CHILDREN'S MEDICAL RESEARCH INSTITUTE

Jeans for Genes®

STEM Careers in Medical Research

Introduction

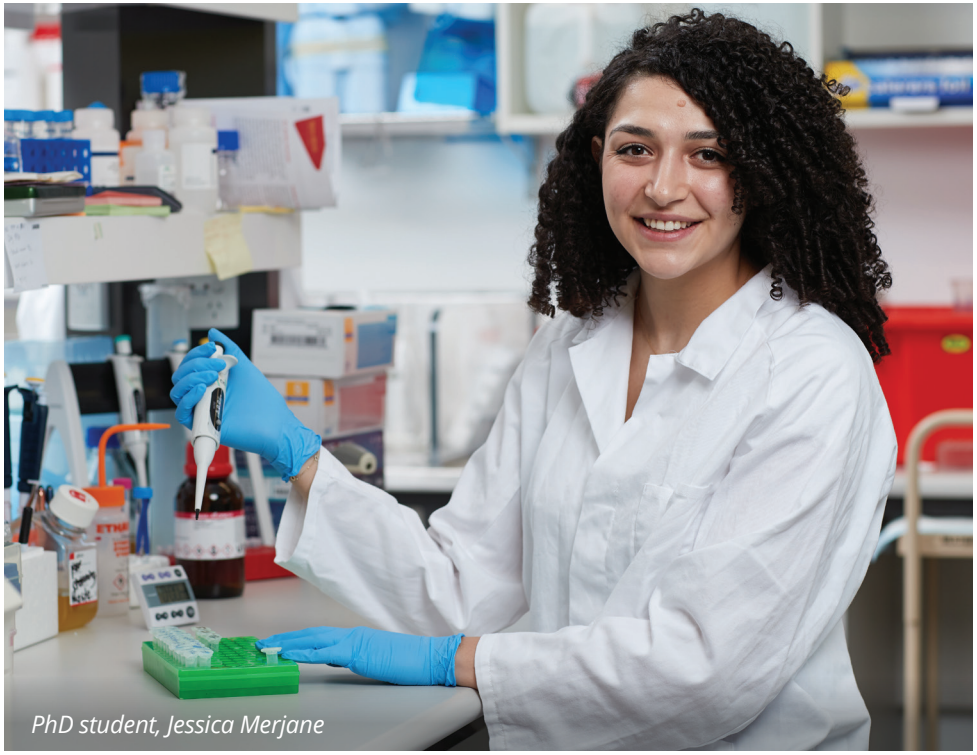
This booklet is a resource for high school and university students interested in a career in science. This resource also helps us improve science awareness and science literacy in the community.

Children's Medical Research Institute (CMRI) is on the cutting edge of science and technology, and this guide provides some examples of how careers in STEM (Science/Technology/Engineering/Mathematics) are vital to our mission of improving the health of children.

These careers are more than a job, they provide purpose and an unmatched feeling of accomplishment, knowing you are doing something that helps others and creates a future that never would have existed without you.

Were you a curious child? Do you still ask a lot of questions? Such as... Why is the sky blue? What is cancer? How does the brain work...? If yes, then you have the makings of a scientist!

It takes cleverness, creativity, and tenacity to succeed in STEM, but it's also far more accessible that you might imagine. People from all over the world, from every type of economic and cultural background, have discovered a path for themselves in science, and you can too.



PhD student, Jessica Merjane

STEM Careers Paths at CMRI

Medical research is like being a detective, discovering how cells and molecules in the body, which are too small to see with your eyes, normally function and what goes wrong to cause disease.

Most STEM careers begin with university and involve getting a **Bachelor's** degree in science, chemistry, or a field related to your area of interest. In Australia, this degree usually takes three years. An extra year of study, called Honours, is recommended as it provides hands on experience and is a steppingstone to a higher qualification.

During **Honours**, students carry out a one-year project (or two six-month projects) in the laboratory, and results are written up in an Honours thesis. After this degree, graduates can apply for a research position, such as Research Assistant.

Most scientists interested in undertaking independent medical research will go on to study for a **Master's** degree or, more commonly, a PhD (Doctor of Philosophy).

