice of procedure used to recover legionellae from water samples is dependant upon the expected degree of bacterial contamination in a particular water source. Potable waters generally have low bacterial densities and are either cultured directly or concentrated to detect legionellae. Nonpotable waters, such as those from cooling towers, generally do not require concentration because of their high bacterial concentrations. This manual describes the procedures currently employed by the Centers for Disease Control to process environmental samples obtained during investigations of legionellosis outbreaks. It includes information of the collection and concentration of water samples, preparation of samples for bacteriologic examination, formulas for media, sources of reagents,

and air sampling techniques."--Page 1.
Legionella pneumophila is a waterborne pathogen that causes Legionnaires' disease, an infection which can lead to potentially fatal pneumonia. In a culture-based technique, Legionella is detected using buffered charcoal-yeast extract (BCYE) agar supplemented with L-cysteine, iron salt and antibiotics. These supplements provide essential and complex nutrient requirements and help in the suppression of non-target bacteria in Legionella analysis. Legionella occurs naturally in freshwater environments and for their detection, a sample is plated on solid agar media and then incubated for several days. There are many challenges in the detection of Legionella in environmental waters and the built environments. A common challenge is that a variety of environmental bacteria can be presumptively identified as Legionella using the culture-based method. In addition, proper identification of Legionella requires long incubation period (3-9 days) while antibiotics used in BCYE agar have relatively short half-life time. In order to overcome some of the challenges, Legionella has been genetically modified to express reporter genes such Green Fluorescent Protein (GFP) that can facilitate its detection in process validation studies under controlled laboratory conditions. However, such studies had limited success due to the instability of genetically modified Legionella strains. The development of a genetically modified Legionella with a much rapid growth rate (1-2 days) in simulated environmental systems (tightly-controlled water distribution system) is achieved. The mutant Legionella is engineered by transforming with a specific plasmid encoding CymR, LacZ and TetR genes. The newly engineered Legionella can grow on conventional BCYE agar media without L-Cysteine, iron salt and only require one antibiotic (Tetracycline) to suppress the growth of other microorganisms in media. To the best of our knowledge, this is the first report of L. pneumophila strain capable of growing without L-Cysteine. We believe that this discovery would not only facilitate the study of the fate and transport of this pathogen in environmental systems, but also further our understanding of the genetics and metabolic pathways of Legionella.
Legionella bacteria are an emerging pathogen found in natural and engineered water systems. Infection occurs when infected water becomes aerosolized and is breathed into the lungs. Reclaimed water is commonly used in scenarios where the water becomes aerosolized, such as for spray irrigation and in industrial cooling towers. It is important to measure the risk of Legionella infection from these waters but, their prevalence in reclaimed water distribution systems has not been adequately documented. To determine the occurrence and concentration of Legionella in reclaimed water, a monitoring study was conducted at six water utilities. The systems, located in California, Florida, Texas and Arizona, represented different treatment processes, storage conditions and distribution system sizes. The treatment systems produced water varying in organic carbon and other nutrients, which allowed the examination of each water quality parameter in relation to the occurrence of Legionella and their associated protozoa hosts. From each water utility, samples were taken from the plant effluent, storage reservoir and three points within the distribution system. Legionella was found frequently throughout the storage and distribution systems, though their concentrations were generally low. Sixteen species of Legionella were identified using culture plating and molecular methods, with L. pneumophila being the species most frequently detected and the only species found in all six reclaimed water utilities. Disinfectants were effective at controlling Legionella growth when present, but were rapidly consumed in the distribution systems. Chlorine residuals of at least 1 mg/L (total chlorine) and 0.2 mg/L (free chlorine) reduced Legionella concentrations over 80%. High levels of assimilable organic carbon (AOC), total organic carbon (TOC) and ammonia had a clear impact on the occurrence of Legionella. Over 70% more Legionella were detected in locations where AOC was above 1000 ?g/L and/or TOC was above 10 mg/L. In samples where ammonia was less than 2 mg/L, the concentration of viable Legionella was 90% lower than in samples where ammonia was above 2 mg/L. The reclaimed system with the lowest occurrence of Legionella also had the lowest average concentrations of AOC, TOC and ammonia. The two systems with the most Legionella also had the highest average concentrations of AOC, TOC and ammonia. Mesophilic and thermophilic protozoa were regularly detected throughout the reclaimed water systems and their numbers increased as the water aged in the distribution system. Legionella pneumophila was first isolated as the

