

# EPSRC Hub for Quantitative Modelling in Healthcare (Hub for QMH)

Advancing quantitative modelling techniques that transform healthcare therapies, treatments and delivery.

# Who are we?

- Prof Krasimira Tsaneva-Atanasova, Director, Mathematics and LSI, University of Exeter
- Prof Robert Beardmore, Co-Director, Biosciences, University of Exeter
- Prof Peter Challenor, Co-Investigator, Mathematics and IDSAI, University of Exeter
- Prof Peter Ashwin, Co-Investigator, Mathematics, University of Exeter
- Prof Ivana Gudelj, Co-Investigator, Biosciences, University of Exeter
- Dr Kyle Wedgwood, Co-Investigator, Mathematics and LSI, University of Exeter
- Prof Neil Gow FRS, Deputy Vice-Chancellor (Research and Impact), Co-Investigator, MRC Centre for Medical Mycology, University of Exeter
- Prof Andrew Hattersley FRS, Co-Investigator, Exeter Centre of Excellence for Diabetes Research, University of Exeter
- Prof Waljit Dhillon, Co-Investigator, Head of the Section Endocrinology and Investigative Medicine & Head of Division of Diabetes, Endocrinology and Metabolism at Imperial College London; Director of Research for the Division of Medicine & Integrated Care at Imperial College Healthcare NHS Trust.

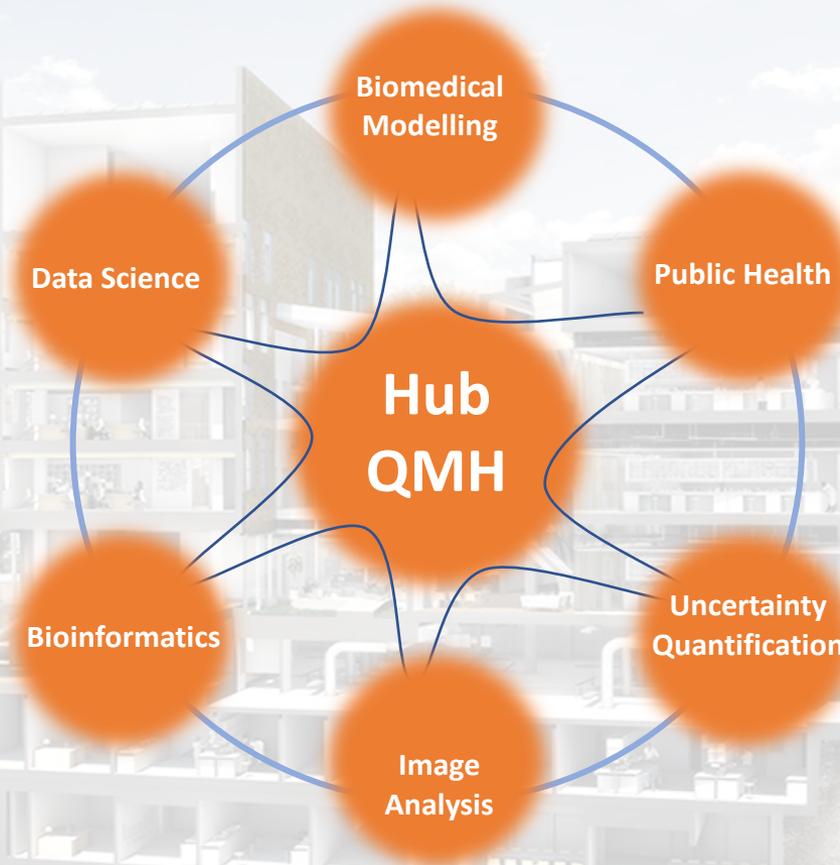
# The Hub for Quantitative Modelling in Healthcare is embedded in the Living Systems Institute



# Our Expertise

The Hub for QMH is nested **physically and virtually co-located** between our STEM Colleges

It brings together over 30 academics and researchers with **expertise** across applied mathematics and statistics involving uncertainty quantification dynamic network modelling, mechanistic modelling and dynamical systems analysis.



