

# CURRICULUM VITAE

## Michael RAGHUNATH

Updated 6<sup>th</sup> June, 2015

### Associate Professor Michael Raghunath, MD, PhD (Habilitation)

Department of Biomedical Engineering (Faculty of Engineering)  
& Department of Biochemistry (Yong Loo Lin School of Medicine)  
National University of Singapore (NUS)

### CONTACT INFORMATION

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**Date of Birth:** January 13, 1961  
**Place of Birth:** Frankfurt, Germany  
**Marital Status:** Married, one son  
**Military Service:** 1980-1981 (Leer/Bremen, 1987 (Munich, Kaiserslautern) German Army, medical orderly and army physician  
**Nationality:** German

### PROFESSIONAL EXPERIENCE

January 2014 - present 25% joint appointment as Principal Investigator, Institute for Medical Biology (IMB), A\*STAR

August 2003 – present Associate Professor, Department of Bioengineering, National University of Singapore, tenured since January 2009

July 2002 Senior Research Fellow, Dept. of Dermatology, Lecturer in Physiol. Chemistry

July 2003 University Hospital Muenster; Consultant to CliniPharm AG, Frankfurt

August 2000 - June 2002 Director of R&D; Dr. Suwelack Skin & Health Care AG Billerbeck, Germany  
Consultant in genodermatoses, Lecturer in Physiological Chemistry and Pathobiochemistry, University of Muenster

May 1997 Resident in dermatology and senior research fellow in dermatology, Dept. of

July 2000 Dermatology University of Münster

- Extracellular matrix biology and disorders of cornification
- Clinical duties, UV-therapy, photodynamic therapy, implementation and running of the genodermatosis clinic
- Teaching in dermatology and pathobiochemistry, guide for medical doctoral theses
- In parallel from January 2000- August 2000 R&D Scientific Advisor to Dr. Suwelack Skin & Health Care AG

April 1995 - Fellowship Professorial Qualification Programme of the German

April 1997	Science Foundation (DFG) at the Institute of Physiological Chemistry and Pathobiochemistry, University of Muenster, Germany <ul style="list-style-type: none"> <li>Habilitation in Physiol. Chem. &amp; Pathobiochem., teaching and research</li> </ul>
April 1990 April 1995	Postdoctoral fellow at the Department of Metabolic and Molecular Disorders, Children's Hospital, University of Zürich, Switzerland (with Prof. Beat Steinmann) <ul style="list-style-type: none"> <li>Pathobiology of heritable connective tissue disorders</li> <li>Regeneration of skin after keratinocyte autotransplantation in severely burned children</li> </ul>
January 1988	Postgraduate scholarship of the DFG at the Institute of Immunology, March 1990 University of Heidelberg <ul style="list-style-type: none"> <li>Basic research: glomerulonephritis, autoimmune diagnostics, immunohistopathology of the skin</li> </ul>

### ACADEMIC ACHIEVEMENTS

Since January 2009	Tenure (T65) as Associate Professor at NUS
Since January 2008	Adjunct Investigator, Institute for Medical Biology (IMB), A*STAR
August 2005 March 2009	Deputy Head Research & Enterprises, Department of Bioengineering
August 2005 December 2008	Chair, Graduate Programme in Bioengineering
Since August 2003	Associate Professor for Bioengineering, Faculty of Engineering & Biochemistry, Yong Loo Lin School of Medicine, National University of Singapore
July 2003	Appointed "ausserplanmässiger Professor" (Associate Professor) by the University Hospital of Münster
July 1997	Appointed "Privatdozent" (Reader) after acceptance of a habilitation thesis (equivalent to a British Doctorate) by the Medical Faculty of the University of Münster, permission to teach (Venia Legendi) in Physiological Chemistry & Pathobiochemistry
May 1988	Doctorate in medicine, Dr. med., „magna cum laude“, Institute of Paediatric Pathology, University of Mainz

### STIPENDS AND FELLOWSHIPS

June 1995	Professorial Qualification Programme of the German Science Foundation, (DFG; Ra 447-3/1 and Ra 447-3/2)
May 1997	
Oct 1996	EMBO Short Term Fellowship
July 1988	Postdoctoral programme (2 yrs.) of the DFG (Ra 447- 1-1)
April 1990	
April 1982 - May 1987	German Scholarship Foundation ( <a href="http://en.wikipedia.org/wiki/Studienstiftung">http://en.wikipedia.org/wiki/Studienstiftung</a> ); (3 <sup>rd</sup> to 12 <sup>th</sup> semester; recruitment at University, 0.5% of students receive this stipend)

### HONOURS

2013	SMART Faculty Fellow (Singapore-MIT Alliance for Research & Technology)
2011	SMART Faculty Fellow
April 2010	E.T.S. Walton Visiting Fellow, Science Foundation of Ireland
August 2011	National University of Ireland, Galway
June 2008 - July 2009	Raine Visiting Professor, University of Western Australia

## PRIZES AND AWARDS

2011 (Singapore)	Excellent Mentor Award, NUS Graduate School for Engineering and Integrative Sciences (NGS)
2006/7	Faculty of Engineering: Dean's Commendations List (education and teaching)
1998 (Münster)	Promotion Award of the University of Münster for the best habilitation thesis
1998 (Cologne)	Marfan Research Prize (Marfan Hilfe Deutschland e.V.)
1997 (Dublin)	poster prize; Eur. Academy of Dermatology and Venereology
1996 (Zürich)	1 <sup>st</sup> European Club for Paediatric Burns Prize
1995 (Langenthal)	Marfan-Passage (Marfan Stiftung(Schweiz))
1992 (Bern)	Nestlé-Prize for Paediatric Research

## Prizes won by my graduate students

2015	Paula Benny, best poster prize, UK-Singapore Skin Symposium, 11-15 March 2015, Singapore
2013	Adeline Sham Fong Wai, 1 <sup>st</sup> prize, oral presentation, category Scientific Young Investigator Award, TERMIS Asia Pacific, Wuzhen, 26 October 2013
2012	1. Pradeep Paul Panengad, 3 <sup>rd</sup> place poster award, TERMIS World Congress, Vienna, September 2012 2. Wang Yingting, Poster Prize, 4th Annual Symposium of Singapore Stem Cell Society, 6-7 September Singapore
2011	1. Clarice Chen: 2 <sup>nd</sup> Prize for the 2011 Johnson & Johnson Asia Outstanding Graduate Thesis Award in BioTech; 2. Ariel Tan, Bronze Award for presentation graduate student category BES Singapore 3. Ariel Tan, second prize for best poster at TERMIS Asia Pacific August 2011, Singapore
2010	1. Anna Blocki best poster presentation, TERMIS –EU Galway: 2. Clarice Chen, best abstract 3. Felicia Loe, best abstract
2007	1. WONG Yuan Sy: 2nd poster prize TERMIS-NA meeting Toronto, silver award graduate student category oral presentation BES national conference 19 May 2007, 2. Karthik Have: Bronze award for oral presentation graduate student category (Biomedical Engineering Society of Singapore)
2006	1. Wong Yuan Sy, best oral presentation GPBE conference 2. Wong Yuan Sy, best poster prize, National Graduate Student Conference on Bioengineering 3. Peng Yanxian, 2 <sup>nd</sup> prize for oral presentation GBPE conference