causative agent of a deadly infectious pneumonia at a convention of the American Legion forty years ago. Since then, Legionnaires' disease continues to be a significant public health concern. Today, our understanding of the Legionella genus, comprising environmental bacteria and opportunistic human pathogens, has dramatically increased. The study of how pathogenic Legionella interact with host cells, both protozoan and mammalian, has not only taught us about host-pathogen interactions but has revealed novel and unexpected insights into human cell biology and immunology. The capacity of pathogenic Legionella to commandeer cellular processes such as eukaryotic vesicular trafficking to establish an ER-like replicative niche, reflects the exquisite ability of this pathogen to manipulate eukaryotic cell biology in order to replicate in an intracellular compartment. This requires the specific and targeted action of a cohort of translocated bacterial effector proteins. In addition, we have learnt much about cell autonomous innate immune sensing of intracellular bacteria through the inability of L. pneumophila to avoid intracellular mammalian defense mechanisms. Now, in the age of large-scale comparative "omics", it is clear that different Legionella species utilize different cohorts of effectors to replicate inside eukaryotic cells. While we understand some of the strategies employed by L. pneumophila and L. longbeachae to replicate within eukaryotic cells, there is still much to learn about many aspects of the Legionella life cycle. This Research Topic highlights the latest findings regarding the biology of Legionella species, their interactions with eukaryotic host cells, and how the application of various technologies has increased our understanding of this important pathogen.

Preventing Legionellosis

A STUDY ON LEGIONELLA PNEUMOPHILA, WATER CHEMISTRY, AND ATMOSPHERIC CONDITIONS IN COOLING TOWERS AT THE SAVANNAH RIVER SITE.

ScholarlyPaper

Legionella

Hospital-laboratory diagnosis of legionella infections

Advances in Legionella Research and Application / 2012 Edition is a ScholarlyBrief™ that delivers timely, authoritative, comprehensive, and specialized information about Legionella in a concise format. The editors have built Advances in Legionella Research and Application / 2012 Edition on the vast information databases of ScholarlyNews.™ You can expect the information about Legionella in this eBook to be deeper than what you can access anywhere else, as well as consistently reliable, authoritative, informed, and relevant. The content of Advances in Legionella Research and Application / 2012 Edition has been produced by the world's leading scientists, engineers, analysts, research institutions, and companies. All of the content is from peer-reviewed sources, and all of it is written, assembled, and edited by the editors at ScholarlyEditions™ and available exclusively from us. You now have a source you can cite with authority, confidence, and credibility. More information is available at http://www.ScholarlyEditions.com/.

Since the discovery of Legionella pneumophila in 1976, its significance increased rapidly in terms of public health and it became an important pathogen. With the discovery of a new kind of species, the life cycle of Legionella pneumophila has been investigated and interestingly, it was found that humans are an accidental host of the life cycle of these bacteria. L. pneumophila constitute an important part of community originated cases of atypical pneumonia and travel associated diseases, so it is important that there exists strict control in man-made habitats. Moreover, understanding the biology of L. pneumophila is critical for the development of more effective combat methods. During the preparation of this book, a large number of valuable works were examined and all aspects of L. pneumophila were introduced. The different features of this interesting microbe's journey from the existence in the environment to the diseases caused in humans were discussed and the prevention methods also have been mentioned. This book is a good start for researchers who want to have a first overlook at this subject.

Preventing Legionellosis covers the biology of Legionella and presents a comprehensive review of best practices for legionellosis prevention from around the world. Recent outbreaks, climbing incidence rates and pending lawsuits have raised public awareness about legionellosis, a serious, preventable form of pneumonia that can be contracted from water systems in buildings. Legionellosis has harmed millions of people worldwide and causes annual monetary losses in the billions. However, to really understand the effects of the disease, one must listen carefully as the victims, or their survivors, describe the suffering they have endured. Preventing Legionellosis provides concise detail for: Improving awareness and education Implementing water management plans Mitigating against commercial conflict of interest The book will give the scientific basis for the worldwide technical consensus on the prevention of legionellosis. It will be an invaluable source of information for public health administrators, epidemiologists, infection control professionals, facility safety managers, industrial

