Introduction

Welcome to the Institute of Infection and Global Health’s Annual Report.

Over these pages we look back at the achievements of the Institute and its staff and students over the past year, and share our goals, aims and objectives for the year to come.

Our position as global leaders in human and animal health research continues to be reflected in our involvement in some of the major global health challenges such as food security, the Ebola crisis and the Zika epidemic, performing cutting edge research to inform policymakers. The Institute, one of five research institutes in the Faculty of Health and Life Sciences integrates medical, veterinary and basic science approaches to focus on some of the most important global health challenges, from tracking emerging and zoonotic infections to pioneering diagnostics, treatments and vaccines.

At the start of the year we published our Strategic Plan for the coming 5 years. Five major challenges were identified (see box) where we will make contributions to securing human and animal health (page 9). Throughout this report we indicate how our research is helping us address these major challenges.

All our achievements are underpinned by the happy, creative and supportive environment within the Institute’s walls. This year, we received the Athena SWAN Silver Award which recognises the support we give to the women working in IGH.

Tom Solomon
Institute Director

“I am absolutely delighted that the changes being implemented in IGH to encourage, support and promote women scientists have been recognised in this Silver Award”

Professor Matthew Baylis

Our research is organized into five themes which cut across three departments, and through which we are addressing the major challenges identified in our strategic plan.

Major challenges we are addressing through our strategic plan (see pages 9-10)

<table>
<thead>
<tr>
<th>Major Challenges</th>
<th>Department of Infection Biology</th>
<th>Department of Clinical Infection, Microbiology and Immunology</th>
<th>Department of Epidemiology and Population Health</th>
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</thead>
<tbody>
<tr>
<td>ENVIRONMENTAL CHANGE</td>
<td>Understanding how pathogens cause disease</td>
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<tr>
<td>FOOD SECURITY</td>
<td>Pioneering diagnostics, treatments and vaccines</td>
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<tr>
<td>ANTIMICROBIAL RESISTANCE</td>
<td>Enhancing food safety and security</td>
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<tr>
<td>DIAGNOSTIC TESTS</td>
<td>Tracking emerging and zoonotic infections</td>
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<tr>
<td>VACCINES</td>
<td>Improving the health of pets, working animals and their owners</td>
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</tbody>
</table>

All IGH researchers Raquel Medialdea Carrera and Ravi Mehta studying Zika in Brazil.

“The University’s infection research, spearheaded by the Institute of Infection and Global Health, continues to be internationally outstanding, as judged by external metrics, and to have a major impact in the UK and globally”

Janet Beer, Vice-Chancellor, University of Liverpool

International Collaboration

The Institute has active research collaborations in the shaded countries. In addition, our major strategically-important collaborations, with embedded staff or major initiatives include Malawi, Kenya, India, Singapore and, as of 2016, Brazil.

Research Income

<table>
<thead>
<tr>
<th>Research Income</th>
<th>2011/12</th>
<th>2012/13</th>
<th>2013/14</th>
<th>2014/15</th>
<th>2015/16</th>
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<tbody>
<tr>
<td>£4,818,355</td>
<td>£6,370,882</td>
<td>£8,584,164</td>
<td>£9,402,511</td>
<td>£9,892,768</td>
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</tbody>
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Front Cover: IGH researchers Raquel Medialdea Carrera and Ravi Mehta studying Zika in Brazil.

Athena SWAN Silver Award

[Diagram of the world with shaded countries and a map of the world with shaded countries and a globe with shaded countries]
Understanding How Pathogens Cause Disease

Exposure to airborne dust and high temperatures are significant risk factors for bacterial meningitis

Dr Daniel Neill, Professor Aras Kadioglu and colleagues found that outbreaks of bacterial meningitis occurred shortly after sandstorms and extreme high temperatures in West Africa. “These findings have implications for areas of the world with high bacterial carriage rates coupled with hot climates and high levels of natural pollution”, Aras commented.


New study to improve HIV prevention in women in Rwanda

Professor Janneke van Wijgert has secured £415K from The European & Developing Countries Clinical Trials Partnership (EDCTP) to improve HIV prevention, and sexual and reproductive health care in women at high risk in Rwanda. In this new study, several novel point-of-care diagnostic tests are being introduced so that women can be screened, diagnosed and treated within one visit.