## Prizes won by my undergraduate and attachment students

2014	Muhammad Abdulrahim, best poster presentation 8 <sup>th</sup> Biomedical Society Meeting, Singapore 8 <sup>th</sup> May
2008	Leong Yuan Chang, Hwa Chong Institution (internship): 1st Award 2008 Taiwan Internatl. Science Fair

## EDUCATION AND PROFESSIONAL TRAINING

April 1981	Studies in Medicine, Johannes Gutenberg University Mainz;
April 1987	Approbation as MD (license to treat) in May 1987

## PROFESSIONAL RESPONSIBILITIES (since 2000)

2012-: premedical advisor for Faculty of Engineering and Faculty of Arts and Social Sciences for undergraduate students aiming for the Duke NUS Graduate Medical School (premed programme)

2011- : Member of the NUS *Institutional Animal Care and Use Committee (IACUC)*; evaluation of proposed work with animals, monitoring of animal welfare at the university, inspection of animal holding facilities,

2011 - : Chair Outreach Committee, Department of Biomedical Engineering: outreach activities for prospective and current students, website outreach, communication with media and decision makers

2005- 2009: Deputy Head Research of the Department of Biomedical Engineering, I was responsible for all administrative issues concerning the endorsement of grant applications and discussion of scientific issues with the Department and the Faculty of Engineering on Faculty Research Committee Level, monitoring of the scientific progress of the Department. I was member of the Faculty Research committee of the Faculty of Engineering deciding on allocating intramural funding to research proposals. I represented and steered the Department through three International Advisory Panel visits. The Department was judged to be world class level by the last visit of the international advisory Panel in January 2009. In 2008, the degree programme for Bachelor of Engineering (Bioengineering) was accredited by the Engineering Accreditation Board, The Institution of Engineers, Singapore, a signatory state of the Washington Accord. Also here I participated in my capacity as Deputy Head.

2005–2008: Chair of the Graduate Programme in Bioengineering. This interfaculty, university-level programme was founded in 2001. During my tenure as Chair of GPBE some 80 PhD students were under my care and 30 MSc students graduated. In this role I was in charge of running an elite graduate programme in Bioengineering. Together with the management committee I revamped the curriculum and turned the programme around from MSc to a PhD programme. We attracted more European PhD students into the programme. Under my aegis the first national Graduate Student conference in Bioengineering was implemented, followed by an international graduate student meeting in Bioengineering in Dec 2008 in collaboration with Tohoku University, Sendai, Japan. In December 2008 I transferred the programme into fully fledged focus areas of the NUS Graduate School of Engineering & Integrative Sciences thereby negotiating advantageous terms for my scholars. Thereafter my duty ceased but I am still involved as senior faculty in NGS both as student advisor and teacher.

2000-2002: Director of R&D at Dr Suwelack Skin & Health Care AG, my task was to form an R&D team to position the company in the biomedical market (Wound Care, Tissue Engineering). I led an R&D team of 10 people, to ensure compliance with regulatory issues, to assess intellectual property opportunities, to outsource research that was important to implement sound scientific evidence to document quality, efficacy and safety of the products. I attracted BMBF (Federal Ministry of Research) funds in collaboration with the RWTH Aachen, one of the leading German Universities in Engineering, into the company. The biomedical product I was involved in and which is currently on the market is Matriderm®, a dermal template for burn treatment and reconstructive surgery.

### **Teaching Commitments**

BN4101: Introduction to Research Methodology (compulsory for final year students and first year grad students in Bioengineering, open to the whole Faculty of Engineering)

ReCoRSE: Proper Research Conduct (NUS Graduate School for Integrative Sciences & Engineering)

BN4403: Cellular Bioengineering (Course coordinator)

BN5203: Advanced Tissue Engineering (Course coordinator)

MD120A: Biochemistry of Connective Tissue for dental students

BN3402: Bioanalytical Techniques (Lecture and lab demonstration)

EG2401: Engineering Professionalism (Tutor)

MDG5223: Stem Cells and Regenerative Medicine

EG5911 Research Methodology and Ethics, newly created graduate course as member of a task force of the Faculty of Engineering, taught faculty-wide wef from January 2014

BN5103 Advanced Molecular Biology: Discontinued in 2007

### **Membership in Scientific Advisory Boards**

- Tissue engineering/regenerative medicine (TE/RM) Scientific Advisory Board (SAB) for Biomedical Engineering Department, (Head Prof Vo Van Toi), International University of Vietnam National Universities, HCM City, International Scientific Advisory Board for TERMIS AP Shanghai 2013

**Membership in Scientific and Professional Societies:**

Biomedical Engineering Society Singapore; TERMIS; Council Member TEMIS Asia-Pacific 2011-2013; Scientific Advisory Board of the German Marfan Foundation, Biophysical Society, and subgroup "Biopolymers in Vivo"; Matrix Biology Society of Australia and New Zealand (MBSANZ)

**Member of Editorial Boards**

Journal of Tissue Engineering and Regenerative Medicine, Frontiers in Bioengineering and Biotechnology (specialty section "Tissue Engineering and Regenerative Medicine" (started in September 2014)

**Activities as reviewer**

- governments and academic institutions: Australian Government, German Ministry of Education and Research (BMBF), A\*STAR; School of Biological Sciences, University of Manchester, UK, University of Western Australia, Medical Research Council UK, Nanyang Technological University
- funding bodies: Wellcome Trust, UK, Biomedical Research Council Singapore, National Research Foundation Singapore, SMART Singapore, National Medical Research Council Raine Foundation Western Australia; German Ministry of Education & Research (PT Juelich), Science Foundation of Ireland, Health Research Board Ireland
- scientific journals: Hum Gen, Lab Invest, J Invest Dermatol, Arch Dermatol Res, Exp Dermatol, J Cell Biol, Eur J Cell Biol, Adv Drug Del Rev, Tissue Engineering, Bioconjugate Chem, Biomacromolecules, Biomaterials, Adv Health Care Mat, Adv Functional Mat, Adv Mat, JTERM, Acta Biomaterialia, Biomedical Materials, Cancer Research, Eur J Pharm Biopharm, Int J Macromolecules, Biotech Bioengn, CMC Pharmacol, In vitro Toxicol, J Biol Engineering, J Mol Histology, Future Medicine, Cellular Reprogramming, Stem Cell Rev Rep, Drug Discovery Today, Stem Cells Int
- external examiner of PhD and Masters theses: University of Sydney, University of Cape Town, University of Tampere (Finland; reviewer and opponent), University of Wuerzburg, Rhenian Westphalian Technical University Aachen (RWTH), Duke NUS Graduate Medical School, University of Eindhoven (The Netherlands)

**Chaired symposia**

August 2011 TERMIS AP, Singapore; June 2011 TERMIS EU, Granada, Spain; June 2010 TERMIS Galway Ireland; October 2010 TERMIS Sydney Australia

**Organiser of conferences**

ICBME 2005 Programme chair; ICBME 2008 sponsorship Chair; TERMIS AP 2011, Programme Chair

**Invited non-keynote Presentation in 2014**

- Wenner-Gren Institute, Stockholm, Sweden April 10
- University of Uppsala, Department of Chemistry, April 9

