Curriculum Vitae

Sathuluri Ramachandra Rao, M.Sc. Ph.D.
Cellular and Molecular Endocrinology Laboratory
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Date of Birth & age : May 13, 1969, 48 years
Sex & Marital status : Male & married

Education

Ph.D., Biochemistry (2 Dec. 1993-11 May 1998)	Plant Cell Biotechnology Department, Central Food Technological Research Institute (CFTRI), Mysore India. Ph.D. Degree was awarded by the University of Mysore, 5 Dec. 2000
M.Sc. Biochemistry (28 Jan. 1990-30 April 1992)	Department of Biochemistry, Andhra University, Visakhapatnam, Andhra Pradesh (A.P.), India
B.Sc. Chemistry (13 June 1986-30 April 1989)	Department of Chemistry, V.R.S. & Y.R.N. Degree College, Chirala, Nagarjuna University, Nagarjuna Nagar, A.P. India
Intermediate (Pre Univ.) (12 June 1984-30 Mar. 1986)	Chemistry, Physics, Biology, Y.V.C.R.C.S.P Jr. College, Karamchedu, Board of Intermediate Education, Hyderabad, India
Secondary School Cert. (12 June 1983-30 Mar. 1984)	General Sciences, Social Studies, Mathematics, Z.P. High School, Swarna, Board of Secondary Education, A.P., India

Professional affiliations

2 August 2017- till date	Reader, Dept. RBM, NIHFW, New Delhi, India
1 Sept. 2016- 30 June 2017	Faculty, Dept. Chemistry & Appl. Chemistry, Saga Univ., Saga, Japan
20 June 2014- 31 Mar. 2016	Senior Scientist, Measurement Soln. Res. Center, AIST Kyushu, Tosu, Japan
1 April 2011-31 Mar. 2014	Senior Research Scientist, Biomedical Res. Inst., AIST, Tsukuba, Japan
1April 2008-31 Mar. 2011	Senior Associate Researcher, Dept. Applied Physics, Osaka Univ., Japan
16 June 2003-31Mar. 2008	Postdoctoral Researcher, Toyama New Industry Org. (TONIO), Japan
25April 2001-24April 2003	JSPS-Postdoctoral Fellow, School of Materials Science, JAIST, Japan
5 Oct. 1999-31Mar. 2001	MONBUSHO Researcher, School Materials Science, JAIST, Japan
10 Nov. `98-30 Sept. `99	SRF-Extend (CSIR), Plant Cell Biotechnol. Dept., CFTRI, Mysore, India
17 Oct. 1997- 9 Nov. 1998	Project Asst., Plant Cell Biotechnology Dept. CFTRI, Mysore, India
7 Sept. 1992-30 Sept. 1997	Junior & Senior Res. Fellows, Plant Cell Biotechnol. Dept., CFTRI, India

List of publications and other accomplishments

Peer-reviewed International Journal articles

1. R. Kawamura, M. Miyazaki, K. Shimizu, Y. Matsumoto, Y.R. Silberberg, **S. Ramachandra Rao**, M. Iijima, S. Kuroda, F. Iwata, T. Kobayashi, C. Nakamura, A new cell separation method based on Antibody-immobilized nanoneedle arrays for the detection of intracellular Markers, **Nano letters, 17 (11), 7117–7124, 2017** (DOI: 10.1021/acs.nanolett.7b03918) (impact factor: 12.712).

2. **S. Ramachandra Rao**, Y.S. Kurniawan, J.-Y. Kim, M. Maeki, W. Iwasaki, S. Morisada, H. Kawakita. M. Miyazaki, K. Ohto, Droplet-based microreactor system for stepwise recovery of precious metal ions from real metal waste with calix[4]arene derivatives, ***Separation Science and Technology,* 53 (8) 1261-1272, 2018** (**August 2017, DOI: 10.1080/01496395.2017.1366518**) (impact factor: 1.106).

3. W. Iwasaki, **S. Ramachandra Rao**, R. Kurita, O. Niwa, M. Miyazaki, Influences of electrodes placement and measurement time on electrochemical signal of redox species flowing through porous material, ***Sensors and Materials*, 28 (12), 1329-1335, 2016.**

4. D. Matsumoto, A. Yamagishi, M. Satio, **S. Ramachandra Rao**, Y.R. Silberberg, F. Iwata, T. Kobayashi, C. Nakamura, Mechanoporation of living cells for delivery of macromolecules using nanoneedle array, ***Journal of Bioscience and Bioengineering*, 122 (6), 748-752, 2016** (impact factor 2.24).