Extensive **academic collaborations** both nationally and internationally

Established links with **patient groups** and stakeholders

A growing base of **Industry relationships with Health Tech sector** and the NHS



# EPSRC Hub for Quantitative Modelling in Healthcare

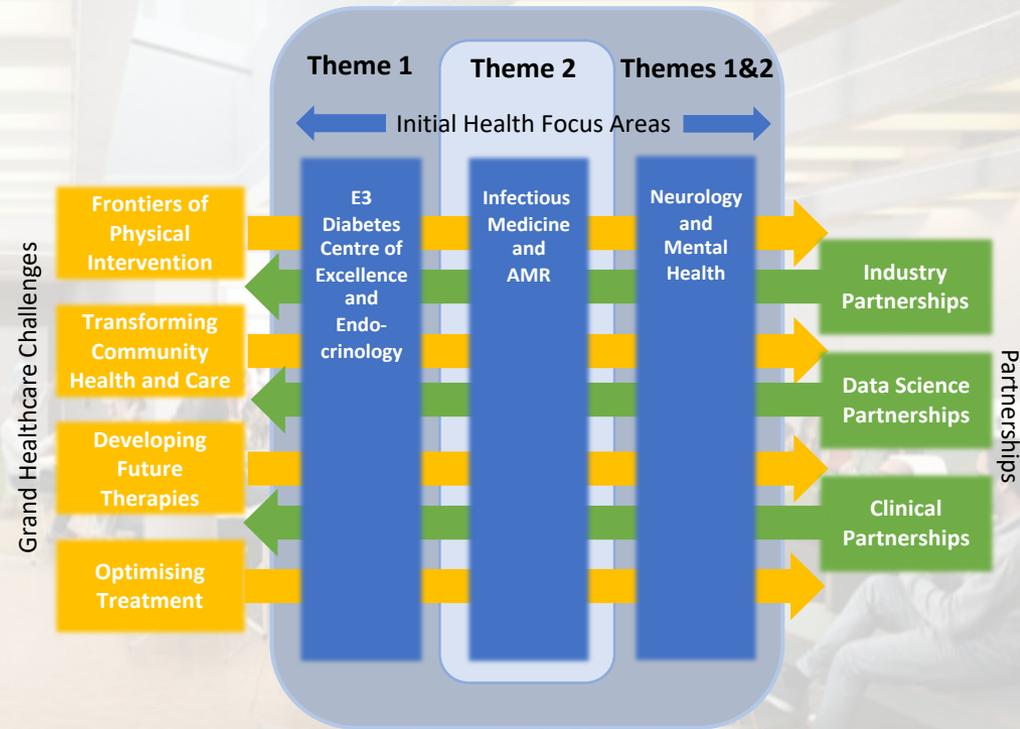
## Research Themes

The Hub has two Themes that address mathematical and statistical challenges in the healthcare arena.

**Theme 1:** Uncertainty quantification (UQ) for computational modelling in biomedicine and healthcare.

**Theme 2:** Reversibility and Resilience (RR): A Mathematical Approach to Evolving Microbial Communities.

The hub facilitates the Clinical Translation and Engagement with Partners for which we have concrete plans for the initial phase based on existing research, while leaving flexibility to engage with emerging themes in the later phases.



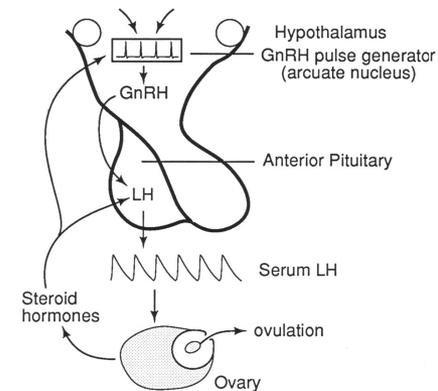
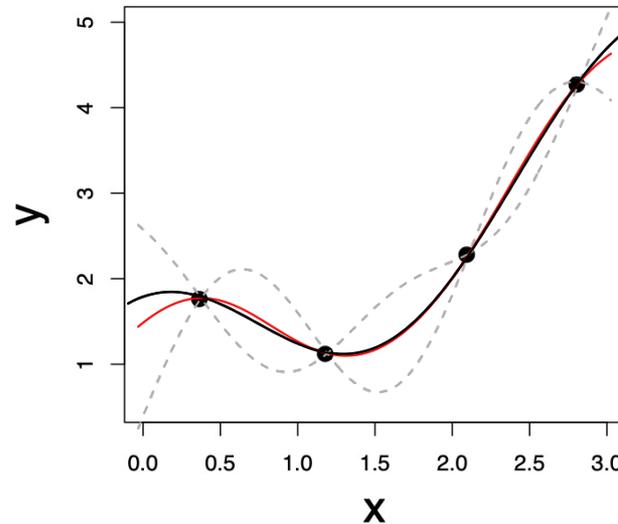
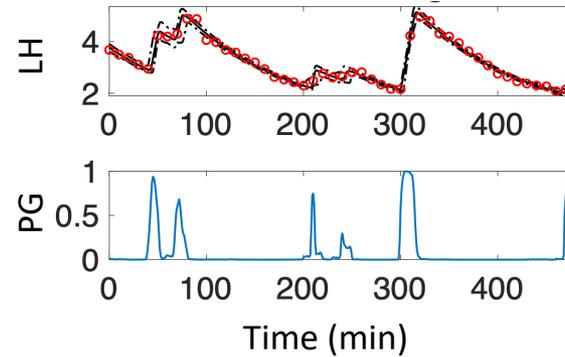
# Decision Making and Uncertainty Quantification