**Invited Presentations in 2010 – 2013**

- TERMIS Asia Pacific Meeting Wuzhen, 25 October 2013
- University of Natural Resources and Life Sciences, (BOKU), Vienna, Austria 18 September 2013,
- Berlin Brandenburg Center for Regenerative Therapies, Berlin, Germany, 7 August 2013
- London Matrix Club, 18 July, UCL, London, UK
- CNRS & University of Orleans, Center for Molecular Biophysics, France, 17 June 2013
- Curtin University, School of Biomedical Sciences, 28 February 2013, Perth, Australia
- Institute for Cancer Research, University of Genoa, 18 December 2012
- KOREA Regenerative Medicine Initiative Forum, 2012, Institute for Regenerative Medicine, Dankook University, Daegu, December 13,
- Lecturer of the Year, Department of Paediatric and Adolescent Surgery, Medical University of Graz, Austria, 4 September 2012

- Canadian Connective Tissue Conference 2012, Toronto June 8-10, 2012, keynote
- Matrix Dynamics Group, Dept of Dentistry, U of Toronto, June 14
- IBBME University of Toronto, June 5
- Stemgent, Cambridge, MA, 30 May 2012
- Tufts University, Department of Dentistry, 29 May 2012
- 4<sup>th</sup> BME conference Ho Chi Min City, Vietnam, January 8 , 2012
- NFB retreat, National University of Ireland , Galway, June 2, 2011, keynote
- TERMIS Granada, Spain, June 8, 2011
- Korea-Singapore Symposium on enabling technologies, TERMIS AP, August 2011
- University of Utah, Dept of Chemistry, Feb 2010
- Stanford University (Mechanical Engineering),
- National University of Ireland, Galway, July 2010
- Berlin Brandenburg School for Regenerative Medicine
- University of Wuerzburg, Germany, August 2010
- Australian Institute of Bioengineering and Nanotechnology (University of Queensland), Oct 2010
- IHBI (Queensland University of Technology), Oct 2010

***Invitations to give keynote lectures***

2015 WITE, 4th International Conference "Strategies in Tissue Engineering" from June 10 to 12, 2015 Würzburg, Germany.

2014

- TERMIS- EU, Genoa, June 10-13
- TCES UK, Newcastle upon Tyne, July 2-4
- TERMIS AP, Daegu 21 September
- 38th Annual Scientific Meeting Matrix Biology Society of Australia and New Zealand (MBSANZ) October 26-29, 2014 (declined due to conflicting schedules)

2013

TERMIS AP, Shanghai/Wuzhen, Symposium on Emerging Technologies in Tissue Engineering

2012

- Korea Regenerative Medicine Initiative Forum, 2012, in conjunction with ITREN-WCU Symposium Korea, Kyongpook University, Cheonan, December 14

2010

- TERMIS Galway, Ireland (June),
- TERMIS Sydney , Australia (September),
- Berlin Brandenburg School for Regenerative Therapies, Berlin Germany, (August)
- KALBE Awards Jakarta (Indonesia, in the presence of the Minister of Health of Indonesia)

***Invited publications***

- book chapter *Biomacromolecules* (editor Dimitrios Zevgolis)
- book chapter *Biomaterials*, Elsevier, (editor Dietmar Hutmacher, QUT)
- review article for *Adv Drug Delivery Rev* (editor Katja Schenke-Layland, Fraunhofer Institute Stuttgart)
- review article for *Fibrogenesis & Tissue Repair* (editor, Michael Zeisberg, Harvard University)  
***(highly accessed and most viewed article in that journal of all time as of Dec 2012)***

***Students supervised (since 2003 at NUS)***

**(1) Postdocs/research engineers (10):**

Dr Ricky Lareu (currently Senior Research Fellow, Curtin University, Western Australia), Dr Dimitrios Zeugolis (currently Lecturer National University of Ireland, Galway), Dr Gina To'a Salazar (currently UN, New York) , Dr Karthik Harve Subramhanya (currently lecturer in Anatomy, National University of Singapore), Dr Wang Zhibo (currently postdoc Harvard U), Dr Clarice Chen (currently Assistant head National Research Foundation, SG), Ms Chris Heyjin Park (currently ZEISS, Singapore), Dr Peng Yanxian

(currently PALL, SG), Dr Rafi Rashid (currently postdoc Nanyang Technological U, SG), Dr Pradeep Paul Panengad (currently at Audacity); visiting: Dr Aroem Naroemi (2011 from U of Indonesia)

**(2) PhDs completed (22)**

*Main supervision (20):* Wang Yuan Sy (2009, currently scientific officer at Defense Science Organisation, Singapore); Karthik Harve Subramhanya (2010, currently senior lecturer at NUS); Wang Zhibo (2010, currently postdoc at Harvard U); Felicia Loe (2011, currently HR manager at HBSC, SG); Clarice Chen (2011, currently Ass. Head, National Research Foundation, SG); Peng Yanxian (2011, currently product manager with Merck Millipore); Subha Narayan Rath (2010, currently assistant professor at IIT Hyderabad); Viknish Krishnankutty (2012; currently at IMB, A\*STAR); Piriya d/o Sasajalan (2012, currently NUS Office of Student Affairs); Pradeep Paul Panengad (2012, currently private industry); Ariel Tan (2012, currently executive officer Joint Council Office, ASTAR); Anna Blocki (2012, currently postdoc Singapore Bioimaging Consortium A\*STAR); Shayanti Mukherjee (2013, currently postdoc in Australian National University, Cairns); Rebekah Margaret Samsonraj (2013, currently postdoc Mayo Clinic); Lim Sei Hien (2014, current private industry); Jean-Yves Dewavrin (2014, currently R&D scientist at Mesoblast), Adeline Sham Fong Wai (2014, industry-funded postdoc in my group); Priscilla Peh (Jan 2015) currently research fellow in my group, Michelle Lee (March 2015), currently research fellow in my group, Ang Xiu Min (April 2015), currently Patent Office Singapore.

*Co-supervision (2):* Sebastian Beyer (2012, currently postdoc Singapore MIT Alliance for Research & Technology), Rafi Rashid (2012, currently postdoc at Nanyang Technological University, Singapore),

**(3) PhD students currently in main supervision (5)**

NGS (2) : Wang Yingting, Rokus Kriszt

Bioengineering (2): Natalie Lim, Anna Goralczyk (SINGA Scholarship)

School of Medicine (1): Paula Benny

**(4) PhD students currently in co-supervision (0)**

**(5) Masters students completed (6)**

Irma Arsianti, Rajeswari Ramachandran, Paula Benny, Wang Yingting, Sebastian Kress (Germany), Christian Leicht (Germany)

**(6) Masters students currently in main supervision (1)**

Mathilde Koch, Ecole Polytechnique (Paris), starting in August 2015, Marc Rabaza Gairi

Table: Synopsis of all NUS grad students (MSc and PhD supervised from 2003 onwards, as compiled by e-portfolio)