A **PhD** requires 3-4 years of full-time study, usually in a laboratory, focused on an individual research project. This project answers scientific questions never resolved before and is a genuine contribution to worldwide knowledge. Results are published in a PhD thesis and usually in one or more international scientific journals. PhD students also present their work at local, national, and international meetings or conferences.

PhD student tuition is usually covered by scholarships, and a living allowance is provided. CMRI offers very competitive PhD scholarship awards to successful applicants. Learn more on our website: https://www.cmrijeansforgenes.org.au/research/opportunities-for-research-students

Areas of interest for scientists at CMRI could include:

Biology - Medicine - Chemistry - Software Engineering - Biomedical Engineering - Mathematics/Data Science/Information Technology (a current area of need)

Types of roles include:

Role	Study Paths
Technician/Analyst	Undergraduate degree → Honours/Masters/possibly even PhD in relevant field depending on role
Research Assistant	Undergraduate degree, usually Honours or Masters as well
Post-doctoral Fellow (Post-doc)	Undergraduate degree → Honours/Masters → PhD
Research Officer/Research Scientist	Undergraduate degree → Honours/Masters → PhD → Post-doc
Lab or Facility Manager	Undergraduate degree → Honours/Masters/PhD
Clinician Scientist	Undergraduate degree → Medical Degree → PhD → Post-doc
Lab Head	Undergraduate degree → Honours/Masters/Medical Degree → PhD → Post-doc

Examples of STEM Jobs at CMRI

Dr Julia Hill

Head of Commercialisation

What got you interested in science?

I was always very interested in medicine but didn't think I was the right personality to deal with the emotional challenges that career would bring. I also loved animals, as I grew up on a farm, and so considered becoming a vet. I started a University degree in Biology with a view to potentially switching over to veterinary science if that still interested me. However, I was totally fascinated with biochemistry in my second year of Biology and so ended up pursuing further biochemistry courses and an honours project in biochemistry.

Tel us about your current role?

I am the Head of Commercialisation (otherwise known as technology transfer). I work with the scientists to understand the research they are doing and to determine whether it may lead to a new medical application, e.g. a new drug, diagnostic or medical device. When I find science that has the potential to be developed into a product that can be used in the clinic, I work with the scientists to protect the intellectual property (a process called patenting which stops other people from working on the same solution) and then I market their idea to pharmaceutical companies and investors who are interested in establishing new companies based on ground breaking research. The companies or investors then partner with the scientists to provide the funding and expertise to develop a new product from their research.

What study path did you take?

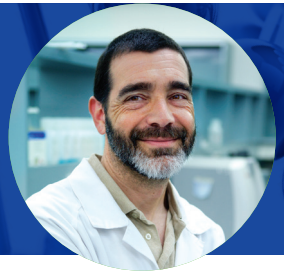
I completed a Bachelor of Science (Hons), followed by a PhD, and then an MBA to give me the business skills required for this role.

Was there anything 'unconventional' about the approach you took?

I was the first (and only) person in my immediate family to finish High School let alone study for all those degrees. In my very large extended farming family (in the UK which is where I grew up) there was one of my father's cousins who had been very gifted in music and had studied at Cambridge, but nobody else had been to University on either side of my family. They had a hard time understanding why I wanted to do it, particularly given that I am a female (this was a very big deal for many of them)

What would you say to inspire the next generation of scientists?

Follow your heart and your interests. Don't allow anyone to tell you that you 'can't' do it – where there is a will there is a way!



Dr Scott Cohen

Cell Biology

Scott was the first in the world to identify the structure of telomerase, a molecule that allows cancer cells to keep growing and is also important for human aging.

What got you interested in science?

My first fascination with science was a bit indirect – a fascination with flight. My Dad was a pilot and from an early age, I was around aircraft (one of my cherished memories as a child in the 70s was walking with my Dad under a 747, and up the stairs to the cockpit – you could do that in the 70s). As I prepared for college, I became interested in aerodynamics and the physics and chemistry associated with it. And the more physic and chemistry I learned, the more focused I became on these core physical sciences.