HIV and strokes in young African adults

In Africa, young adults have a much higher risk of stroke than in the west. Research conducted by Dr Laura Benjamin, an NIHR clinical lecturer in IGH, currently seconded to University College London as a Berkeley Fellow, found that HIV infection is the leading risk factor for stroke in young African adults. Interestingly, the risk went up even further for those who had just started treatment for HIV infection. Dr Benjamin has received a further £1.1 million from GlaxoSmithKline, as a co-principal investigator, to continue studying this through the Malawi-Liverpool-Wellcome Trust Clinical Research Programme.

Understanding Japanese encephalitis virus

Japanese encephalitis, a viral disease that results in brain swelling, affects tens of thousands of children across Asia every year. Dr Lance Turtle and colleagues have been examining the body’s defences (immune response) to the virus. They have shown how sometimes this response gives complete protection, but in other circumstances it may actually further contribute towards brain damage. The results of this study will help with developing improved vaccines.


Antiretroviral HIV treatment helps stop disease transmission to non-infected sexual partners

A new study led by Professor Anna Maria Geretti has shown that antiretroviral treatment stops HIV positive individuals from sexually transmitting the virus to their partners. This research was part of the PARTNER study, the largest study of people with HIV who have had condomless sex with their HIV negative partners.


“More research is needed to help us manage health risks caused by increasing global pollution, and to combat its effects”

Professor Aras Kadioglu

“More research is needed to help us manage health risks caused by increasing global pollution, and to combat its effects”

Professor Aras Kadioglu
Raised levels of specific blood proteins help predict risk of bleeding in septic patients

A study carried out by Professor Cheng-Hock Toh and colleagues found that monitoring levels of histones, a type of protein found elevated in the blood of patients with a low number of platelets, could help doctors predict the risk of life-threatening bleeding in these patients.


Antibiotic alternatives for the future

An independent report on antibiotic resistance commissioned by the Wellcome Trust and co-funded by the Department of Health was published in *Lancet Infectious Diseases*. The report, co-authored by Professor Aras Kadioglu, focuses on substitutes to antibiotic compounds and assesses whether these alternatives could contribute to controlling the rise of drug-resistant infections.


Vaccine against invasive streptococcal disease less effective in HIV positive women

Professor Neil French and colleagues compared the safety and effectiveness of group B streptococcus vaccine in pregnant women with and without HIV in Malawi and South Africa. The bacterial vaccine was found to be less effective in women infected with HIV which led to a decrease in antibodies transferred from mother to infant.


Evaluating rotavirus vaccine efficacy across continents

To further investigate the effectiveness of rotavirus vaccine, Professor Miren Iturriza-Gomara has been awarded £1.1M Newton funding from the Medical Research Council (MRC), the Department of Biotechnology and India’s Department of Biotechnology. The project will evaluate Rotavirus vaccine effectiveness in Liverpool; Vellore, India and Blantyre, Malawi, and is a fantastic example of the Institute’s strengths in linking UK and global health. According to Miren, “the results of the study will ultimately lead to reducing the global burden of childhood diarrhoeal disease.”

New meningitis guidelines to aid rapid diagnosis

Dr Fiona McGill, Professor Tom Solomon and colleagues have led the development of new national guidelines for the diagnosis and treatment of meningitis, with the Meningitis Research Foundation and others. This work is a good example of our partnership with patients and the public.

Appointment of new livestock economics chair for N8 Agrifood Initiative

Through the N8 Agrifood Initiative the Institute has appointed Professor Jonathan Rushton as Chair in the area of livestock and food systems economics, further strengthening our position in food security. Jonathan was previously at the Royal Veterinary College where he was the professor in animal health economics. He works on the global burden of animal diseases, costs of animal health systems and the importance of livestock food systems in the emergence of disease.

Bovine Digital Dermatitis spreading to new species

Research by Professor Stuart Carter, Dr Nick Evans and colleagues has revealed a worrying emerging spread of Bovine Digital Dermatitis from dairy cattle into beef cattle, dairy goats and wild American elk. The team is now focusing on developing new methods to control this disease.

£812K awarded to further study the development of drug resistance in liver fluke

Understanding liver fluke drug resistance

Fasciolosis, caused by liver fluke (Fasciola hepatica) is a common and important disease of livestock which is predominantly controlled using a drug called triclabendazole. However, resistance to the drug is now thought to be spread worldwide. After recently publishing the first genome of the parasite, the team led by Dr Jane Hodgkinson and Professor Diana Williams has been awarded £812K from the BBSRC to further study the development of resistance to this drug in liver fluke.

Preventing and mitigating disease in shellfish

Dr Rob Christley is leading the Institute’s contribution towards the EU Funded Project “VIVALDI: Preventing and Mitigating Farmed Bivalve Diseases”. This project is a collaborative effort between 21 partners across Europe.