S. No.	From	Until	Name	Thesis title	Examiner Category	Degree	Year Conferred	Student Status
9	2003/2004	2005/2006	IRMA ARSIANTI	Implementation of a Drug Discovery Tool for the Evaluation of Anti-Fibrotic Compounds: Application in Fibrovascular Disorders	Sole	MASTER OF SCIENCE	2006	GRADUATED
8	2003/2004	2007/2008	WONG YUAN SY	Applying side effects of anti fibrotic compounds to promote neovascularization for tissue engineering	Main	DOCTOR OF PHILOSOPHY	2008	GRADUATED
33	2004/2005	2008/2009	HARVE SUBRAMHAN YA KARTHIK	Excluded Volume Effects in Molecular Biology and Extracellular Matrix Biochemistry: Biophysical Considerations and Molecular Modeling	Main	DOCTOR OF PHILOSOPHY	2009	GRADUATED
3	2005/2006	2009/2010	WANG ZHIBO	Epigenetic potential of histone deacetylase inhibitors in treating fibroproliferative diseases and preventing peri-implantational fibrosis	Sole	DOCTOR OF PHILOSOPHY	2010	GRADUATED
19	2005/2006	2010/2011	SUBHA NARAYAN RATH	Tissue engineering of a vascularized bone graft	Main	DOCTOR OF PHILOSOPHY	2010	GRADUATED
38	2005/2006	2010/2011	LOE HUI LI / FELICIA CELESTE LOE	Applying Macromolecular Crowding to Promote the Expansion and Adipogenic Differentiation of Human Mesenchymal Stem Cells in vitro; an Effect of Matrix Reciprocity	Sole	DOCTOR OF PHILOSOPHY	2010	GRADUATED
7	2006/2007	2010/2011	PENG YANXIAN	In vitro-bioassembled human extracellular matrix and its application in human embryonic stem cell cultivation	Sole	DOCTOR OF PHILOSOPHY	2011	GRADUATED
29	2008/2009	2010/2011	RAJESWARI RAVICHANDRAN	Biomimetic surface modification of dental implant for enhanced osseointegration	Sole	MASTER OF ENGINEERING	2011	GRADUATED
32	2005/2006	2010/2011	CHEN ZHEN CHENG, CLARICE	Towards Topical Antifibrotics in Tissue Engineering and Repair	Sole	DOCTOR OF PHILOSOPHY	2011	GRADUATED
13	2008/2009	2012/2013	SEBASTIAN BEYER	Colloidal Nanomaterials for Life Science Applications - Fabrication and Physicochemical Studies	Co-Supervisor	DOCTOR OF PHILOSOPHY	2012	GRADUATED
21	2010/2011	2011/2012	PIRIYA D/O SASAJALA	Pregnancy associated progenitor cells migrate, integrate and contribute to maternal hematopoietic compartments in the murine model	Main	DOCTOR OF PHILOSOPHY	2012	GRADUATED



31	2008/2 009	2011/2 012	VIKISH KRISHNAN KUTTY	Accelerated and Enhanced Differentiation of Human Neural Stem Cells by a Cell-Contact Mediated Mechanism	Co- Supervisor	DOCTOR OF PHILOSOPHY	2012	GRADUATED
37	2011/2 012	2011/2 012	BENNY PAULA-BETH ANGELICA TIQUI	Enhancing the extra- cellular matrix synthesized by epithelial and mesenchymal cells through macromolecular crowding, in 2D cell monolayer and 3D organotypic co-cultures	Sole	MASTER OF SCIENCE	2012	GRADUATED
5	2007/2 008	2012/2 013	RAFI RASHID	The Biophysical Properties of Macromolecular Crowders and Their Uptake, Distribution and Fate in Cells	Co- Supervisor	DOCTOR OF PHILOSOPHY	2013	GRADUATED
11	2011/2 012	2012/2 013	WANG YINGTING	Pericytes are more than MSCs: A Comparison of Three Cell Populations	Sole	MASTER OF ENGINEERING	2013	GRADUATED
16	2008/2 009	2012/2 013	ANNA MARIA BLOCKI	Peripheral Blood: A Simple Cell Source for the Generation of Angiogenic Progenitors from Monocytes	Main	DOCTOR OF PHILOSOPHY	2013	GRADUATED
18	2008/2 009	2013/2 014	SHAYANTI MUKHERJEE	Nanostructured Biomaterial Strategies for the Regeneration of Infarcted Myocardium	Sole	DOCTOR OF PHILOSOPHY	2013	GRADUATED
23	2007/2 008	2012/2 013	TAN BING- SHI, ARIEL	Reversal of phenotype and plasticity of myofibroblasts to target peri-implantation fibrosis	Sole	DOCTOR OF PHILOSOPHY	2013	GRADUATED
26	2006/2 007	2012/2 013	PRADEEP PAUL PANENGAD	Enzyme Tissue Transglutaminase Based Biological Tissue Glue	Main	DOCTOR OF PHILOSOPHY	2013	GRADUATED
1	2010/2 011	2014/2 015	DEWAVRIN	Turning of Collagen I Fibrillogenesis Kinetics via Macromolecular Crowding	Sole	DOCTOR OF PHILOSOPHY	2014	GRADUATED
6	2009/2 010	2013/2 014	LIM SEI HIEN	Induction of Angiogenesis in Microfluidics by using Prolyl Hydroxylase Inhibitor and Sphingosine 1-Phosphate	Main	DOCTOR OF PHILOSOPHY	2014	GRADUATED
34	2008/2 009	2013/2 014	REBEKAH MARGARET SAMSONRAJ	Benchmarking Human Mesenchymal Stem Cells for Improving Orthopaedic Efficacy	Main	DOCTOR OF PHILOSOPHY	2014	GRADUATED
2	2008/2 009	2010/2 011	MENG XUBIN	A small molecule approach to generating neural tissues from induced pluripotent stem cells	Main	DOCTOR OF PHILOSOPHY		WITHDRAWN
4	2011/2 012		ANG XIU MIN	Effect of Proliferation on MSCs using macromolecular crowding	Main	DOCTOR OF PHILOSOPHY		FULL TIME
10	2012/2 013		WANG YINGTING	Application of angiogenic cells in animal models	Main	DOCTOR OF PHILOSOPHY		FULL TIME
12	2004/2 005	2006/2 007	KONG PUI CHING	Optoelectronic Protein Chip BIOMOLECULAR- MICRO-OPTP-ELECTRO- MECHANICAL -SYSTEMS	Main	GRADUATE PROGRAM (SOM)		REFUSED READMISSION

				(BIOMEMS)				
14	2010/2 011		EKARIN CHULIKORN	Differentiation of mesenchymal and neuronal stem cells under conditions of macromolecular crowding	Main	DOCTOR OF PHILOSOPHY		FULL TIME
15	2007/2 008		EKARIN CHULIKORN	Differentiation of mesenchymal and neuronal stem cells under conditions of macromolecular crowding	Main	GRADUATE PROGRAM (SOM)		FULL TIME
17	2006/2 007	2006/2 007	POORNIMA SIVAKUMAR	Cartilage	Sole	DOCTOR OF PHILOSOPHY		WITHDRAWN
20	2007/2 008		PIRIYA D/O SASAJALA	Fetomaternal cell trafficking	Main	GRADUATE PROGRAM (SOM)		PART TIME
22	2012/2 013		ROKUS GYORGY KRISZT	Differentiation of human bone marrow-derived mesenchymal stem cells (hbmMSC) into brown adipose tissue	Sole	DOCTOR OF PHILOSOPHY		FULL TIME
24	2009/2 010		PEH ZHI YI PRISCILLA	Bone Marrow Stem Cell Based Tissue Modulating Strategy for Wound Healing	Main	DOCTOR OF PHILOSOPHY		PART TIME
25	2011/2 012		LIM SHENG JIE NATALIE	Tissue Engineering	Main	DOCTOR OF PHILOSOPHY		FULL TIME
27	2013/2 014		ANNA GRAZYNA GORALCZYK	Bioengineering	Sole	DOCTOR OF PHILOSOPHY		FULL TIME
28	2009/2 010		LEE HUI CHING MICHELLE	Adipogenic Induction Under Macromolecular Crowding With Ficoll Unlocks the Intrinsic Potential in Adult Human Bone Marrow Mesenchymal Stem Cells Towards a Brown Adipocyte Phenotype	Sole	DOCTOR OF PHILOSOPHY		PART TIME
30	2008/2 009		SHAM FONG WAI, ADELIN	Applications of Prolyl Hydroxylase Inhibitors in Tissue Engineering and Regenerative Medicine	Sole	DOCTOR OF PHILOSOPHY		PART TIME
35	2011/2 012		BENNY PAULA-BETH ANGELICA TIQUI	Developing a novel bioengineered skin equivalent for wound healing applications	Main	DOCTOR OF PHILOSOPHY		FULL TIME
36	2008/2 009		BENNY PAULA-BETH ANGELICA TIQUI	Effects of macromolecular crowding in human epithelia	Sole	GRADUATE PROGRAM (SOM)		FULL TIME