hygienists, and academic engineers and scientists. Legionnaires disease is a pneumonia caused by the inhalation of the bacterium Legionella pneumophila. The majority of illnesses have been associated with cooling towers since these devices can harbor and disseminate the bacterium in the aerosolized mist generated by these systems. Historically, Savannah River Site (SRS) cooling towers have had occurrences of elevated levels of Legionella in all seasons of the year and in patterns that are difficult to predict. Since elevated Legionella in cooling tower water are a potential health concern a question has been raised as to the best control methodology. In this work we analyze available chemical, biological, and atmospheric data to determine the best method or key parameter for control. The SRS 4Q Industrial Hygiene Manual, 4Q-1203, 1 - G Cooling Tower Operation and the SRNL Legionella Sampling Program, states that 'Participation in the SRNL Legionella Sampling Program is MANDATORY for all operating cooling towers'. The resulting reports include L. pneumophila concentration information in cells/L. L. pneumophila concentrations>107 cells/L are considered elevated and unsafe so action must be taken to reduce these densities. These remedial actions typically include increase biocide addition or 'shocking'. Sometimes additional actions are required if the problem persists including increase tower maintenance (e.g. cleaning). Evaluation of 14 SRS cooling towers, seven water quality parameters, and five Legionella serogroups over a three-plus year time frame demonstrated that cooling tower water Legionella densities varied widely though out this time period. In fact there was no one common consistent significant variable across all towers. The significant factors that did show up most frequently were related to suspended particulates, conductivity, pH, and dissolved oxygen, not chlorine or bromine as might be expected. Analyses of atmospheric data showed that there were more frequent significant elevated Legionella concentrations when the dew point temperature was high--a summertime occurrence. However, analysis of the three years of Legionella monitoring data of the 14 different SRS Cooling Towers demonstrated that elevated concentrations are observed at all temperatures and seasons. The objective of this study is to evaluate the ecology of L. pneumophila including serogroups and population densities, chemical, and atmospheric data, on cooling towers at SRS to determine whether relationships exist among water chemistry, and atmospheric conditions. The goal is to more fully understand the conditions which inhibit or encourage L. pneumophila growth and supply this data and associated recommendations to SRS Cooling Tower personnel for improved management of operation. Hopefully this information could then be used to help control L. pneumophila growth more effectively in SRS cooling tower water.

Occurrence of Legionella in Groundwater

The Control of Legionella Bacteria in Water Systems

Legionnaires' Disease

Occurrence, Survival, and Characterization of Legionella in Water

Biology and Pathogenesis of Legionella

The methods described in the second edition on Legionella are for the study of distinct features of L. pneumophila. Chapters guide readers through ecology and physiology of legionella, legionella genetics, cellular microbiology of legionella, biochemical assays to study legionella effectors and enzymes, immunity and host response against legionella, metagenomics, proteomics, and host microbiomes of legionella. Written in the highly successful Methods in Molecular Biology series format, chapters include introductions to their respective topics, lists of the necessary materials and reagents, step-by-step, readily reproducible laboratory protocols, and tips on troubleshooting and avoiding known pitfalls. Authoritative and cutting-edge, Legionella: Methods and Protocols, Second Edition aims to be useful for scientists studying Legionella, and for a broader research community interested in the ecology, physiology, pathogenesis, immunity, genetics and evolution of other bacterial pathogens. Drawn from ASM?s 1992 symposium on the subject, this book completely updates information on all aspects of Legionella and Legionnaires disease. Strategy sessions held at the symposium to address current issues involving preventive measures to minimize the presence of Legionella and occurence of Legionnaires disease, the evolution of chemotherapy and diagnostic tests, and prospects for vaccine development are summarized. Legionella is required reading for anyone working in this area of infectious disease. As the sole source of current knowledge and theory on Legionella, it is an extremely useful reference for clinical microbiologists, environmental microbiologists, epidemiologists, infectious disease and other clinical specialists, and environmental engineers.