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### IGH Strategic Plan 2016-21

#### Major Challenges

<table>
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<tr>
<th>Number</th>
<th>Challenge</th>
<th>Strategy</th>
<th>Impact Within 8 Years We Will Have</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Environmental Change</td>
<td>IGH will provide evidence to help predict and mitigate the impacts of climate, environmental, and societal change on human and animal health</td>
<td>Determined the impact of future climate change on one major endemic disease of livestock</td>
</tr>
<tr>
<td>2</td>
<td>Food Security</td>
<td>IGH will be an international leader in food security research, especially through improved control of infectious disease in food producing animals, and improved food safety</td>
<td>Developed at least one novel prototype vaccine against an endemic infectious disease of animals, in partnership with industry</td>
</tr>
<tr>
<td>3</td>
<td>Antimicrobial Resistance</td>
<td>IGH will investigate the clinical and environmental factors that drive the evolution and development of AMR, and develop novel antimicrobial treatment strategies</td>
<td>Developed at least one novel alternative to treat antimicrobial resistant infections and take this towards clinical trials</td>
</tr>
<tr>
<td>4</td>
<td>Diagnostic Tests</td>
<td>IGH will undertake research to develop new diagnostic tests for diseases of humans and animals, as well as improving existing diagnostic tests</td>
<td>Developed at least one new diagnostic through to commercialisation with an industrial partner</td>
</tr>
<tr>
<td>5</td>
<td>Vaccines</td>
<td>IGH will undertake research to improve the effectiveness of current vaccines and drive the development of new vaccines for major diseases of humans and animals</td>
<td>Informed a change in global immunisation policy to include the incorporation of one new vaccine (e.g. Group B streptococcus, malaria)</td>
</tr>
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#### Global Study Finds Three Different Types of Salmonella Enteritidis

Salmonella enteritidis is a major cause of blood poisoning and death in Africa and food poisoning in the Western world. Professor Melita Gordon and colleagues analysed DNA sequences of a large number of isolates on a global scale. The results, reported in Nature Genetics, showed the existence of three separate types of this bacteria. Melita said "our research at the Malawi-Liverpool-Wellcome Trust (MLW) Clinical Research Programme will hopefully support the implementation of relevant public health strategies to prevent this disease.”


#### Decrease of Viral Disease in Malawi Children After Rotavirus Vaccine Introduction

Following the introduction of monovalent human rotavirus vaccine to Malawi’s infant immunisation schedule in 2012, Dr Noir Bar-Zeev and colleagues have assessed the effectiveness of this WHO recommended policy. Findings published in the Lancet Infectious Diseases show a year on year decrease in prevalence of rotavirus in children after introduction of the vaccination.


#### New Test for Rapid and Accurate Diagnosis of Bacterial Sepsis

Dr Dan Neill, Professor Aras Kodjoli and colleagues have developed a novel test for accurate and quick detection of specific bacterial toxins that are released into the bloodstream during sepsis. This rapid and precise method has recently been filed for patent by the University of Liverpool.
**Tracking Emerging and Zoonotic Infections**

### Tackling Zika virus

The Institute has played a major role in the global response to the Zika epidemic in Latin America. Even before the World Health Organisation announced it as a public health emergency, our research teams were in Brazil helping the local scientists investigate the outbreak which has been especially marked in the large overpopulated favelas (below). Our initial work was supported through the NIHR Health Protection Research Unit in Emerging and Zoonotic Infections, which is a collaboration between the University, Public Health England and the Liverpool School of Tropical Medicine. This preliminary work meant that we were well placed to obtain further funding from the Zika Rapid Response grant call funded by the Medical Research Council (MRC), the Newton Fund and the Wellcome Trust. Institute investigators received more than £500,000 for studies on improving the diagnosis, led by Dr Mike Griffiths, defining the clinical features, led by Professor Tom Solomon, better understanding the disease mechanisms, led by Professor Lisa Ng, and examining how the virus is spread by mosquitoes, led by Professor Matthew Baylis. Our teams have already published some preliminary observations, and have been advising the UK Government through its Strategic Advisory Group on Emergencies, as well as the World Health Organisation. To further develop this research, Institute scientists were awarded €1.1M, as part of a €12.5M consortium called ZikaPLAN (Preparedness Latin American Network). In addition to the above research areas, Dr Lance Turtle and Professor Julian Hiscox will lead studies examining the body’s immune response to infection.