**(6) international TAC member (2)**

Jennifer Cheng, graduated, (UNSW Sydney, Australia, supervisor Laura Poole-Warren)  
Chee Wai Wong, (Curtin University, Australia, supervisor Deirdre Coombe)

**(7) honors students (4)**

Paula Benny, Shri Kayatthir, Durkeshwari d/o Anbalagan, Subashiyni Ramakrishnan

**(8) final year students: Around 30**

**(9) UROPS (undergraduate research opportunity programme) and Vacation internship projects (VIP)  
(5)**

Angelina Lim, Png Si Ning, Tan Li Che, Teo En Wei, Tan Yu Lin Michelle

**(10) External international examiner for doctoral theses (4)**

Opponent: 2012 26.9.2012 Jertta-Riina Sarkanen: Engineering vascularized soft tissue, University of Tampere, Faculty of Medicine, Department of Anatomy and Cell Biology;

Livia Nivison-Smith, University of Sydney 2011; Lage Ahrenstedt, University of Cape Town 2012; Jertta Riina Sarkanen, University of Tampere 2012; Laura Kyllonen, University of Tampere 2013

Student exchange, summer internships:

My lab has attracted a considerable number of students and interns (20) from reputable institutions from overseas:

Natasha Lee (Cambridge U), Amelia Ann Michael (Imperial College), Leslie Goldberg (Rice U), Jenny Holm (Rice University, Whittaker Fellow), Stephanie Tzouanas (Global Engineering Research Scholarship, Rice University), Hin Wan Tuan (U Toronto), Ariel Tan (final year project, UWA), Anna Blocki and Kathryn Krause (Bachelor thesis, U of Applied Sciences Dortmund Germany), Christian Leicht (MSc Thesis, RWTH Aachen, Germany), Jenny Cheng (UNSW, Sydney, Australia), Sachi Gorkhali (post BSc, U British Columbia), Sebastian Kress (MSc, U of Wuerzburg), Maria Koch (BSc, U of applied Sciences Bremen, Germany), Samantha de Witt and Willeke Traa (U of Eindhoven, Netherlands), Sabitoj Virk Singh (Amritsar, India), Grace Ong (Imperial College, UK), Anna Goralczyk (Krakow, Poland), Matthias Graupp (ENT surgeon, Medical University of Graz, Austria), Marc Vijven (U of Eindhoven, for 2015), Marc Rabaza Gairi (U of Barcelona, 2015).

The three UG students from Rice U were very satisfied with their time with us. Jennifer Holm is a co-author on Peng et al 2012, and won a NSF scholarship for her PhD at Texas Austin; Leslie Goldberg got accepted into Med School in U of Florida, Stephanie Tzouanas won a prestigious Goldwater fellowship at Rice U based on her work with us. Students come self-funded or with stipends.

## **Tissue Modulation Laboratory, research statement and summary of achievements**

### **Research Statement**

After over 26 years of matrix biology research, clinical and industrial experience it is my mission to translate knowledge I have gained in basic and clinical research to the bedside and the market. It is very satisfying to me that as then director of R&D at Dr Suwelack Skin & Healthcare AG I have contributed to the characterisation of a dermal template that is now successfully used internationally in plastic and burn surgery (Matriderm®). In the last over eleven years at NUS I have generated IP related to our crowding technology that shall lay the basis for commercialization of products and services related to cell-based therapies and nutraceutical screening. I pursue a dual strategy that covers both basic research aspects and translational work. Both aspects are important to me. While translational work gives me a sense of purpose, I enjoy the intellectual pursuit of identifying biological mechanisms. *The different research thrusts have a common denominator, the extracellular matrix as microenvironment.* **The characteristic ingredient that my lab brings to the table is our broad scope/helicopter view and integrative knowledge across medical and biological disciplines. I view myself as a person that connects the dots, one that can put knowledge and information from different fields together.**

### **Brief description of current and future projects**

We have coined the term “Tissue Modulation” to describe efforts to influence the development and composition of tissue in a wound healing and repair situation by modulating the behaviour and the phenotype of cells building or remodelling their microenvironment. We prefer to use synthetic compound, small chemicals or large sugar polymers that have already been approved for a different clinical indication. Using this approach we hope to shorten the bench to bedside time and to ease regulatory pathways. My research is currently organized into the following thrusts:

#### ***1) Tissue Modulating Materials***

##### ***(A) Scar Wars; application and discovery of antifibrotic drugs (Scar in the Jar)***

Scarring, a surplus of collagen deposition, threatens the integration of implanted devices and tissue constructs into host tissue by enshrouding them in an avascular fibrotic capsule which effectively sequesters them. To curb this process we employ small chemicals, prolyl hydroxylase inhibitors that interfere with collagen synthesis and secretion. The ultimate goal is to reprogram myofibroblasts, the cellular culprits of fibrosis, into a more benign phenotype. For this purpose we have been evaluating the histone deacetylase inhibitor SAHA for its antifibrotic purposes. (Wang et al 2009).

##### ***(B) Self-Vascularising Biomaterials for Tissue Regeneration and Advanced Wound Care***

The prolyl hydroxylase inhibitors which we employ for antifibrosis also stabilise HIF-1 $\alpha$ , an angiogenic master switch. We are now developing these substances into advanced functional biomaterials that prevent peri-implantation fibrosis while inducing mesenchymal cells in the host tissue stroma to induce endothelial sprouting into these implanted biomaterials. Current strategies involve the chemical coupling or incorporation of 2,4-pyridine dicarboxylic acid or ciclopirox olamine into materials that have been approved for medical use such as gelfoam. Based on our earlier work in vitro (Raghunath et al 2009), we have proven this concept in the rat renal pouch model (Sham et al. 2014). We have also discovered that the combination of prolyl hydroxylase inhibitors and sphingosine-1-phosphate is particularly angiogenic (IP generated, Lim et al 2013).