This Water Management Legionella Log Book allows you to document your actions to prevent the growth of legionella bacteria in the water systems you are responsible for as an employer or landlord. Is starts in a logical way, from identifying the outlets that are rarely used, to daily, weekly, monthly, quarterly,

and annual tests and checks. What is included: List of rarely used outlets Daily flushing of rarely used outlets Twice weekly flushing of rarely used outlets Weekly flushing of rarely used outlets Monthly cold-water temperature checks Monthly hot water temperature checks Outgoing monthly temperature checks of the hot & cold-water cylinders Return monthly temperature checks of the hot & cold-water cylinders Monthly temperature checks at the sentinel hot and cold-water outlets Quarterly descaling and cleaning of shower heads, tap aerators, and spray heads Annual thermostatic mixing valves maintenance Annual temperature testing of a representative number of hot and cold-water outlets Defects & Events Log Maintenance Log General Notes Adequate size A4 - 60 pages. The total number of pages for a building is 23 and this log book has been created to allow you document the flushing, and temperature checks carried out for two buildings, plus extra pages for notes at the end. If you are not responsible for two water systems, you can use this book for 2 years.

Legionellosis is a collective term for diseases caused by legionella bacteria including the most serious Legionnaires' disease, as well as the similar but less serious conditions of Pontiac fever and Lochgoilhead fever. People contract Legionnaires' disease by inhaling small droplets of water (aerosols), suspended in the air, containing the bacteria. Certain conditions increase the risk from legionella if: the water temperature in all or some parts of the system may be between 20-45 °C, which is suitable for growth it is possible for breathable water droplets to be created and dispersed e.g. aerosol created by a cooling tower, or water outlets water is stored and/or re-circulated there are deposits that can support bacterial growth providing a source of nutrients for the organism e.g. rust, sludge, scale, organic matter and biofilms

Legionella spp. in groundwater sources have been reported to be the cause of waterborne infections, specifically Legionnaire's Disease and Pontiac Fever. Legionellae are known to be ubiquitous in surface waters, but much less is known about their occurrence in groundwater, which is the source of potable water for millions in North America. Federal drinking water regulations may not eliminate the threat of Legionella exposure from groundwater-derived drinking water. The primary reason is because current regulations focus on fecal contamination. Presently, there is no evidence that demonstrates an association between fecal contamination and Legionella. The study showed that (1) several species of Legionella are present in warm- and cold-system groundwater not known to be under the direct influence of surface water, (2) the water quality and ecological parameters studied showed no correlation with the presence or absence of Legionella, (3) limited Legionella-positive samples tested were also positive for several types of protozoa. While the sources of these bacteria in groundwater are not known, wide-spread Legionella colonization of the distribution systems studied suggests that treated waters from such groundwater sources may present a health risk, particularly to those debilitated or immunocompromized. This was a two-phased study. A literature review of groundwater temperatures in the United States was conducted and two warm-water sites were selected to demonstrate that Legionellae could be isolated from environmental samples. Legionellae were detected by combining a quantitative culture method (considered the gold standard) with a qualitative semi-nested PCR assay. The use of immuno-magnetic separation (IMS) was also evaluated to selectively capture Legionellae from the samples. Once the detection method was successfully demonstrated, several other warm- and cold-water sites throughout North America were surveyed for the presence of Legionellae. When combining results from the two study phases, 56% of water samples (37/66) and 29% of biofilm samples (20/69) were found positive by cultivation. PCR was able to detect Legionellae in 32 of the 105 (30%) samples tested in Phase II; PCR inhibitors proved to be a problem, especially in biofilm samples. Based on the wells sampled, rather than individual samples, 11 of 12 (92%) wells were positive for Legionellae in Phase I and 27 of 34 (79%) sampled were positive for Legionellae in Phase II. Utilities with only negative samples were 0/2 in Phase I and 2/16 in Phase II. Each of these two had submitted only single samples from one well. Thus it is possible that repeated sampling or inclusion of other wells would have changed the picture. Although most of the wells were surveyed only once in this study, two wells from one utility in Phase II were re-sampled on a monthly basis for a year. In these samples it became clear that there was great temporal variability in the numbers and types of Legionellae detected. This is the first comprehensive study on the presence of Legionellae in

groundwaters and its findings suggest that untreated well waters must be considered as potential sources of these opportunistic pathogens. Based on the level of contamination observed and the general assumption that all Legionella species should be considered pathogenic, we recommend that Legionella be considered for regulation in any future rules on groundwater quality. Research is also needed on the impact of a switch from chlorination to chloramination on microbial communities including Legionella.