5. I. Nakashima, A. Kishidai, Y. Takaoka, S. Morisada, K. Ohto, H. Kawakita, W. Iwasaki, **S. RamachandraRao**, M. Miyazaki, Adsorption and elution of glucuronic acid and chondroitin sulfate using amino-group-containing spherical gel, ***Journal of Applied Glycoscience***, **63, 69-75**, **2016**.

6. D. Matsumoto*****, **S. Ramachandra Rao***, Y. Kato, Y.R. Silberberg, R. Kawamura, F. Iwata, T. Kobayashi, C. Nakamura, Oscillating high-aspect ratio monolithic silicon nanoneedle array enables efficient delivery of functional bio-macromolecules into living cells, ***Scientific Reports,* 5, 15325, 2015** (*Co-first Authors, impact factor 5.578) (14 citations).

7. W. Iwasaki, **S. Ramachandra Rao**, O. Niwa, M. Miyazaki, Influence of contact force on electrochemical responses of redox species flowing in nitrocellulose membrane at micropyramid array electrode, ***Analytical Sciences,* 31 (7), 729-732, 2015** (impact factor 1.394) (2 citations).

8. R. Kawamura, M. Mishima, S. Ryu, Y. Arai, M. Okose, Y.R. Silberberg, **S. Ramachandra Rao**, C. Nakamura, Controlled cell adhesion using a Biocompatible Anchor for Membrane-conjugated bovine serum albumin/bovine serum albumin mixed layer, ***Langmuir,* 29 (21), 6429-6433, 2013** (impact factor 4.187; 17 citations)

9. **S. Ramachandra Rao***, H. Yoshikawa, E. Shimizu, M. Sato, E. Tamiya, Gold nanoparticle-based surface-enhanced Raman scattering for noninvasive molecular probing of embryonic stem cell differentiation, ***PLoS ONE*, 6 (8), e22802, 2011** (*corresponding author, impact factor: 4.13; 55 citations).

10. M.M. Hossain, E. Shimizu, M. Saito, **S. Ramachandra Rao**, Y. Yamaguchi, E. Tamiya, Non-invasive characterization of mouse embryonic stem cell derived cardiomyocytes based on the intensity variation in digital beating video, ***Analyst,* 135 (7), 1624-1630, 2010** (impact factor: 3.969; 30 citations).

11. M.U. Ahmed, M. Saito, M.M. Hossain, **S. Ramachandra Rao**, S. Furui, A. Hino, Y. Takamura, M. Takagi, E. Tamiya, Electrochemical genosensor for the rapid detection of GMO using loop-mediated isothermal amplification, ***Analyst,* 134 (5), 966-972, 2009** (impact factor: 3.969; 52 citations).

12. **S. Ramachandra Rao**, S. Yamamura, E. Tamiya (**2008**) Microsystems technology and biosensing, ***Advances in Biochemical Engineering/Biotechnology,* 109, 285-350, 2008** (impact factor: 4.165; 20 citations).

13. D. K. Kim, K. Kerman, M. Saito, **S. Ramachandra Rao**, T. Endo, S. Yamamura, Y.S. Kwon, E. Tamiya, Label-free DNA biosensor based on localized surface plasmon resonance coupled with interferometry, ***Analytical Chemistry,* 79 (5), 1855-1864, 2007** (Ranked top 10 articles of highly accessed for the period Jan-March 2007), (impact factor: 5.695; 145 citations).

14. T. Nakayama, Y. Kurosawa, S. Furui, K. Kerman, M. Kobayashi, **S. Ramachandra Rao**, Y. Yonezawa, K. Nakano, A. Hino, S. Yamamura, Y. Takamura, E. Tamiya, Circumventing the air-bubbles for microfluidic systems and quantitative continuous-flow PCR applications, ***Analytical and Bioanalytical Chemistry,* 386 (5), 1327-1333, 2006** (Ranked top 5 articles highly accessed), (impact factor: 3.659; 97 citations).

