

An Indian-Australian research partnership

<b>Project Title:</b>	Real-time, AI-assisted Multi-Omics Profiling of the Gut Microbiome in patients with Chronic Kidney Disease (CKD)	
<b>Project Number</b>	IMURA1297	
<b>Monash Main Supervisor</b> (Name, Email Id, Phone)	Prof. Sharon Ricardo Sharon.Ricardo@monash.edu	<i>Full name, Email</i>
<b>Monash Co-supervisor(s)</b> (Name, Email Id, Phone)		
<b>Monash Head of Dept/Centre</b> (Name, Email)	Professor John Carroll	
<b>Monash Department:</b>	Monash Biomedicine Discovery Institute	
<b>Monash ADGR</b> (Name, Email)	Priscilla Johanesen priscilla.johanesen@monash.edu	
<b>IITB Main Supervisor</b> (Name, Email Id, Phone)	Prof. Ashutosh Kumar ashutoshk@iitb.ac.in	
<b>IITB Co-supervisor(s)</b> (Name, Email Id, Phone)		
<b>IITB Head of Dept</b> (Name, Email, Phone)	Prof. Shamik Sen	
<b>IITB Department:</b>	Department of Biosciences and Bioengineering	

**Research Clusters:**
**Research Themes:**

<b>Highlight which of the Academy's CLUSTERS this project will address?</b> <i>(Please nominate JUST one. For more information, see <a href="http://www.iitbmonash.org">www.iitbmonash.org</a>)</i>		<b>Highlight which of the Academy's Theme(s) this project will address?</b> <i>(Feel free to nominate more than one. For more information, see <a href="http://www.iitbmonash.org">www.iitbmonash.org</a>)</i>	
1	Material Science/Engineering (including Nano, Metallurgy)	1	Artificial Intelligence and Advanced Computational Modelling
2	Energy, Green Chem, Chemistry, Catalysis, Reaction Eng	2	Circular Economy
3	Math, CFD, Modelling, Manufacturing	3	Clean Energy
4	CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control	4	Health Sciences
5	Earth Sciences and Civil Engineering (Geo, Water, Climate)	5	Smart Materials
6	Bio, Stem Cells, Bio Chem, Pharma, Food	6	Sustainable Societies
7	Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng	7	Infrastructure
8	HSS, Design, Management		

## The research problem

### *Define the problem*

The human gut microbiome plays a pivotal role in health and disease, influencing metabolism, immunity, and chronic disease progression. The symbiotic relation between the gut microbiome and humans has been at the focal point of human well-being, and any disturbance in this may lead to dysbiosis. Advances in multi-omics technologies—including metagenomics, metabolomics, and proteomics—now allow comprehensive, high-resolution profiling of microbial communities and their functional outputs in health and disease conditions.

This project aims to leverage artificial intelligence (AI) to integrate multi-omics gut microbiome data with minimal clinical variables, enabling non-invasive, precision diagnostics and risk prediction for patients with chronic kidney disease. Eventually, this information may lead to personalised intervention in terms of medication and nutrition.

## Project aims

### *Define the aims of the project*

1. Build a longitudinal multi-omics atlas (shotgun metagenomics + targeted/untargeted metabolomics + stool proteomics) of CKD stages 2–4 vs. matched controls.
2. Develop and validate AI models that predict patient-specific responses to diet and synbiotic interventions, focusing on uremic toxin reduction (indoxylo sulfate, p-cresyl sulfate) and (short-chain fatty acid) SCFA restoration.
3. Conduct a trial comparing standard care vs. AI-guided diet/synbiotic plans in CKD, measuring biochemical, renal, and patient-reported outcomes.

## How skills/experience of the IITB and the Monash supervisor(s) support the proposed project

*Prof. Sharon Ricardo* from Monash Biomedicine Discovery Institute is a leading expert on CKD research, where she has a mouse model for CKD. Additionally, she has published many leading works to provide insight into the food needed for the CKD patient.

Prof. Ashutosh Kumar has done NMR-based metabolomics and developed an AI-based model for the early prediction of prediabetic/diabetic people using signature NMR spectra.

The complementary skill and expertise provided by both lead researchers will be crucial for successfully implementing this project.

## What is expected of the student when at IITB and when at Monash?

*The student will coordinate with the hospital in India to collect the microbiome sample and metabolite samples, record the NMR data on the patient samples, do the analysis, and develop the AI model.*

*When in Monash, the student will work on a mouse model using the optimized diet to investigate the effect. The student would collect samples in a time series manner, and those samples would be brought back to IITB for metabolomics and AI model generation.*

## Expected outcomes

*Highlight the expected outcomes of the project*

1. A clinically validated AI tool for CKD-specific diet/synbiotic prescription with explainability.
2. An open, de-identified multi-omics CKD microbiome atlas for India.
3. Biomarker panel (targeted LC-MS/MS) SOPs fit for multicenter diagnostics.
4. Clear clinical impact: reduced uremic toxins, improved SCFAs, better eGFR trajectory/QoL.
5. Commercial pathway: licensing of the AI tool + synbiotic formulation(s) optimized for Indian diets.

## How will the project address the Goals of the above Themes?

*Unfortunately, India and South Asia are becoming the diabetic capital and secondary complications of diabetes with DKD and KCD. KCD has become a complex, tractable problem due to frequent dialysis. A similar but slightly better situation is also prevailing in Australia. Hence. Addressing such problems and finding a long-term, manageable solution is the need of the hour. This project deals with an urgent and immediate need for healthcare, where we not only delineate the pathogenesis of the disease but also try to make an AI model to provide a possible solution for synbiotic formulation(s) optimized for the Indian diet.*

## How well the IITB and the Monash supervisor(s) know each other

*Both PIs had several meetings online, and the Indian PI visited Monash Biomedicine Discovery Institute in 2024 to define the research problem and explore the overlapping area of collaboration.*

## Potential RPCs from IITB and Monash

1. Prof. Kshtij Jadhav/Prof. Saket Chaowdhary from KCDH
- 2.

## Capabilities and Degrees Required

*M. Sc. in Biomedical Sciences/Biochemistry/Bioinformatics or related healthcare engineering and strong inclination for AI related model building.*

## Necessary Courses

1. Basic of AI/ML
2. Physiology for Engineers

## Potential Collaborators

*Please visit the IITB website [www.iitb.ac.in](http://www.iitb.ac.in) OR Monash Website [www.monash.edu](http://www.monash.edu) to highlight some potential collaborators that would be best suited for the area of research you are intending to float.*

**Keywords** relating to this project to make it easier for the students to apply.

KCD, AI model, NMR metabolomics.