### How humans and animals share pathogens

Professor Matthew Baylis’ team has created an open-access database of human and animal pathogens with information on their hosts, and where these are found in the world. Recent funding from BBiRC will allow the database to also include the pathogens of crop plants, increase its functionality and promote its use in wider audiences. The beautiful pathogen networks created using this database were published in Nature’s Scientific Data and widely shared through popular science channels such as “I F***ing Love Science”.


### £1.5m awarded from UK and European funders for Zika Research

Dr Georgette Kluiters was awarded a highly prestigious BBSRC Future Leader Fellowship for a project looking at the effect of a parasitic nematode on disease transmitting midges in the UK. Georgette’s recent work has shown that some biting midges – which can transmit viruses like Bluetongue and Schmallenberg – are infected with nematode worms called mermithids. During her fellowship, Georgette will investigate the effect of the nematodes on the biology of the midges, and also whether they affect the midge’s ability to transmit viruses.

### Midge parasites as agents of biological control

Dr Lance Turtle and Professor Julian Hiscox will lead studies examining the body’s immune response to infection.

### Real-time genomic surveillance of Ebola

The Ebola epidemic in West Africa was responsible for over 28,599 cases and more than 11,299 deaths. Members of Professor Julian Hiscox’s research group who were deployed as part of the European Mobile Laboratory to Guinea, have gathered and processed samples to help test a portable device for genome sequencing. Dr Georgios Pollakis used the data to calculate the rate of evolution of the virus and the project demonstrated that real-time genomic surveillance is possible in resource-limited settings and can be established rapidly to monitor outbreaks.


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Big data research into pet health and disease

The Small Animal Veterinary Surveillance Network (SAVSNET) has been awarded £700K by the BBSRC to expand its database of UK pet health records and support ‘big data’ research of animal and human diseases. The team led by Dr Alan Radford is involved in real-time disease surveillance, disease outbreak detection and developing models of tick activity in the UK. The data can be explored online by the veterinary and pet owner community raising awareness of the need to monitor disease levels and transmission.

Canine babesia in UK dogs

The SAVSNET team was also at the forefront of a recent outbreak of canine Babesia, a tick transmitted emerging disease, in the UK. The team used electronic health data from diagnostic laboratories and veterinary practices to understand the distribution of cases of canine babesiosis as well as related tick activity. This work highlights the importance of electronic health data to describe disease risk following the emergence of a pathogen.


Antimicrobial resistance in pets

Antibacterial resistance is not just a problem for humans, but also for animals and the veterinary surgeons that treat them. Through a multidisciplinary “big data” approach combining epidemiological information and modern microbiological techniques, Professor Nicola Williams, Dr Gina Pinchbeck and colleagues are providing new insight into the molecular mechanisms underlying resistance. They are also examining the role of antibacterial use in companion animal veterinary practices, highlighting where there may be risks to humans. The researchers aim to support antimicrobial stewardship and infection control programmes in animals, to reduce antimicrobial resistance and help ensure the efficacy of critical antibiotics in the future.

Dog aggression

Experts have argued that dog bites are preventable if owners are properly educated on how to read canine behaviour and identify high risk situations. However, the effectiveness of this theory has not been evaluated in any great depth. Dr Cari Westgarth interviewed victims of dog attacks and found a common tendency for these individuals to blame themselves for the attack, rather than the animal, or in cases where the dog was not known to them, they blamed the dog owner. A collaboration – the Merseyside Dog Safety Partnership – has since been launched that links experts and organisations across Merseyside, including the Royal Mail and Merseyside Police. Dr Rob Christley, who is leading the partnership, added: “Our initial goal is to identify key targets for intervention to minimise the risk and impacts of dog bites.

University Research Impact Award given to IGH Professor

Professor Stuart Carter was recognised with the University Research Impact award for work identifying a new and fatal immunodeficiency syndrome in foals, discovering its genetic basis, and developing an effective eradication programme based on a novel test. The work also featured as a highly commended REF Impact Case Study.
With a current total of 170 students, the IGH postgraduate community continues to thrive. Our postgraduates have benefitted from a range of development events organized by the Institute in conjunction with the Postgraduate Society which took place throughout the year and have included thesis writing workshops, science communication training and our first public engagement course.