15. S. Yamamura, H. Kishi, Y. Tokimitsu, S. Kondo, R. Honda, **S. Ramachandra Rao**, M. Omori, E. Tamiya, A. Muraguchi, Single-cell microarray for analyzing cellular response, ***Analytical Chemistry,* 77 (24), 8050-8056, 2005** (impact factor: 5.695; 229 citations).

16. Y. Akagi, **S. Ramachandra Rao**, Y. Morita, E. Tamiya, Optimization of fluorescent cell-based assays for high-throughput analysis using microchamber array chip formats, ***Science and Technology of Advanced Materials,* 5 (3), 343-349, 2004** (impact factor: 3.752; 18 citations).

17. S. Yamamura, Y. Morita, Q. Hasan, **S. Ramachandra Rao**, K. Yokoyama, E. Tamiya, Characterization of keratin degrading bacterium isolated from deer fur. ***Journal of Bioscience and Bioengineering,* 93 (6), 595-600, 2002** (impact factor: 1.737; 73 citations).

18. **S. Ramachandra Rao***, G.A. Ravishankar, Plant cell cultures: Chemical factories of secondary metabolites, ***Biotechnology Advances*, 20(2), 101-153, 2002** (Ranked top 25 hottest articles of Biotechnology Advances Since 2002 to December 2012), (*corresponding author, impact factor: 9.59; 1197 citations).

19. **S. Ramachandra Rao**, T. Usha, G.A. Ravishankar, Biotransformation of digitoxin in cell cultures of *Capsicum frutescens* in the presence of β-cyclodextrin, ***Biocatalysis and Biotransformation***, **20 (2), 137-143, 2002** (impact factor: 1.275; 8 citations).

20. T. Usha, **S. Ramachandra Rao***, G.A. Ravishankar, Biotransformation of phenylpropanoid compounds to vanilla flavor metabolites in cultures of *Haematococcus pluvialis*, ***Process Biochemistry,* 38 (3), 419-426, 2002** (* Corresponding author, impact factor: 2.627; 40 citations).

21. **S. Ramachandra Rao**, T. Usha, B. Suresh, G.A. Ravishankar, Enhancement of secondary metabolite production in hairy root cultures of *Beta vulgaris* and *Tagetes patula* under the influence of microalgal elicitors, ***Food Biotechnology,* 15 (1), 35-46, 2001** (impact factor: 0.521; 12 citations).

22. B. Suresh, T. Rajasekaran, **S. Ramachandra Rao**, G.A. Ravishankar, K.S.M.S. Raghava Rao, Studies on osmolarity, conductivity, and mass transfer for designing a bioreactor for *Tagetes patula* hairy root cultures, ***Process Biochemistry,* 36 (10), 987-993, 2001** (impact factor: 2.627; 25 citations).

23. **S. Ramachandra Rao,** G. A. Ravishankar, Biotransformation of protocatechuic aldehyde and caffeic acid to vanillin and capsaicin in freely suspended and immobilized cultures of *Capsicum frutescens*, ***Journal of Biotechnology,* 76 (2), 137-146, 2000** (impact factor: 3.340; 58 citations).

24. **S. Ramachandra Rao,** G.A. Ravishankar, Vanilla flavor: Production by conventional and biotechnological routes, ***Journal of the Science of Food and Agriculture*, 80 (3), 289-304, 2000** (impact factor: 1.759; 292 citations).

25. G.A. Ravishankar, **S. Ramachandra Rao,** Biotechnological production of Phyto-pharmaceuticals, ***Journal of Biochemistry, Molecular Biology and Biophysics,* 4 (2), 73-102, 2000** (impact factor: 2.2; 72 citations).

26. **S. Ramachandra Rao,** G.A. Ravishankar, Biotransformation of isoeugenol to vanilla flavor metabolites and capsaicin in freely suspended and immobilized cell cultures of *Capsicum frutescens*: Study of the influence of β-cyclodextrin and fungal elicitor, ***Process Biochemistry,* 35 (3-4), 341-348, 1999** (impact factor: 2.627; 54 citations).

27. **S. Ramachandra Rao**, T. Usha, G.A. Ravishankar, Biotransformation of codeine to morphine in freely suspended cells and immobilized cultures of *Spirulina platensis, **World Journal of Microbiology and Biotechnology,* 15 (4), 465-469, 1999** (impact factor: 1.262; 32 citations).