- Numerical models are increasingly being used in healthcare and clinical decision making
- If we are to use such models they need to be well calibrated and include measures of uncertainty
- We cannot afford to use sampling methods with the raw models

# Emulators and UQ

- We use fast surrogate models (with known uncertainty)
- These are known as emulators
- Fast emulators allow us to carry out:
  1. Prediction
  2. Sensitivity Analysis
  3. Uncertainty analysis
  4. Model Calibration



# The problem with antibiotics: data are sparse / unreliable / biased ... microbes lead complex lives

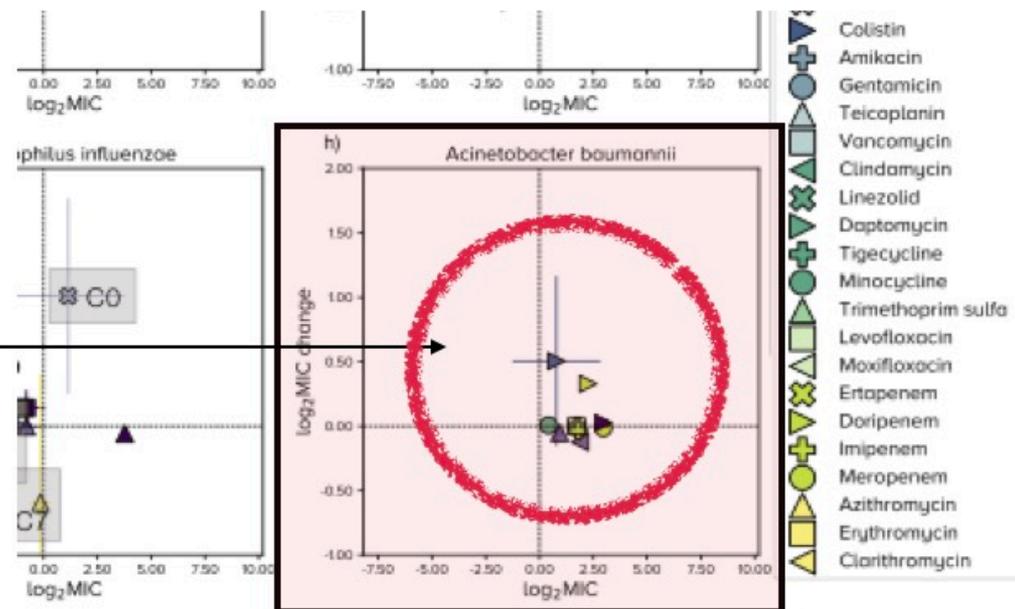
‘take all your medicine: textbook advice, where’s the data?  
not just warfare: antibiotics can be beneficial (antioxidant)  
hardware: hospital robots yield unreliable AbR phenotypes  
pan Ab resistance: how to optimise viral (phage) therapy?’

eg Atlas MIC data:

Acinetobacter b is highly MDR ... may be getting worse

pan Ab resistant

use phage?



clinician



Jon: U Sydney  
phage+sepsis

virologist



Justin: UCSD  
phage genetics

mathmo



Pablo: CIII Madrid  
open MIC data

clinician



Gus: Bristol  
BRI  
infection  
genomics  
nanopore



Emily: Exeter



Ivana: Exeter



Rob: Exeter



Somerset:  
tech development

real-time sequencing of long-term infections: Nanopore / Illumina / PacBio + math modelling of outputs (eg genome structure)

global resistance patterns in open phenotype data: eg Atlas et al

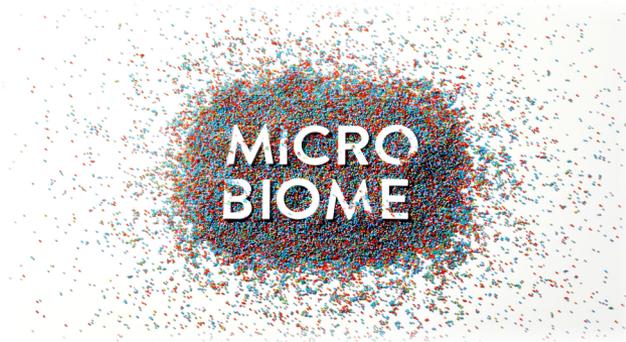
tech development: eg v low-cost spectrophotometry