“...been the perfect place for me, as a veterinary epidemiologist, to work on international animal welfare through a ‘One Health’ approach and has opened a lot of doors for future professional opportunities”

Gabrielle Laing, PhD student

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**Our People**

**Fostering talent**

Robin Flynn

Robin recently joined the Department of Infection Biology as a Senior Lecturer, coming from the University of Nottingham. His group dissects the immune response to parasitic infection, identifying parasite cell signalling molecules as vaccine or diagnostic candidates.

Joseph Angell

Joseph has recently started as a Tenure Track Fellow in Veterinary Infectious Diseases. Joe, a production animal veterinary surgeon and veterinary epidemiologist, is particularly interested in diseases that impact on animal welfare and reduce production.

Georgette Kluiters

Georgette is a BBSRC-funded Future Leader Fellow. Her research interests lie in Culicoides biting midges, important biological vectors of livestock viruses in Europe (see page 12).

Fernando Sanchez-Vizcaino

Fernando has recently been awarded a Veterinary Research Fellowship in Emerging and Zoonotic Infections at the NIHR Health Protection Research Unit in Emerging and Zoonotic Infections to develop a novel ‘One Health’ antibiotic resistance and surveillance approach.

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Tom started his NIHR Academic Clinical Lecturer post in infectious diseases at IGH in March 2016. His research aims to address the social determinants of health, with a particular focus on improving prevention and cure of tuberculosis in low-resource settings.

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Chitra Pattabiraman

Chitra has been awarded both the Royal Society-SERB Newton International Fellowship and a Wellcome Trust/Department of Biotechnology India Alliance Early Career Fellowship to identify viruses that cause acute encephalitis and understand how these enter the brain to cause the disease. She is the first Indian fellow supported through the Liverpool National Institute of Mental Health and Neurosciences Partnership.

See also page 8:

Professor Jonathan Rushton
Public Engagement

Infectious Science in the Pub
The Institute held its first Pint of Infectious Science in the Pub event which drew together researchers from a variety of institutions and brought scientific conversation into an informal domain for adults.

Public Involvement Panel
In September, the IGH Public Involvement Panel celebrated its first anniversary with a training day for scientists and members of the public (below). A morning of talks by academics, clinicians and representatives from the NHS Clinical Research Network was followed by an afternoon of presentations from our panel members reflecting on their experiences and how public involvement can benefit research.

Primary School Science Festival at the World Museum in Liverpool
Institute researchers ran the interactive "Disease Detectives Assemble!" which taught pupils from years 4 to 6 about the epidemiology of disease outbreaks and easy steps to limit the transmission of infectious diseases.

Roald Dahl’s Marvellous Medicine
As a junior doctor in Oxford in 1990, Tom Solomon looked after world-famous author Roald Dahl. Now he has written the untold story of Dahl’s fascination with medicine - he came up with some extraordinary medical devices which still have an impact. "I wanted to use the book to introduce some amazing areas of medical science to people who would not otherwise pick up a popular science book," Tom commented at the Cheltenham Literature Festival. The book featured in national TV, radio and newspapers, and sold out in its first week, prompting a rapid reprinting.

Rats!
Scientists from the Institute ran an activity called “The world of rats and science” looking at our relationship with rats as pets, explaining the risk of disease from rats and why they are thought of as pests. Young children were also able to participate in rat-related crafts such as colouring in, finger puppets and a “Rats in popular culture” quiz. The event was part of the Faculty’s “Meet the Scientists” programme at the World Museum Liverpool.

Naked Scientist
Dr Chris Smith, The Naked Scientists podcast host and BBC radio’s ‘5 live Science’ presenter, was the invited speaker for the annual Sutcliffe Kerr lecture, jointly organized by The Walton Centre and IGH. He delivered a whistle-stop tour of the world of scientific and medical media, describing how the Naked Scientists, one of the most downloaded science shows, came into being and the formula the team use to make science meaningful for everyone.

Summer School
In July 2016 we hosted the second IGH Summer School. Twelve local students participated, aged from 16 to 19 participated. Through talks, meetings and even practical experiments, all students took part in ongoing studies. For some of them this was their first contact with structured scientific research.

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Professor Diana Williams

Department of Clinical Infection,
Microbiology and Immunology
Professor Nigel Cunliffe

Department of Epidemiology
and Population Health
Dr Rob Christley

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Mathew Baylis (p10: theme 5), David Singleton
(p14: antimicrobial-pathogen network),
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(p16: R. Flynn, C. Caminade, F. Sanchez-Vizcaino,
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Laura Winters (p17: Primary School Fest),
Debbie Howarth (p18: Summer School),
Spencer McPherson (p18: Roald Dahl)
Chris Smith (p18: Naked Scientist).