Microbiology and Infection research themes

Microbiology and Infection research at the University of Birmingham spans all areas of microbiology from basic science aimed at understanding the fundamental biology of various species to the development of novel anti-infective strategies.

The broad range of expertise and facilities present at Birmingham allows an integrated approach to the study of molecular microbiology and numerous current research projects involve researchers interested in many of the themes listed below. According to the Web of Science, microbiology is third on the list of research areas at the University of Birmingham in terms of average number of citations per paper. By the same criterion, Birmingham ranks among the top half dozen academic institutes in the UK for microbiology research.

A network of joint studentships and research projects, twinned with a trail of co-authored papers, provides proof of a rich local culture of research collaboration. Our papers appear in a range of journals, including journals with the highest impact factors. Our campus location also provides excellent opportunities for local collaborations with other research disciplines and core facilities (e.g. biochemistry, mass spectrometry, immunology, structural biology, genomics, modelling). Recruitment and retention of talented students and staff are facilitated by our position at the heart of a dynamic, well connected, regenerated but affordable metropolis.

Specific research strengths are present in the following areas:

Antimicrobial development and resistance

Birmingham hosts a group of researchers at the forefront of research into the mechanisms of antibiotic resistance, development of novel antimicrobials and the study of the epidemiology of resistant pathogens.

(Besra; Henderson; Alderwick; Webber; Hawkey; Piddock).

Bacterial physiology

Understanding the fundamental physiology of bacteria is key to all aspects of microbiology and Birmingham researchers are investigating how bacteria can adapt to life under different conditions, survive different stresses and are using this information to develop improved biotechnology processes.

(Cole; Lund; Overton; Kreft; Falciani; Macaskie)

Bioengineering

Microbial biotechnology reaches across biosciences and chemical engineering. We investigate the way in which microorganisms can be harnessed to perform useful tasks in bioprocesses, the physiological and regulatory reasons for bioprocess failure, and the development of methods to allow physiological data to inform bioprocess design and control.

(Overton; Macaskie)

Cell envelope structure and function

The microbial cell envelope is key to a variety of aspects of pathogen biology including the secretion of virulence factors as well as being host to targets for novel antimicrobial and vaccine design. As a result Birmingham researchers are actively engaged in the study of the structures and functions of molecules involved in the biosynthesis of the cell wall of major pathogens including *E. coli*, Salmonella and Mycobacteria

(Bhatt, Besra, Henderson, Alderwick, Lovering).

Environmental microbiology

We have research ongoing in cooperation and communication of microbes in biofilms, metabolic division of labour, individual-based modelling, and systems biology, as well as bioremediation, biomineralization, immobilized cells and biofilms.

(Pinay, Renshaw, Macaskie)

Genome evolution

Bacterial genomes are not static and are constantly evolving leading to the development of new strains of pathogens with increased infective potential or resistance to antimicrobials. Researchers at Birmingham have led the field of bacterial genomics and applied this expertise to the study of pathogen evolution, development of resistance to specific stresses, epidemiology of hospital acquired infection and the evolution of pathogenesis in multiple species.

(Pallen; Lund; Webber; Piddock; Penn; Henderson)

Healthcare associated infection

The acquisition of infection as a result of healthcare intervention is a common and often serious occurrence, the heroic success of modern medicine guarantees the prolonged survival of vulnerable patients in our healthcare facilities and communities, while leaving them open to infection. Researchers at Birmingham are at the cutting edge of efforts to understand, prevent and manage infections in collaboration with clinical colleagues based locally and around the world. Our co-location with the brand-new Queen Elizabeth "superhospital", the Royal Centre for Defence Medicine, and the recently funded £10m NIHR-funded Centre for Surgical Reconstruction allow infection research from 'bench to bedside'.

(Hawkey; Chapple; Sammons; Piddock; Pallen)

Host-pathogen interactions and Immune responses to infection

Whilst a thorough understanding of pathogen biology is important in devising novel anti-infective strategies a complete knowledge of relevant host-pathogen interactions is also key to identifying molecules and pathways which contribute to the success or failure of an infection. At Birmingham we are utilising a range of appropriate models to study the interactions between various pathogens and their cognate hosts at both a cellular and whole organism level.

(Cunningham; Besra; Bhatt; Alderwick; Henderson; Piddock; May)

Mechanisms of pathogenesis

The molecular basis of the pathogenesis of various species including *E. coli*, Salmonella and *Mycobacterium tuberculosis* is actively investigated by researchers at Birmingham using a range of functional genomic approaches.

(Pallen; Penn; Henderson; Piddock; Besra; Bhatt; Alderwick)

Metagenomics

Recent advances in sequencing technology have allowed the diversity of the microbiota present in various environmental or animal sites to be determined. This allows the study of communities of bacterial species as a whole allowing an understanding of the interactions between species and identification of characteristic normal and abnormal flora with associated implications for various diseases. Birmingham researchers have been amongst the first to develop metagenomics and have received significant funding in this area.

(Penn; Pallen)

Mobile genetic elements

The transfer of resistance and virulence genes on mobile genetic elements is a major weapon in the armoury of pathogenic bacteria. Researchers in Birmingham are studying the basic mechanisms of these genetic elements as well as developing novel tools to perturb this transfer and track the spread of mobile genetic backbones.

(Thomas; Hawkey; Webber; Piddock)

Transcription and regulation of gene expression/chromosome structure

Birmingham is at the forefront of efforts to understand biology's premier model organism, *E*scherichia coli, with a particular focus on regulation of transcription and chromosome structure, Salmonella is also a focus of research at Birmingham and insights as to similarities and differences between the two organisms are allowing us to understand how bacteria control gene expression., with a particular focus on regulation of transcription and chromosome structure, Salmonella is also a focus of research at Birmingham and insights as to similarities and differences between the two organisms are allowing us to understand how bacteria control gene expression.

(Busby; Grainger; Pallen; Penn; Webber; Piddock; Cole).

Vaccinology

The development of novel vaccine candidates is of paramount importance in the fight against infection due to the rise of antibiotic resistance and the potential of vaccines to provide herd immunity and thereby eradicate pathogens from a population. At Birmingham researchers are identifying novel bacterial targets for development of vaccines and evaluating the protective efficacy in various infection models.

(Cunningham; Henderson)

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