28. T. Usha, R.Sarada, **S. Ramachandra Rao**, G.A. Ravishankar, Production of astaxanthin in *Haematococcus pluvialis* cultured in various media, ***Bioresource Technology,* 68 (2), 197-199, 1999** (impact factor: 4.98; 97 citations).

29. **S. Ramachandra Rao**, R. Sarada, G.A. Ravishankar, Phycocyanin, a new elicitor for capsaicin and anthocyanin accumulation in plant cell cultures, ***Applied Microbiology and Biotechnology,* 46 (5), 619-621, 1996** (impact factor: 3.689; 31 citations).

30. R. Madhusudhan, **S. Ramachandra Rao**, G. A.Ravishankar, Osmolarity as a measure of growth of plant cells in suspension cultures, ***Enzyme Microbial Technology,* 17 (11), 989-991, 1995** (impact factor: 2.592; 23 citations).

Peer-reviewed publications in International Conference Proceedings

31. K. Ohto, J.Y. Kim, S. Morisada, H. Kawakita, M. Maeki, **S. Ramachandra Rao**, M. Miyazaki, Precious metal separation with calixarene derivatives using microreactor system, In**: Proceedings of the 4th International Conference on Methods and Materials for Separation Science (SSTP 2016), Brunow, Poland, September, pp. 22-25, 2016,** ISBN 978-83-7493-949-2.

32. **S. Ramachandra Rao**, M. Maeiki, Y. Ueda, J.Y. Kim, K, Ohto, M. Miyazaki, Droplet-based microreactor system for an efficient recovery of rare metal ions with calix[4]arene derivatives from acidic media, In: **Asia Pacific Confederation of Chemical Engineering Congress 2015: APCChE 2015, incorporating CHEMECA 2015**. **Melbourne: Engineers Australia, 2015: pp. 2014-2019, 2015** ISBN:9781922107473.

33. W. Iwasaki, R. Mizuki, **S. Ramachandra Rao**, O. Niwa, M. Miyazaki, Development of Microperiodic array-based electrochemical sensor for quantitative immunochromatography, ***Proceedings of MicroTAS 2015*: The 19th International Conference on Miniaturized Systems for Chemistry and Life Sciences, pp. 1716-1718, 2015**, ISBN:978-0-9798064-8-3, ISSN:1556-5904.

34. Y. Yamaguchi, M.M. Hossain, T. Ikeuchi, A. Hashimoto, **S. Ramachandra Rao**, M. Saito, E. Tamiya Hanging drop culture device for embryonic stem cell, ***Proceedings of MicroTAS 2012*: *The* 16th International Conference on Miniaturized Microsystems in Chemistry and Life Sciences, pp. 1057-1059**, **2012,** ISBN: 978-0-9798064-5-2.

35. **S. Ramachandra Rao**, M. Kitamura, S. Yamamura, E. Tamiya, Novel picoliter compartmental microfluidic chip devices for high-throughput single-cell sorting and analysis. ***Proceedings of MicroTAS* 2006: The 10th International Conference on Miniaturized Microsystems in Chemistry and Life Sciences, Vol. 1, pp. 957-959, 2006**, ISBN: 4-9903269-0-3-C3043.

36. **S. Ramachandra Rao**, M. Kitamura, S. Yamamura, E. Tamiya, Development of high-throughput compartmental microfluidic devices for multiplexed single-cell sorting, manipulation and analysis. ***IEEE Sensors Proceedings Vol. 1-3*, pp. 642-645**, **2006,** ISBN: 978-1-4244-0375-2.

37. **S. Ramachandra Rao**, S. Yamamura, Y. Takamura, E. Tamiya, Multiplexed microfluidic device for single-cell manipulation and analysis. ***Proceedings of MicroTAS* 2004: The 8th International Conference on Miniaturized Microsystems in Chemistry and Life Sciences, Vol. 1, pp. 61-63, 2004,** ISBN:0-85404-643-7 (7 citations)

38. S. Yamamura, **S. Ramachandra Rao**, M. Omori, Y. Tokimitsu, S. Kondo, H. Kishi, A. Muraguchi, Y. Takamura, E. Tamiya, High-throughput screening and analysis for antigen specific single-cell using microarray, ***Proceedings of MicroTAS* 2004: The 8th International Conference on Miniaturized Microsystems in Chemistry and Life Sciences, Vol. 1, pp. 78-80, 2004,** ISBN: 0-85404-643-7 (10 citations)