⇒ We are developing this work towards an advanced wound healing product for chronic skin wounds (IMB, A\*STAR), but envision this system also to be useful for cardiac patches or non-union bone fractures

### **(C) Biomaterial-based local induction of stem cell homing and differentiation**

These materials either directly influence the tissue composition around them or function as a homing beacon for a variety of cell types to modulate inflammation, remodeling and repair locally. We have successfully incorporated a range of diverse active compounds simultaneously into electrospun microfibers (growth factors, vitamins, hormones) and demonstrated that their bioactivity is preserved after release (Peh et al, submitted); preliminary data suggest that electrospun meshes with these ingredients are able to achieve epithelial coverage in splinted skin wounds that normally would not re-epithelize.

⇒ In a MINDEF (Ministry of Defense of Singapore)-funded project we are evaluating this system for acute wounds whereby we test these electrospun meshes as capture systems for bone marrow derived mesenchymal stromal cells (autologous or allogeneic) prior to implantation, we envision this system also to be very useful to be evaluated in chronic wounds. This system is currently evaluated with human MSC's in immunosuppressed rats. We are implementing a diabetic rat model in the Institute for Medical Biology to test this system further.

⇒ We have been able to incorporate an adipogenic induction cocktail into electrospun fiber meshes and could direct adipogenic differentiation of mesenchymal stem cells without the addition of differentiating factors into the culture medium; the data show potential for building a device for circulating or resident stem cells with a view to locally "brown" white adipose tissue. This project is in its very early stage, but very exciting as a therapeutic vision.

## **2. Macromolecular Crowding & Stem Cell Platform**

Growing cells on plastic in dilute aqueous media hardly compares to the macromolecularly crowded tissue microenvironments they come from. To create conditions that mimic tissue physiology more closely we developed culture additives comprising mixtures of carbohydrate-based macromolecules larger than 50 kDa that enable both differentiated cells and adult stem cells to build their own complex microenvironments. This leads to substantial improvements for the ex vivo expansion of stem cells while retaining their differentiation capacity.

### **(A) Biophysics of Macromolecular Crowding**

We study the underlying biophysical effects of macromolecular crowding in simpler models and computer simulations. We have modelled DNA hybridization under crowded conditions and are simulating the effects of mixed macromolecular crowding, i.e. usage of more than one size species of crowders. We are studying the micro-architectural effects of collagen assembly under crowded conditions and exploit this to build crowding gradients to influence collagen assemblies (Dewavrin et al 2014).

### **(B) Stem Cell Technologies**

We are deeply interested in studying and exploiting the effects of extracellular matrix deposited under crowded conditions on the proliferation and differentiation of human adult stem cells. Our publication series on stem and progenitor cells began with Zeiger et al 2012 (a collaboration with MIT) showing the influence of matrix formation via MMC and its influence on cytoskeletal orientation and the effects of matrix made under crowding for the propagation of human embryonic stem cells (Peng et al 2012). We have demonstrated that and how macromolecular crowding amplifies adipogenesis of MSCs via cell- matrix

reciprocity thus confirming Mina Bissell's postulate from the 80ies (Ang et al 2013 epub). We have shown with Lonza and patient cells from the National University Hospital in Singapore that MMC drives stem cell proliferation. The effects can be related to a beneficial microenvironment formed under MMC and has enabled to secure substantial funding and interest from industry (ThermoFisherScientific). As Co-I on a 5 M SGD Bench & Bedside grant (PI's Simon Cool and James Hui) I am currently evaluating that best in class MSCs can be generated using macromolecular crowding in comparison to standard procedures, and potentially in combination with small heparan sulfate sugars. The idea is to grow MSCs at faster rate without losing their potential and immunomodulatory potential.

**(C) Platform to differentiate pericyte-like cells from peripheral blood.** We have also shown that pulsed macromolecular crowding allows the generation of a pericyte-like angiogenic phenotype derived from monocytes from peripheral blood. We have termed cells exhibiting this phenotype "blood derived angiogenic cells" (BDAC). This work has strong therapeutic potential and is currently evaluated in a hind limb ischemia model to make way for a larger project on critical ischemia treatment in human patients. Current preclinical work, also employing MRI for small animals shows an acceleration of revascularisation of ligated limbs but also a protective effect on skeletal musculature which suggests additional effects of BDAC on myocytes or satellite cells (Blocki et al 2014). We are currently in the process to evaluate the effect of injected BDACs on muscle degeneration and ischemia protection. Our dream would be to treat stroke patients with autologous pericyte-like cells. This is an ongoing collaboration with Kishore Bhakoo from the Singapore Bioimaging Center.

### ***3. Metabolic Tissue Engineering***

We have shown for the first time that MSCs and isolates from the stromal vascular fraction of subcutaneous fat tissue can be turned into brown/brite fat cells without gene transfer under the influence of macromolecular crowding. The cells we generate express high levels of UCP-1 mRNA (and protein), and exhibit uncoupled respiration. UCP1 interrupts the flow of protons through ATP synthase by providing an alternative channel to dissipate the proton gradient, thus shorting the circuit. To maintain the proton gradient, mitochondrial respiration is increased, more oxygen is consumed and with it glucose and free fatty acids. Less ATP is produced, and heat is generated. This is a unique property of brown adipocytes (BA).

It therefore follows that a natural or synthetic substance that could activate BAT in a consumer would increase his/her metabolic rate and would help to lose weight and to burn off excess glucose. This would be the dream product of a nutraceutical and food supplement company, both as a lifestyle supplement and as a clinically highly valuable auxiliary compound to treat metabolic syndrome. On a global scale, only three *human* tissue sources with appreciable UCP1 mRNA induction (>20-fold) without genetic manipulation and reprogramming have been published: Prepubic subcutaneous fat from infants (Pisani et al 2011), while Lee et al 2011 and Silva et al 2014 retrieved BA in biopsies from supraclavicular and mediastinal fat deposits in adults, respectively. All sources require either parental consent (babies), image guided biopsies, or open chest surgery. Obviously, the availability of human BA progenitor cells is thus very limited as is the number of cells that can be harvested. There are efforts to generate BA from induced pluripotent cells, but yields are notoriously low. We therefore are confident to have at NUS the first combination of a sustainable autologous cell source for the generation of a BAT phenotype and a successful protocol worldwide. We are not aware of a similar comprehensive undertaking elsewhere. The interesting facet of this platform is that it would contribute to create a market segment by making it possible to test compounds in human cells.

We are currently building a platform to study thermogenic and browning agents for the pharmaceutical and nutraceutical industry. This is an ongoing and very successful collaboration with Dr Allan Sheppard (Liggins Institute, Auckland NZL) and we are in the process of sending manuscripts out to respective journals. My group will spearhead the generation of human brown adipose tissue from bone-marrow derived and other mesenchymal progenitor cells. This will put us at the cutting edge of metabolic tissue engineering and therapeutic avenues. This technology involves macromolecular crowding and shall lay the foundation for a nutraceutical screening platform for the pharmaceutical and food industry with a particular focus on Asian Functional Food. This platform was pitched in July 2013 to Nestlé at their headquarters in Lausanne, Switzerland, to Dr Ed Baetge ([www.nestleinstitutehealthsciences.com](http://www.nestleinstitutehealthsciences.com)). We have received interested feed-back and are staying in a dialogue with Nestlé. The therapeutic vision is to develop and test compounds that when taken orally drive the metabolic rate and reduce the amount of glucose and free fatty acids in the circulation and thus to restore insulin sensitivity. The alternative approach is to generate brown adipose tissue in vitro and then to implant it, or to implant a drug delivery system that locally converts progenitor cells in white adipose tissue to a brown phenotype.

