

## **Abstract**

*Streptococcus pneumoniae*, also referred to as pneumococcus, was first isolated in 1881. Over the ensuing 130-year period, the organism has been recognized as one of the most virulent microbial pathogens, recording case fatality rates of up to 66%. An important characteristic of *S. pneumoniae* is the presence of a polysaccharide capsule, which is the main virulence determinant of the organism and the basis of about 95 pneumococcal capsular types, as well as current pneumococcal vaccines. Clinically, pneumococcus causes several invasive and non-invasive diseases including pneumonia, meningitis, septicaemia, sinusitis and acute otitis media. Globally, there are about 14.5 million episodes of serious pneumococcal disease among children less than 5 years of age each year, resulting in approximately 500,000 deaths, the majority of which occur in low- and middle-income countries. *S. pneumoniae* is noted for causing outbreaks in some sub-Saharan African countries and particularly, serotype 1 of the organism has been implicated in outbreaks in Ghana, Burkina Faso, Mali and The Gambia.

The public health burden related to *S. pneumoniae* is further heightened by the increasing resistance of the organism to essential antimicrobial agents particularly penicillin, cephalosporins and macrolides. The high occurrence of pneumococcal antibiotic-resistant genes coupled with the ease with which such genes can spread horizontally, have enhanced global dissemination of successful multi-drug resistant pneumococcal clones such as Spain23F-1, South Africa19A-13 and Greece 6B-22. It is estimated that up to 40% of *S. pneumoniae* display multi-drug resistant phenotypes, which is highly variable among countries. Paradoxically, *S. pneumoniae* is carried as part of the normal bacterial flora of the upper respiratory tract of humans, and carriage is the precursor for development of pneumococcal disease, and is also responsible for transmission of the organism from person-to-person. Carriage of pneumococcus is particularly high among children younger than five years; the colonization rate rises from birth and peaks around the age of 1–2 years, and thereafter experiences an age-related decline. The enormous public health burden associated with *S. pneumoniae* underscores the importance of its control through vaccination. At present, two types of pneumococcal vaccines are available: conjugate vaccines and the pure polysaccharide vaccine (unconjugated). The pure polysaccharide vaccine has 23 serotypes, and has a good efficacy of 60%–70% in protecting against these serotypes. However, its usefulness is limited as it induces no herd effect, its duration of protection is short, and infants respond poorly to it. Most of these limitations have been overcome by the relatively new conjugate vaccines, in which purified capsular polysaccharides are conjugated to a nontoxic variant of the diphtheria toxin.

Current pneumococcal conjugate vaccines (PCVs) consist of 10 or 13 capsular types and have been introduced into the immunisation programme of about 146 countries. Following the introduction of PCVs, there has been a dramatic decline in pneumococcal infections in vaccinated children and a herd immunity effect in other age groups. However, this success has been tempered by serotype replacement for ongoing invasive pneumococcal disease. The trend of escalating pneumococcal antibiotic resistance coupled

with the failure of discovering new antibiotics in recent times to “attack” the pneumococcus, and the limitations of current pneumococcal vaccines, seem to be tilting the “pneumococcal war” in favour of the organism. A pneumococcal vaccine based on a highly conserved surface protein among all pneumococcal serotypes and strains is required to eventually defeat *S. pneumoniae*. However, such a vaccine has eluded the scientific community for many years now.

In this lecture, Professor Eric Sampane-Donkor will provide an in-depth review of pneumococcus, delivering insights into the biology and pathogenicity of the organism. He will discuss pneumococcal interventions and evolutionary responses of the organism to these interventions. In particular, the lecture will highlight important contributions that his research group at the Department of Medical Microbiology, University of Ghana Medical School, has made to this exciting and important field of infectious disease research in the past two decades.

### **Profile**

Professor Eric Sampane-Donkor is a Professor of Bacteriology and Global Health in the Department of Medical Microbiology, University of Ghana Medical School, College of Health Sciences. He holds a PhD in Medical Microbiology from the London School of Hygiene and Tropical Medicine, UK, and a PhD in Public Health from the University of Iceland, Reykjavik. He undertook postdoctoral studies in Microbial Genomics at University of Cambridge, UK. His other academic qualifications include MSc Structural Molecular Biology from Birkbeck College, University of London, UK, MPhil Animal Microbiology and Immunology from the University of Ghana, Legon, MBA Management from Kwame Nkrumah University of Science and Technology, Kumasi, Postgraduate Diploma in Infectious and Tropical Diseases from the London School of Hygiene and Tropical Medicine, UK, and a BSc (Hons) degree in Biochemistry from the University of Ghana, Legon.

With a broad academic background, Professor Sampane-Donkor applies concepts from several fields to help address the global infectious disease challenge through research. His current research interests focus on understanding the dynamics of infectious pathogens in at-risk populations, such as patients with stroke, sickle cell disease and diabetes. He has authored 112 journal articles, mainly in international journals, of which he is first and/or senior author of 62. Many of Professor Sampane-Donkor’s publications appear in reputable journals, such as MBio, BMC Genomics, Lancet Infectious Diseases, Lancet EClinical Medicine, Frontiers in Infection and Cellular Microbiology, Journal of Antimicrobial Chemotherapy, and Genes. Additionally, he has 15 publications in the form of book chapters (5), books (2) and technical reports (8).