39. Y. Akagi, **S. Ramachandra Rao**, Y. Morita, Y. Takamura, E. Tamiya, Screening of a novel neurotrophic factor using microarray cell-based chip and its response on PC12 cells neurosignaling pathway, ***Proceedings of MicroTAS 2004:* The 8th International Conference on Miniaturized Microsystems in Chemistry and Life Sciences, Vol. 2, pp. 309-311, 2004**, ISBN:0-85404-643-7

40. **S. Ramachandra Rao**, Y. Akagi, Y. Morita, E. Tamiya, High-throughput screening of anticancer drugs using miroarray based cell chip. ***Proceedings of MicroTAS* 2002: The 6th International Conference on Miniaturized Microsystems in Chemistry and Life Sciences, Vol. 2, pp. 862-864, 2002,** ISBN: 1-4020-1010-9 (7 citations)

41. Y. Morita, H. Onishi, **S. Ramachandra Rao**, T. Sakaguchi, Y. Murakami, K. Yokoyama, E. Tamiya, Biodegradation of alkane by psychrotropic bacteria for cold environment. ***Proceedings of Enzyme Engineering Conference XVI*, pp. 288-290, 2001**.

42. G.A. Ravishankar, M. Mahadevaswamy, **S. Ramachandra Rao**, K.M. Priyasethu, A. Kumar, R. Sarada, G. Manoj, T.N.Prabha, L.V.Venkataraman, Potentials and prospects of *Spirulina* for varied applications: Focus on CFTRI's Contribution and Indian Scenario. ***Proceedings of International Seminar on Spirulina Development*, pp.110-123, 1996**.

List of book chapters contributed

43. K. Ohto, Y. Ueda **S. Ramachandra Rao,** H. Kawakita, S. Morisada, K. Inoue, Silver extraction and recovery with macrocyclic and tripodal Compounds, In: **Silver Recovery from Assorted Spent Sources, Toxicology of silver ions**, (ed.) Syed Sabir, World Scientific Publishing Co. pp. 275-302, **March 2018**. ISBN: 978-1-78634-457-1.

44. **S. Ramachandra Rao**, S. Yamamura, E. Tamiya, Microsystems technology and biosensing, ***In: Biosensing for the 21st Century, Advances Biochemical Engineering/Biotechnology,*** (eds.) Renenberg, R., Lisdat, F, Springer Publishers, **109, pp.285-350, 2008,** ISBN 978-3-540-75201-1 (20 citations).

45. S. Yamamura, **S. Ramachandra Rao,** E. Tamiya, Pico/nano-liter chamber array chips for single-cell, DNA, and protein analyses. In: **Nanomaterials for Biosensors, Vol. 8. Nanotechnology for the Life Sciences** (ed.) Kumar, C., Wiley-VCH publishers, Weinheim, pp. **368-397, 2007**, ISBN-13: 978-3-527-31388-4, ISBN-10: 3-527-31388-5 (2 citations).

46. G.A. Ravishankar, N. Bhagyalakshmi, **S. Ramachandra Rao,** Production of food Additives In: **Biotechnology: Secondary Metabolites: Plants and Microbes, 2nd ed**.(eds.) Ramawat, K.G. and Merillon, J.M., CRC Press, Taylor and Francis Group, Boca Raton, **pp. 103-130, 2007**, ISBN-10: 1578084288 | ISBN-13: 978-1578084289; DOI: 10.1201/b10756-5 (34 citations).

47. G.A. Ravishankar, B. Suresh, P. Giridhar, **S. Ramachandra Rao,** T. S. Johnson, Biotechnological studies on *Capsicum* for metabolite production and plant improvement. In: **Capsicum: The genus**

Capsicum (ed.) De, A.K., Taylor & Francis Publishers, UK pp. **96-128, 2003**, ISBN 0-203-38115-7, (46 citations).

48. G.A. Ravishankar, N. Bhagyalakshmi, **S. Ramachandra Rao,** Production of food additives. In: **Biotechnology: Secondary metabolites** 1st ed. (eds.) Ramawat, K.G. and Merillon, J.M., Oxford IBH Co. India, pp. **89-110, 1999**, ISBN 10: 1578080576 / ISBN 13: 9781578080571, (34 citations).