What is your current role at CMRI and what does it involve?

As a 'Senior Research Scientist' at CMRI, I am incredibly fortunate to have significant independence in carrying out my research on the cancer-associated enzyme 'telomerase'. Most of my time is spent at the lab bench, where I investigate the biochemistry and structure of this amazing molecular machine. My work often begins with multi-step enzyme purification to extract this rare enzyme from immortal cancer cells we grow in the lab. With pure enzyme in hand, I subject it to a variety of experiments to measure enzymatic activity or visualise the molecule under the electron microscope.

What study path did you take to get here?

My training was in chemistry: Bachelor of Science in chemistry at San Diego State University, followed by five years at Caltech earning a PhD in organic chemistry. After Caltech, I moved to the University of Colorado for postdoctoral research in the lab of Nobel Laureate Tom Cech; it was during these years I learned how to produce and handle RNA (the superior biomolecule).

Was there anything 'unconventional' about the approach you took?

If you've read this far, you might be wondering how a Yank (trained in chemistry, no less) ends up in a biomedical institute in Western Sydney! During my time in Tom Cech's lab, he hired a postdoc from Sydney by the name of Tracy Bryan. Tracy had just completed her PhD at CMRI after making a major discovery in telomere biology, and left CMRI with a standing offer to return. We got married, and the rest is history...

Anything you'd like to say to inspire the next generation of scientists?

Science is a journey! Perhaps a cliché but for me it's been true. As my science has taken unexpected turns, I let it guide major decisions in my life, as opposed to the other way around. By being open to unexpected findings and embracing new areas of research you will be more likely to make major discoveries!!!

Dr Andrew Robinson

Peptide Chemist/ Acting Peptide Synthesis Facility Manager

What got you interested in science?

As a child I was always interested in knowing 'why' and 'how'. Why is the ocean blue?

It absorbs less blue than it does other wavelengths of light like red. How do we know that?

We shine light at water and see what happens to it. We can measure that more blue light passes through the water than other wavelengths of light.

As you move further along a STEM career the questions get more complex, but the process is the same. Why is this the way it is? And how do we know that? Using science as a lens to view the world means whenever you have that burning question about 'why' you'll have a system and a toolset to interrogate the 'how'. When those tools don't exist, yet you get to be creative and think them up yourself by standing on the knowledge of thousands of scientists before you.

Sometimes you're the first one in the world to do something a certain way, and it's this process happening thousands of times across thousands of scientists who all test each other's work that pushes the world's collective knowledge forward.

If you're a curious person then it's an easy field to fall into and an easy process to fall in love with.

What is your current role at CMRI and what does it involve?

I'm currently both a research officer and the acting manager of the peptide synthesis facility. We do a lot of peptide chemistry (this means working with the building blocks of proteins that make up our bodies), and we get to creatively assist a variety of research projects, primarily in the cancer space.

There is always a new challenge to tackle. Whether it is developing new projects to understand the fundamentals or achieve a goal, managing and maintaining instruments, optimising processes, or working out how we can apply our knowledge to better other people's work, there is always something to improve and build upon.

Seeing the impact of our work as things translate from the scientific process of understanding to the real-world process of applying that understanding to achieve an outcome is very rewarding.

What study path did you take to get here?

My background is in chemistry, and my path started with enrolment in a science degree and then PhD candidature. The knowledge and skillsets I acquired from these courses equipped me with the ability to start to interrogate the interesting details in my field. But it was the people around me, and the exciting ideas being explored, that really led to fun and impactful work.

If you can take part in research projects that excite you and can see where they push the barriers of our understanding, then you'll always learn something worthwhile. Academic projects, industry projects, collaborative work, consider anything that comes up which genuinely piques your interest.

As you gain experience, you'll learn what you're good at, what you're bad at, what you like, and what you don't like. Understanding that will help you specialise and select your path.

Was there anything 'unconventional' about the approach you took?

If anything, I'd say I had an advantage in this space starting out. I've been around science for a long time and have friends and family in the field which gave me a familiarity with processes that many often aren't exposed to until later in their careers.