Advances in Legionella Research and Application: 2012 Edition
ScholarlyBrief

Procedures for the Recovery of Legionella from the Environment
Part A: Design, installation and testing

Legionella Pneumophila
Legionella species are gram-negative bacteria that are known to cause a severe lung infection,which is known as Legionnaires' Disease and a less severe illness called Pontiac Fever. Legionella species can be aerosolized from showers, faucets, cooling towers, and decorative fountains. Once aerosolized, individuals can contract both diseases via inhalation of these pathogenic bacteria. Legionnaires Disease is of particular concern because the incidence of Legionnaires Disease is rising in the United States. Chapter one will review known information about specific Legionella species associated with human disease. The discussion will focus on the history of Legionnaires Disease, the taxonomy of Legionella species, specific pathogens associated with the disease, epidemiology cases of the disease, and environmental occurrence in premise plumbing systems. Chapter two will confirm that Legionella species associated with human disease are present in different types of buildings from the influent to the taps, all utilizing the same water system. I will also compare physiochemical parameters (water temperature, turbidity, pH, conductivity, and residual chlorine) that affect the concentrations and species of Legionella in cold and hot water taps. Chapter three will demonstrate that water age plays a role in the occurrence and concentration of Legionella species in the water distribution and premise plumbing system. In this chapter, I present data on the concentration of Legionella spp. in the influent and effluent of the reservoir, two buildings, and cooling towers. Examining Legionella species throughout the MSU campus from the water source to the taps, and thecooling towers provide a wholistic view of the MSU water system. Chapter four will confirm the co-occurrence of pathogenic Legionella species and Acanthamoeba spp. Naegleria fowleri in the drinking water supply system on the MSU campus. I show that Naegleria fowleri co-occurs with Legionella bozemanii and Legionella longbeachae in two buildings (F and ERC) on the MSU campus. In chapter five, I conclude by addressing future research trajectories needed to better understand how to manage the risk from the various other pathogenic Legionella species besides the primary water-related bacterium, L. pneumophila. In addition, there is a critical need to develop better methods for the detection of Legionella species in water systems to improve primary prevention strategies instead of reactive approaches. A proactive approach of monitoring for specific Legionella species in a building water system is the best approach to control Legionnaires' disease outbreaks in large buildings.
Bacteria of the Legionella genus are a water-borne pathogen of increasing concern due to being responsible for more annual drinking water related disease outbreaks in the United States than all other microbes combined. Unfortunately, the development of public health policies concerning Legionella has impeded by several key factors, including a paucity of data on their interactions and growth requirements in water distribution networks, a poor understanding of potential transmission sources for legionellosis, and limitations in current methodology for the characterization of these pathogens. To address these issues, a variety of research approaches were taken. By measuring Legionella survival in tap water, association in pipe material biofilms, population dynamics in a model distribution system, and occurrence in drinking water distribution system biofilms, key aspects of Legionella ecology in drinking water systems were revealed. Through a series of experiments qualitatively and quantitatively examining the growth of Legionella via nutrients obtained from several water sources, environmental nutritional requirements and capability for growth in the absence of host organisms were demonstrated. An examination of automobile windshield washer fluid as a possible source of legionellosis transmission revealed Legionella survival in certain windshield washer fluids, growth within washer fluid reservoirs, high levels and frequency of contamination in washer fluid reservoirs, and the presence of viable cells in washer fluid spray, suggesting the potential for exposure to Legionella from this novel source. After performing a systematic and quantitative analysis of methodology optimization for the analysis of Legionella cells via matrix-assisted laser desorption/ionization time-of-flight mass spectrometry, several strains of this microbe isolated from separated and varied environmental water sampling sites were distinctly typed, demonstrating a potential application of this technology for the characterization of Legionella. The results from this study provide novel insight and methodology relevant to the

development of programs for the monitoring and treatment of Legionella in drinking water systems.
Legionnaires’ disease, a potentially fatal type of pneumonia primarily affecting elderly and immuno-compromised persons, is caused by the ubiquitous environmental bacterium Legionella pneumophila. This book offers authoritative reviews of different facets of its virulence, focusing on comparative phagocyte infection, virulence gene regulation, biochemical functions of effector proteins and cellular pathogen-host interactions, as well as host responses and immunity to L. pneumophila. Taken together, the contributions in this compilation provide a state-of-the-art overview of current insights into the molecular pathogenesis of the opportunistic and potentially fatal pathogen L. pneumophila.
Programmed Cell Death in Legionella Infection
Legionella Log Book | Legionella Flushing Log |Legionella Water Temperature Checks |
The control of Legionella, hygiene, "safe" hot water, cold water and drinking water systems
Water Management
Management of Legionella in Water Systems