Non-peer reviewed publications

1. **S. Ramachandra Rao,** Immobilization of cells and placenta of *Capsicum* for capsaicin production. In: *Techniques in Plant Cell Biotechnology*, DBT sponsored short-term training course Laboratory Manual, pp.28-34, 1998.

2. **S. Ramachandra Rao,** Biotransformation of ferulic acid to vanilla flavour metabolites in free and immobilized cell cultures of *Capsicum frutescens*. *ibid*, pp.35-37, 1998.

3. **S. Ramachandra Rao,** Biotransformations by plant cell cultures. *ibid,* pp. 47-54, 1998.

4. R. Madhusudhan, **S. Ramachandra Rao,** Estimation of biomass in plant cell cultures. *ibid*, pp. 12-16, 1998.
5. R. Madhusudhan, **S. Ramachandra Rao** and T.S. Johnson, Testing of viability of plant cells. *ibid*, pp. 17-18, 1998.

6. **S. Ramachandra Rao,** Taxol- a wonder drug. SBC (I) Newsletter, CFTRI Mysore. p.4, 1996

Patents & Technology transfer

Patents granted

1. W. Iwasaki, **S. Ramachandra Rao**, O. Niwa, M. Miyazaki, Electrode for electrochemical analysis and its use in chemical analysis kit, **Japan Patent Application Number 2015-152952** dated 31 July 2015 (JP 2017-032416A)

2. C. Nakamura, **S. Ramachandra Rao**, T. Kobayashi, Nanoneedle array, **Japan Patent 2013-183706,** dated 19 September 2013

3. **S. Ramachandra Rao**, S. Yamamura, Y. Takamura, E. Tamiya, A method of forming a sample solution with minute volume, **Japan Patent 2006-010332,** dated 12 January 2006

4. G. A. Ravishankar, B. Suresh, **S. Ramachandra Rao,** Process for preparation of dopa and dopamine from hairy root cultures of *Beta vulgaris*, **International publication number WO 2004055192 A1** publication date**: 1 July 2004;** also **European Patent 1578978B1, 2005**, dated 29 November 2006

5. **S. Ramachandra Rao**, Y. Morita, E. Tamiya, A novel embryonic stem cell differentiation inducer, **Japan Patent 2005-179257,** dated 7 July 2005

6. S. Yamamura, **S. Ramachandra Rao**, Y. Morita, Y. Takamura, E. Tamiya, A method for immobilizing and collecting living cells, **Japan Patent 2005-102628** , dated 21 April 2005

7. **S. Ramachandra Rao**, S. Yamamura, Y. Morita, E. Tamiya, A new method for synthesizing carotenoids by using bacterium and carotenoids obtained by the method, **Japan Patent 2004-033062,** dated 5 February 2004

8. G. A. Ravishankar, B. Suresh, **S. Ramachandra Rao,** A process for preparation of dopa and dopamine, **Indian Patent 225876,** dated 30 December 2008

9. E.Tamiya, T. Sakaguchi, K. Yokoyama Y. Morita, Y. Murakami, **S. Ramachandra Rao,** A new polycyclic aromatic hydrocarbon-decomposing bacterium and new polycyclic aromatic hydrocarbon decomposing agent containing the same, **Japan Patent 2003-079364,** dated 18 March 2003

10. T. Usha, **S. Ramachandra Rao,** G.A. Ravishankar, A process for the production of vanilla flavor metabolites through biotransformation, **Indian Patent 191241, 1999**

11. **S. Ramachandra Rao,** G.A. Ravishankar, L.V. Venkataraman, An Improved process for the preparation of vanillin, **Indian Patent 186116, 1996,** dated 25 January 2002

12. R. Sarada, **S. Ramachandra Rao,** G.A. Ravishankar, An improved method of effluxing of phycocyanin from cyanobacterium - *Spirulina* species, **Indian Patent 184767, 1996**

Technology transfer

13. R. Sarada, **S. Ramachandra Rao,** G. A. Ravishankar, Technology entitled "Downstream processing of phycobiliprotein from blue-green alga *Spirulina platensis*" developed at CFTRI, Mysore India, and transferred to industries, **2001**.