From the basic science point of view I have developed a particular interest in transient receptor potential channels (TRP's) that are emerging as mechanoreceptors on brown adipose differentiated MSCs in our system. Excitingly, macromolecular crowding seems to influence expression and marked upregulation of these receptors. This is intriguing and we are now trying to understand how crowding might influence mechanoreceptor signaling through ECM-receptor interactions and perhaps also in ECM-independent ways.

#### **International visibility**

- 1) The Tissue Modulation Laboratory was evaluated in July 2012 by an international advisory panel during a review of the NUS Tissue Engineering Programme. The panel comprised of Prof David Williams, Editor-in-Chief of Biomaterials, Institute of Regenerative Medicine, Wake Forest School of Medicine and Prof Kam Leong, then Department of Biomedical Engineering, Duke University.

*The comments of the panel report were: "....Several of the PIs are internationally competitive and two of the groups themselves, the stem cell / cartilage group and the tissue modulation group, are world class within their respective areas. The PIs Professor Lee Eng Hin, Associate Professor Michael Raghunath and Associate Professor James Hui are excellent." .....*

- 2) **WTEC PANEL ON GLOBAL ASSESSMENT OF STEM CELL ENGINEERING** (Sponsored by the U.S. National Science Foundation (NSF), National Cancer Institute (NCI) of the National Institutes of Health (NIH), and National Institute of Standards and Technology (NIST) mentions my stem cell work in connection with macromolecular crowding in the December Report of 2012, on p 234.
- 3) The combination of macromolecular crowding and bioimaging to assess the full deposition cascade of collagen and other ECM components resulted in a screening system for antifibrotics compounds, the Scar in a Jar (Chen et al 2009). After its publication in the British Journal of Pharmacology it was adopted by Glaxo Smith Kline who are using it in a scaled down version very successfully, this method has therefore become *industry standard* (Dr Carmel Nanthakumar, personal communication July 2013, London).

**My translational research interests**

I believe that the macromolecular crowding technology for cell and stem cell culture that my group has developed at NUSTEP is original work that represents a game-changer in regenerative medicine. I have generated several items of IP from this technology. This series of inventions and current and future work will emphasize my thought leadership in this aspect of regenerative medicine. As a signature technology at NUSTEP, it being adopted in labs on campus such as in Dentistry in NUS, in A\*STAR, but also laboratories worldwide have started to pick up the technology, although it took six years for the first group besides us to publish work with crowding after our first publication (Lareu et al 2007a) came out. However, citation counts show an increasing acceptance of our work in the field. Our antifibrotics screening platform, the Scar in a Jar (Chen et al 2009), has become industry standard: it has been successfully implemented by GSK in London. I am approached after presentations abroad and receive positive feed-back from people who tested our technology.



### Funding secured since 2003 at NUS

Agency	Project	TPV	Start	End	Role
NUS, Provost's Office, Office of Life Sciences	Start up: Tissue Modulation Laboratory	200,000 SGD	5/10/03	31/03/04	PI
<b>2004</b>					
National Medical Research Council	Natl Group on Fibrovascular Disorders Programme	324,000 SGD	1/12/04	31/05/07	PI
<b>2005</b>					
Faculty Research Committee,(FRC) Faculty of Engineering	A bioimaging-based drug discovery tool to assess antifibrotic drugs for Tissue Engineering and Scar Wars	175,000 SGD	1/01/05	31/12/06	PI
FRC, Faculty of Engineering	FRC: Biomimetic biomaterials by attaching collagen triple helical subunits to glycodendrimers	120,000 SGD	1/01/05	30/06/07	Co-PI
FRC, Faculty of Engineering	FRC: Characterisation of transglutaminases (TGases) as crosslinker and enhancer of collagen containing bioartificial materials	160,000 SGD	1/01/05	31/12/07	PI
NUS Nanoscience initiative	Capture Of Bone Narrow Derived Mesenchymal Stem Cells On Bioabsorbable Nanofibers	140,000 SGD	1/03/05	31/6/07	Co-PI
<b>2006</b>					
FRC, Faculty of Engineering	Neovascularisation of Biomaterials	154,900 SGD	1/01/06	31/07/08	PI
Office of Life Science	Cross faculty grant: lymph node TE	50,000 SGD	1/01/06	31/07/08	PI
<b>2007</b>					
FRC, Faculty of Dentistry	Towards gingival reconstruction	178,600 SGD	1/04/07	1/3/10	Co-PI
<b>2008</b>					
Economy Development Board	Molecular crowding to enhance PCR – proof of concept	184,000 SGD	14/04/08	14/03/09	PI
NUS Baden Wuerttemberg Research Initiative	Epigenetics in tissue engineering	160,000 SGD	1/07/08	31/05/10	PI
Natl Research Foundation Singapore	Translational clinical Research (TCR) flagship grant, TRIOS	980,000 SGD	1/08/08	31/07/13	Co-PI
<b>2009</b>					
FRC, Faculty of Engineering	Platform technologies for stem cell culture for translational applications in human healthcare	178,500 SGD	1/04/09	30/11/11	PI
FRC, FoE	Self-vascularizing implant sensors: A pilot study	179,000 SGD	1/04/09	31/12/11	Co-PI
<b>2010</b>					
National Medical Research Council	Epigenetic therapy of fibrosis	621,500 SGD	1/02/10	31/01/13	PI
Singapore-MIT Alliance for Research & Technology	Ignition grant: Platform to prime peripheral blood monocytes for induction into multi- and pluripotency – phase 1	50,000 SGD	1/05/10	14/5/11	PI
Science Foundation of Ireland	ETS Walton Visitor Award, 35,000 EURO	35,000 EUR = 61,000 SGD	1/01/10	31/12/11	PI
Ministry of Defence of Singapore	DIRP project Bone Marrow Stem Cell Therapy for Skin Regeneration Suitable for Use in the Field Hospital	599,000 SGD	1/01/11	31/12/14	PI
SMART	SMART Faculty Fellow	10,000 SGD	1/01/11	31/12/11	PI
<b>2011</b>					
SMART	INNOVATION GRANT Generation of autologous pericyte progenitors from peripheral blood for therapeutic angiogenesis	89,600 SGD	1/10/11	30/09/12	PI
<b>2012</b>					
SMART Innovation Ctr	Generation of autologous pericyte	160,200 SGD	1/10/12	30/09/14	PI

	progenitors from peripheral blood for therapeutic angiogenesis – phase II				
<b>2013</b>					
National Medical Research Council &- A*STAR	Bench and Bedside Grant Best in Class mesenchymal stem cells	<b>5,000,000 SGD for me about 210,000 SGD</b>	<b>1/12/12</b>	<b>30/11/15</b>	<b>Co-I</b>
SMART	SMART Faculty Fellow	<b>10,000 SGD</b>	<b>1/1/13</b>	<b>31/12/13</b>	<b>PI</b>
SMART Innovation Ctr	Ignition grant, Xeno-free polymeric coating for serum free stem cell culture	<b>50,000 SGD</b>	<b>1/4/13</b>	<b>30/9/14</b>	<b>PI</b>
A*STAR BMRC Strategic Positioning Fund (BMRC SPF)	“Skin Biology Basic Research” (SPF Ref Number: SPF2013/004, to Prof Birgit Lane, IMB	<b>TPV \$16,256,204 for me about 300,000 SGD</b>	<b>01/07/13 Start for me 01/01/14</b>	<b>31/12/15</b>	<b>Co-PI</b>
<b>2014</b>					
Life Sciences Institute	Intramural funding for MetaTEC, a new metabolic tissue engineering initiative in the NUS Tissue Engineering Programme (Office of Deputy President Research & Technology)	<b>670,920 SGD</b>	<b>1 Nov 2014</b>	<b>30/09/16</b>	<b>PI</b>
ThermoFischerScientific	SANULT grant, industrial funding Non-Protein-based System for Enhancing Xeno-Free Stem Cell Attachment and Proliferation	<b>582,000 SGD</b>	<b>1 Feb 2015</b>	<b>Jan 2017</b>	<b>PI</b>