You should never underestimate the power of having experienced people to ask for help and opinions.

You don't need to have friends or family working in the space to get these benefits though. Interacting with teachers, university professors, industry groups, peers, and student societies or attending meetings and conferences all help build knowledge and experience.

Societies such as the Royal Australian Chemical Institute (RACI), in chemistry, or The Australian Institute of Physics (AIP), in physics, are generally fantastic groups to join to develop a broad network of colleagues and collaborators who will know more in their specialist area than you.

At some stage everyone will need a colleague's brain to pick when they hit a dead end.

If I have one tip for anyone starting out in a STEM field it's to find the relevant people and societies in your field and engage with them.

There will always be personal hurdles to overcome, and each person will deal with those in their own way and at their own pace. STEM as a whole is generally becoming more flexible and supportive of people's unique circumstances, but, like in science, there will always be things that can be improved upon.

Anything you'd like to say to inspire the next generation of scientists?

Keep learning things and keep doing things. There is always more to understand, but heading down a career path in STEM means it's likely that you'll eventually be amongst the best in the world at something. When you're at the forefront of a field of knowledge, you never know when something you discuss with new people or attempt in the lab will lead to an exciting discovery that nobody has seen before.

I'm not one for inspirational quotes, but the world needs people who understand science now more than ever. So, keep learning, and keep doing, and let people know the interesting things you and your colleagues discover so the whole world can know 'why' and 'how'.

Dr Rebecca Poulos

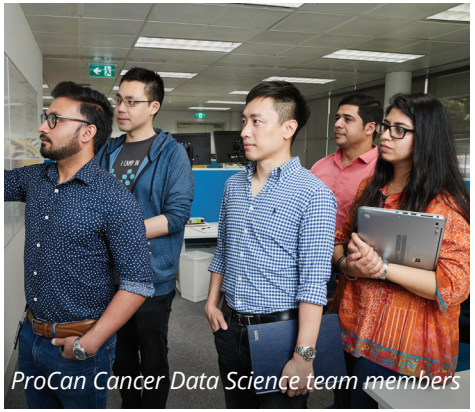
ProCan Cancer Data Science

What got you interested in science?

When I was a kid, I became hooked on astronomy after reading a picture book called “1001 facts about Space”. I had my own telescope and did work experience at the “Dish” in Parkes. When I was choosing university courses, the biology subjects looked most interesting to me, so I chose to study Biotechnology.

What is your current role at CMRI and what does it involve?

I am a postdoctoral researcher in the Cancer Data Science group at CMRI. I don’t do lab work anymore but instead use coding (Python) to analyse DNA and protein cancer datasets that are generated at CMRI and elsewhere around the world. I analyse these data to try and find trends and patterns that describe biological features of cancer and how patients might respond to cancer treatments.



ProCan Cancer Data Science team members

What study path did you take to get here?

When I finished school, I did a double degree in Business (Accounting) and Science (Biotechnology) at UTS. I then did Honours and a PhD at UNSW in the Faculty of Medicine. In these research projects, I learnt bioinformatics to study the genomics of cancer, mostly using publicly available ‘big data’.

Was there anything ‘unconventional’ about the approach you took?

I wanted to be an accountant when I left school, so I started a Bachelor of Business and worked full time as an auditor in a large accounting firm. After a couple of years, I decided that I missed science, so I converted to a double degree. I loved studying science and found genetics to be the most interesting topic. This led me into my cancer research career.

Anything you’d like to say to inspire the next generation of scientists?

Science is a fascinating career that allows you to discover exciting things about the world for a living. It can be a difficult path that requires a lot of time investment, but it is also very flexible and favours those who are self-driven. The COVID-19 pandemic has highlighted the importance of research, and what incredibly rewarding work it can be.

Dr Jason Grealey

ProCan Cancer Data Science

What got you interested in science?

I developed my interest in science in the later years of school when I was around 15 years old. I loved studying and learning about mathematics, physics and biology, and I had friends in similar positions which helped. Somehow, I’ve managed to work in a research role that I think can be thought of as a combination of these main areas of science.

What is your current role at CMRI and what does it involve?