# When the clinician met a mathematician.....



***“There is only one way to see things,  
until someone shows us how to look at  
them with different eyes”***

*– Pablo Picasso*



**Sanjay Haresh Chotirmall**

MB BCh BAO (Hons) MRCPI MRCP (UK) PhD

Assistant Professor (Lee Kong Chian School of Medicine,  
Singapore)

Honorary Senior Clinical Lecturer (Imperial College, London)

# Integration of multi-biome data through weighted-SNF identifies a cluster of bronchiectasis patients who frequently exacerbate

## INTEGRATIVE MICROBIOMICS

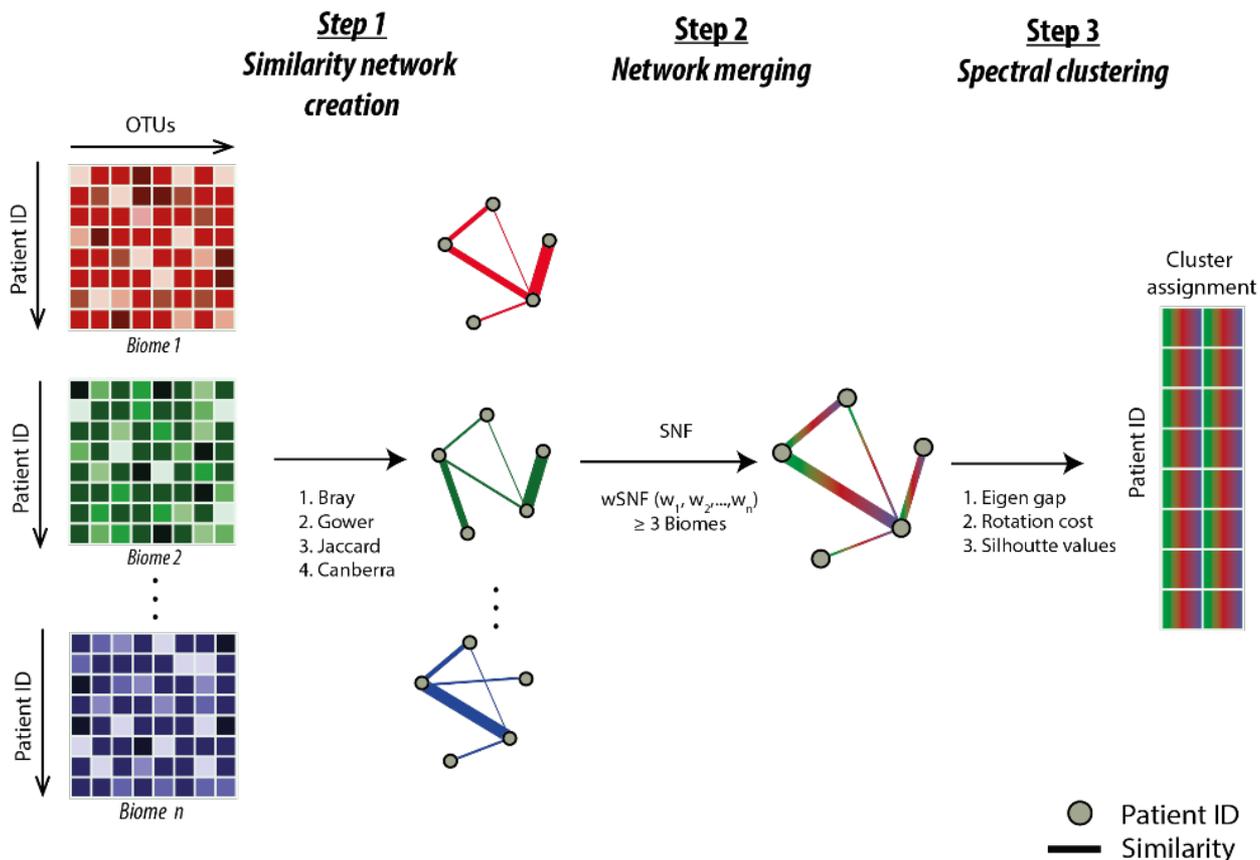
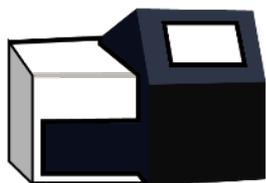
### Sample collection, processing, and library preparation



Environmental samples  
biological samples and etc.



### Sample sequencing and data analysis



# Our initial partners



The Alan Turing Institute

Imperial College London