**Subtotal funding secured as PI Oct 03 – December 2014: ~6,600,000 SGD (~5.06 million USD / 4.04 million EUR/ 5.86 million AUD)**

This list does not include additional funding of 100,000 SGD for co-supervision of PhD student from SMART for four consecutive academic years 2009-2013, and 250,000 in funding received from the NUS Tissue Engineering Programme for manpower support. Current total funding stands at **~6.95 M SGD**. Please note: all PhD students in my laboratory received PhD scholarships (duration 4 yrs each) , this represents an additional funding income of currently **3,114,000 SGD (2.51M USD/1.94 M EUR/2.76 AUD)**.

Participated as consultant in the following NIH grants

1) Recipient: Primorigen Biosciences, Inc.; Title: "A Novel Method To Improve Function Of Sc-Derived Hepatocytes"; Number: 1r43gm101858-01, Institute: National Institute Of General Medical Sciences; Duration: 8/1/12-11/30/13, Amount: \$328,224, Pi. Scott Monsma, Ph.D

2) Recipient: Primorigen Biosciences, Inc.; Title: "A Novel Method To Improve Proliferation And Neural Induction Of Human Mscs"; Number: 1r43ns079001-01, Institute: National Institute Of Neurological Disorders And Stroke, Duration: 5/15/12-5/14/14, Amount: \$344,715, Pi: Brad Garcia, Ph.D.

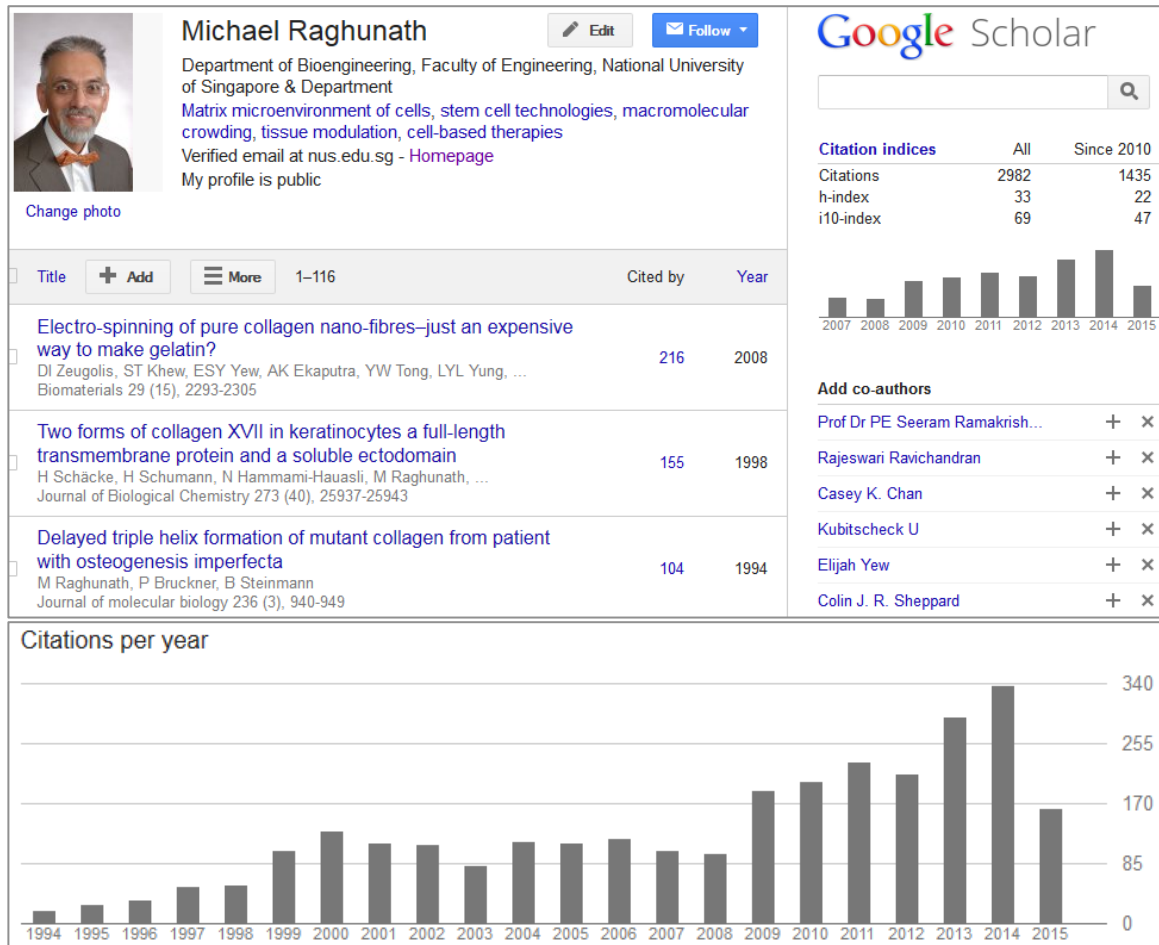
## SCIENTIFIC PORTFOLIO

(as of

6-Jun-15)

ResearcherID E-6483-2010, ORCID ID: 0000-0002-2138-6614

- Google Scholar; 116 publications, h-index 33; total cites: 2982; average per item: ~26



## Original publications

[Impact factors according to Journal Citation Reports given in brackets, publications considered to be particularly important are shaded]

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9. Mackay K, Lund AM, **Raghunath M**, Steinmann B. 1993. SSCP detection of a Gly565Val substitution in the pro $\alpha$ 1(I) collagen chain resulting in osteogenesis imperfecta type II. *Hum Genet*, 91:439-444 [4.02]
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Peh P, Lim NSJ, Blocki AM, Chee SML, Liao S, Chan C, Raghunath M. Simultaneous delivery of highly diverse bioactive compounds from blend electrospun fibers for skin wound healing. *Bioconjugate Chemistry* [4.8]

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### • Review articles

1. **Raghunath, M**, Nienaber C, von Kodolitsch Y. 100 Jahre Marfan Syndrom - eine Bestandsaufnahme. *Deutsches Ärzteblatt* 1997; 94:A-821-830
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### • Contributions to edited books

1. **Raghunath M**, Giunta C, Superti-Furga A, Steinmann B. Prenatal diagnosis of connective tissue disorders. In: *Chorion Villus Sampling*. Kamini A. Rao and Kypros Nicolaides, eds., Jaypee Brothers New Delhi, 1998; pp123-130
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### • Patents

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- **Articles in Newspapers and Magazines**

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