I’m a cancer data scientist where I use mathematics, statistics, cancer biology, and computer science to try to better understand cancer. It involves programming and mathematics, where I develop and use algorithms on information gathered about cancer to try to learn any new and underlying patterns.

What study path did you take to get here?

I studied for five years at the University of Edinburgh where I completed an integrated Masters of Theoretical Physics. My Master’s thesis utilised mathematical simulations to understand cancer growth models. After this, I studied a PhD at Baker Heart and Diabetes Institute at the Inouye Systems Genomics lab where I developed artificial intelligence models for genomic prediction and investigated the carbon footprint of computation. Towards the end of my PhD, I knew I wanted to focus my research on cancer, and I’m happy to have found myself here at CMRI – ProCan.

Was there anything ‘unconventional’ about the approach you took?

I moved across the world from Ireland to Australia to undertake my PhD, which was fun but was also quite difficult at times. Perhaps branching over from theoretical physics to mathematical biology / data science could be considered unconventional and took me a long time to get used to.

Anything you’d like to say to inspire the next generation of scientists?

Try to enjoy the things you study, it will help a lot. I believe a lot in spending time with other students/friends/peers and helping each other out, as some things are better explained by different people, and sharing knowledge is vital. I’d also recommend talking to your lecturers/ teachers about things or topics that interest you. This helped me form the directions of study and research which led me to where I am now.

ProCan Software Engineering team

Dr Katie Zyner

Computational Systems Biology

What got you interested in science?

Science piqued my curiosity when I was a young child. My earliest memory of this was in Year 5, where I was lucky enough to have a primary school teacher who was extremely passionate about science. So much so that she used to demo small scale experiments with us every Friday afternoon. This ranged from dissecting squid and frogs to bringing in cow's lungs. All of this allowed us to gain a better, hands-on understanding of the biology we were learning in the curriculum.

Furthermore, my mother's experience working as a hands-on scientific demonstrator at NASA in the United States and CSIRO in Australia was also a big contributor. Overall, I would describe myself as a person who is fascinated by understanding how things work, especially when it helps to uncover what goes wrong in disease. Science is addictive, and one of my favourite aspects is that there is always something new to learn. The day-to-day activities are never the same, and as a research scientist, we are always trying to push the boundaries of human understanding.

What is your current role at CMRI and what does it involve?

I am currently a Senior Research Officer in the Computational Systems Biology Group led by Associate Professor Pengyi Yang. Using both computational and wet lab studies, the lab seeks to understand how stem cells can develop into the plethora of cell types, despite that fact that all cells of a multicellular organism carry the same basic instruction manual (or DNA sequence).

To achieve this, we take a holistic approach and study changes in: cell signalling pathways (phosphoproteomics, proteomics), gene expression (transcriptomics), histone and DNA methylation (epigenetics), patterns during pluripotency transitions, and cell differentiation.

As a cellular and molecular biologist, I mainly work in the lab doing tissue culture (growing stem cells and differentiating them to various cell types), performing bench experiments (e.g. recombinant protein expression and purification, western blotting and PCR); 3D fluorescence microscopy; sequencing experiments (e.g. ChIP-seq, RNA-seq, ATAC-seq), genome editing techniques (e.g. CRISPR), and genome-wide screens. I also plan to incorporate more data analytics in the near future.

What study path did you take to get here?

At the end of Year 12, I wasn't sure of the type of career I wanted to do, but I knew life sciences had to play a role, so I enrolled in a Bachelor of Medical Science at the University of Sydney. I found this degree to be extremely beneficial, as the core subjects included a combination of anatomy, pharmacology, microbiology, molecular biology, genetics etc, allowing me to have a broad understanding of all the different depths of life sciences and potential career trajectories I could take.

During my third year, I attended a guest lecture discussing the hallmarks of cancer cells, which included their immortality. This was my first introduction to telomerase, a protein complex responsible for elongating the ends of chromosomes, called telomeres. As telomeres normally shorten every time a cell divides (leading to cellular ageing), expression of telomerase allows cancer cells to divide indefinitely. I was instantly captivated by this phenomenon, especially since this is one of the mechanisms cancer hijacks from normal stem cells. Luckily, I found that there are world experts in the Telomere field right here in Sydney, and so I decided to do a Science Summer Research Project with them at CMRI under the supervision of Professor Roger Reddel and Dr Lorel Colgin. Importantly, this 3-month project allowed me to gain valuable insight into the day-to-day life of a scientist to see if research would be a career I would like to pursue.