Professor Sampane-Donkor is a high-level expert on the pneumococcus (*Streptococcus pneumoniae*), a highly virulent microbial pathogen that causes severe invasive and non-invasive diseases, such as pneumonia, meningitis and septicaemia. His work on this pathogen contributed to the introduction of the Pneumococcal Conjugate Vaccine in Ghana in 2012, and also earned him the first African Prize of the Robert Austrian Award in

Pneumococcal Vaccinology from Pfizer Pharmaceuticals, USA. He has also researched extensively on the evolution of antibiotic resistance in Ghana, providing timely data for empirical treatment of bacterial infections in the country. For instance, a paper he published on antibiotic resistance of uropathogens in 2016 was the basis for discontinuation of ciprofloxacin in the treatment of urinary tract infections among bladder outlet obstruction patients at the Korle Bu Teaching Hospital in Ghana. Researching in the area of global health, Professor Sampane-Donkor has been involved in extensive collaborations across the globe, working with institutions such as the Sanger Institute in Cambridge, UK, Centres for Disease Control in Atlanta, Georgia, USA, Murdoch Children's Research Institute in Melbourne, Australia, Sackler School of Public Health, Tel Aviv University in Israel, Nationwide Children's Hospital, Ohio State University College of Medicine in Columbus, USA, and the Department of Clinical Laboratory Sciences, Taif University in Saudi Arabia.

Professor Sampane-Donkor provides consultancy services to several local and international institutions, such as the National Accreditation Board of Ghana, Clinton Health Access Initiative and the World Health Organization. In a recent assignment, he undertook and led a nationwide study for the Ghanaian Ministry of Health towards a public-private partnership in diagnostics as part of the African Health Diagnostics Platform. This study formed the basis for assessing Ghana's share of a € 76-million loan from the European Investment Bank to four African countries, namely Ethiopia, Kenya, Rwanda and Ghana, to improve diagnostics in the sub-region. Overall, Professor Sampane-Donkor has undertaken 15 funded research projects, with funding support from several institutions, such as the Global Alliance for Vaccines and Immunizations, World Health Organization, Wyeth Vaccines and Eimksip Fund. Currently, he is the Principal Investigator of a US\$ 622,000 project funded by the National Institutes of Health, USA, to unravel the impact of vaccination on the population biology of *Streptococcus pneumoniae* with regard to children with sickle cell disease; he is also the site (Ghana) Principal Investigator of an ongoing £ 3.1 million Fleming Fund regional grant project aimed at addressing the problem of antimicrobial resistance in developing countries through surveillance; moreover he is the Principal Investigator of an ongoing US\$ 100,000 project funded by Pfizer Pharmaceuticals, USA on surveillance of invasive pneumococcal disease in Ghana. In the last five years, Prof Sampane-Donkor has received research funds to the tune of US\$ 6.5 million as either Principal Investigator or Co-investigator.

He serves as Academic Editor for several journals, including *Frontiers in Tropical Medicine* (USA), *Pathogens Journal* (Switzerland), and the *Journal of Ghana Science Association*. He also serves as an ad hoc reviewer for many local and international journals. Prof Sampane-Donkor had been a visiting faculty/scientist to several international institutions, such as the University of Copenhagen in Denmark, University of Sussex in the UK and University of Minnesota in the United States. Currently, he is a Visiting Professor of Infectious Diseases at the Sackler School of Public Health, Tel Aviv University, Israel and a Life Fellow of Wolfson College, University of

Cambridge, UK. He is part of several international initiatives, including the Global Pneumococcal Sequencing Consortium, Fleming Fund Convening of Antimicrobial Resistance Experts, Partnerships for International Medical Education, and the Global Bacterial Vaccinology Network (BactiVac).

At the University of Ghana, Professor Sampane-Donkor has served on several committees, including the Graduate School Board, Ethical and Protocol Review Committee of the College of Health Sciences, Scientific and Technical Committee of the Noguchi Memorial Institute for Medical Research, Editorial Board of the UG Readers Project, College of Health Sciences Research Board (Chairman), Board of the Office of Research, Innovation and Development (ORID), UG Academic Board, and Academic Board of the College of Health Sciences. Currently, he is the Vice-Chancellor's representative on the Management Committee of the School of Biological Sciences and the head of the Department of Medical Microbiology, University of Ghana Medical School. Professor Sampane-Donkor has mentored 8 junior faculty members and supervised 3 postdoctoral fellows, 10 PhD students and 31 MPhil/MSc students in Ghana and abroad. He has contributed to the training of about 3000 undergraduate medical students in Ghana, across the University of Ghana Medical School, Accra College of Medicine and Family Health Medical School, in the subject area of Medical Microbiology and Infectious Diseases. He has served as external examiner for several institutions such as the University of London's MSc programme in Communicable Diseases.

In recognition of his high achievements, contribution to science in Ghana, and excellent academic scholarship, Professor Sampane-Donkor was elected to fellowship of the Ghana Academy of Arts and Sciences in 2021. He is also a fellow of the Institute of Biomedical Science in the UK.

Professor Eric Sampane-Donkor fellowships with the Deeper Life Campus Fellowship. He is married to Gloria Sampane-Donkor and they have four daughters: Richelle, Micheline, Shirley and Johanna.

Link to full CV:

<https://dmm.ug.edu.gh/people/faculty/eric-sampane-donkor>