Motivated by my experience, I decided to extend my Bachelor's degree and do an Honours year in the same lab under the supervision of Associate Professor Hilda Pickett. From there I joined the laboratory of Professor Tracy Bryan at the CMRI for my PhD in Medicine to study how telomerase interacts with non-canonical DNA structures called G-quadruplexes which can exist in telomeres.

Next, I travelled to Cambridge in the United Kingdom for my first post-doctorate experience in the multidisciplinary laboratory of Sir Shankar Balasubramanian (co-inventor of the Solexa-Illumina Next Generation DNA sequencing technology) at the University of Cambridge and Cancer Research UK Cambridge Institute. Here I studied the biological role of G-quadruplexes in cancer and stem cells in controlling gene expression and gained valuable experience in performing and analysing large scale sequencing experiments.

I joined the Computational Systems Biology Group at CMRI early this year and hope to start my own independent lab in the future.

Was there anything 'unconventional' about the approach you took?

Overall, I think I was very fortunate during my career path. I was able to work alongside world experts in the field every step of the way and live in different countries (which I recommend to everyone!). For researchers, I would say the major hurdle is obtaining money to do your research. For my PhD studies, I was able to utilise scholarships such as Australian Postgraduate Award and CMRI PhD scholarship, for both of which my supervisors were happy to provide advice with the application.

Anything you'd like to say to inspire the next generation of scientists?

I would implore them to find something they are passionate and curious about. Science benefits the most when the people working on it are enthralled with a particular subject matter and want to learn more. Take the chance on something you are curious about, no matter how difficult it may appear at first. You never know where it may take you!

Jadon Wells

Research Assistant in the Telomere Length Regulation Unit

What attracted you to science?

I think what makes a scientist is having the inclination to question your surroundings and the curiosity to find answers to those questions. I'm not happy unless I'm finding out something new every day, so I think pursuing science was really just a natural progression of this curiosity.

What does a Research Assistant's typical day look like?

Every day is a new learning experience, and no two days are the same. Something I'm really liking about my position is that it allows me to become familiar with every project in the lab. I'm just trying to soak up as much knowledge as possible from the wealth of expertise surrounding me.

What was your study path?

I graduated with a Bachelor of Medicinal Chemistry (Honours) from the University of Wollongong in 2018. My honours year focussed on a new class of G-quadruplex binding molecules as possible anticancer therapeutics. It was through this project that I really fell down the rabbit hole of telomere biology and became passionate about cancer research, which eventually led me here.

What is your favourite part of the job?

Learning something new! I don't think a day has gone by yet where I don't learn something new from my colleagues. I'm finding answers to questions I never would've had 6 months ago, and that's exciting.

Senior Research Officer, Alex Sobinoff

Scott Lee

Research Assistant in the Stem Cell & Organoid Facility

What is your background?

I received my Masters of Science (MSc) in Bioengineering, studying tissue engineering of heart valve leaflets, incorporating the technology of stem cells. I am very passionate about stem cells and regenerative medicine.

What attracted you to CMRI?

I was attracted to CMRI because of the institute's commitment and proactiveness to helping paediatric patients, shown through events such as Jeans for Genes. Also, the translational potential of the Stem Cell and Organoid Facility drew me in even closer.

What does your typical day look like?

My typical day involves maintaining and differentiating induced pluripotent stem (iPS) cells to generate 3D organoids (mini-organs in the dish). We can then freeze them, section them, and stain them in order to characterize the organoids at different time points.

What is your favourite part of the job?

My favourite part of the job is maintaining, differentiating, and generating organoids using human iPS cells. It is absolutely mind-blowing to grow human organs outside of the body for modelling disease, developing new therapeutic approaches, and increasing our understanding of regenerative medicine.

Group Leader, Stem Cell Medicine, Dr Anai Gonzalez Cordero

Dr Kate Mullany

PhD Student in the Gene Therapy Research Unit

What is your background?

I grew up on the South Coast near Nowra as the eldest of five kids in a busy, noisy, crazy, loving household. I completed my university training in Science (Biology) at the University of Wollongong and dabbled in some climate science research, before being accepted into medical school. After graduating medicine, I trained in Paediatric Gastroenterology and Hepatology at Westmead Children's Hospital.

What attracted you to science?

As a clinician, I am so privileged to be able to help sick kids and their families every day in a meaningful way. However, sometimes there are no treatments that I can offer. The opportunity to do a PhD represented a chance to try and find solutions to problems we can't fix yet, and in doing so help my patients that little bit more.

What does your typical day look like?

I'm still pretty new, but the Gene Therapy Research Unit (GTRU) and CMRI have be so wonderful in helping me find my feet. I'm learning lab techniques, designing experiments, and still popping over to the children's hospital to do some shifts on the floor. Each day brings something different and exciting.

What is your favourite part of the job?

Being part of the GTRU at CMRI feels like I'm at the interface of clinical medicine and cutting-edge research. It's very inspiring to being part of such a team.

Research Assistant, Deborah Nazareth

Professor Robyn Jamieson

Eye Genetics Lab Head

Professor Robyn Jamieson leads the Eye Genetics Research Unit at CMRI and if Head of the Speciality of Genomic Medicine at the University of Sydney. She also heads the Eye Genetics Clinic at The Children's Hospital at Westmead and is Head of the Western Sydney Genetics Program. She was recently instrumental in getting the first-ever TGA-approved gene therapy treatment into the clinic—which helped restore sight to two of her teenage patients.

What is the most exciting part of your research?

In most patients and families, with disorders of eye development and blindness, the underlying cause is not known. In our research, it has been exciting to discover changes in new genes that have caused vision loss, and this allows us to look for new therapies to rescue vision or prevent blindness.

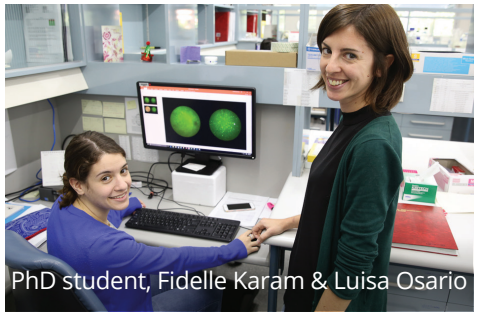
What are you researching now and what does it involve?

My team and I study inherited eye diseases that affect both children and adults. This includes conditions like retinal diseases and also developmental abnormalities of the eye, including very small or absent eyes. Our work is a collaborative effort with scientists at The Children's Hospital at Westmead and the Save Sight Institute, University of Sydney.

In our experiments, DNA from patients is used to identify causes of blindness. We work with human induced pluripotent stem cells differentiated to retinal organoids and retinal pigment epithelium to investigate genetic variants and test novel genetic therapies. We've established a collaborative network with ophthalmologists and clinical geneticists from around Australia and internationally. The aim is to develop detailed understanding of the role of retinal disease genes causing blindness, and to use genome engineering, cellular, and vector technologies for novel treatments for these conditions.

What was your study path?

I studied Medicine at the University of Queensland and trained in paediatrics and clinical genetics in Brisbane and Sydney. I became a Fellow of the Royal Australasian College of Physicians (Paediatrics) with certification in Clinical Genetics. I completed a PhD in developmental biology at the Children's Medical Research Institute and received an NHMRC Neil Hamilton Fairley Fellowship and a RACP Travelling Fellowship to undertake postdoctoral research in genomics and disease gene analysis at the University of Manchester, UK.



PhD student, Fidelle Karam & Luisa Osario

NSW GOVERNMENT

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214 Hawkesbury Rd, Westmead NSW 2145 Australia
Tel: 8865 2800 f: +61 2 8865 2120
info@cmri.org.au | CMRIJeansForGenes.org.au