Awards & fellowships

1. Excellent paper award of The Society for Biotechnology, Japan for the paper entitled "Mechanoporation of living cells for delivery of macromolecules using nanoneedle array" published in the Journal of Bioscience and Bioengineering, Vol. 122, p. 748-752, 2016, award received on **September 11, 2017**.

2. Excellent poster presentation award for the poster presented at Taiwan/Korea/Japan Joint meeting on Chemical Engineering 2015 held in Taiwan, 7 **November 2015**

3. Young Scientist Award for the year- 2001 given away by the Association of Food Scientists and Technologists of India, AFST [I], CFTRI, Mysore – **2002**

4. JSPS Postdoctoral Fellowship from Japan Society for the Promotion of Science based on worldwide Competition – **2001**

5. MONBUSHO-Scholarship from the Ministry of HRD, Govt. of India & Japanese Embassy, New Delhi to carry out Advanced Research in Japan – **1999**

6. Senior Research Fellow (Extended) award from Council of Scientific and Industrial Research (CSIR), Govt. of India – **1998**

7. Foreign Travel Grant Award received from CSIR, Govt. of India towards research excellence to attend International Symposium on "*Principles Regulating Biosynthesis and Storage of Secondary Products*" organized by Phytochemical Society of Europe (PSE), Halle, Germany – **1996**

8. Foreign trip travel award received from the Department of Science & Technology (DST), Govt. of India – **1996**.

9. Best poster award for the paper presented at the 64th Annual meeting of Society of Biological Chemists (India) held in CDRI Lucknow, India – **1995** dated October 8 1995.

10. Best poster award for the paper presented at the Plant Tissue Culture Association of India, PTCA (I) National Symposium held in CFTRI, Mysore (June 22-24, 1995) India – **1995** dated June 24 1995

11. Senior Research Fellowship (**SRF**) award in the Life Sciences category from CSIR, Govt. of India – **1994**

12. Best poster award for the paper presented at the Annual meeting of Society of Biological Chemists (India), Mysore Chapter held on December 14 1993 – **1993**.

13. Junior Research Fellowship (**JRF**) award in the Life Sciences category from joint CSIR-UGC National Eligibility Test (**NET**) based on All India Merit – June **1993**

14. Graduate Aptitude Test in Engineering (**GATE**) Fellowship award in the field of Basic Sciences & Engineering category with 91.61 percentile based on All India Merit– 31 March **1992**

Honors received

15. Biography listed in the Marquis Who's Who in the World- **2006, 2007, 2009** (23rd, 24th and 26th Editions) - Who's Who in the Asia – **2007 (1st** edn.); Who's Who in Science and Engineering **2003-2004** (7th Edn.); Who's Who of Emerging Leaders-**2007** (1st Edn.) – Published in U.S.A.

16. Biography listed in the Dictionary of International Biography (32nd Edn.) – **2005;** 2000 Outstanding Scientists of the 21st Century-**2004**– published in the U.K.

17. Honorary member of the Phytochemical Society of Europe (PSE) for the period **1996-1999** given away by the Phytochemical Society of Europe (PSE) – **1996**

Invited talks

International conferences/symposia

1. Invited lecture on the topic entitled "Microreactor system for precious metal ion recovery with calixarene derivatives, at the 11th Saga University-Daegu University Symposium held at Saga University, October 30-November 2, 2016, Japan.

2. Invited talk on the topic titled "Nanoneedle array for efficient delivery of macromolecules into living cells", at the International Conference on Bioelectronics, Biosensors, Biomedical devices, BioMEMS/NEMS Applications (Bio4Apps2015) at December 9-11 2015, Kyushu University, Fukuoka, Japan.

3. Invited talk on the topic titled "Development of high-aspect-ratio silicon nanoneedle array of single-cell manipulations", presented at 86th Japan Tissue Culture Association (JTCA) – International Meet, May 30-31, 2013, AIST Tsukuba, Japan.

4. Invited talk on the topic titled "Development of high-aspect-ratio silicon nanoneedle array of single-cell manipulations", presented at the International workshop on Nanosensors and Technology (IWNST-2013), Feb 27-March 1 2013, NIST, Berhampur, Odisha, India.

5. Invited lecture on the topic "Nanomaterials interactions with embryonic stem cells towards novel opportunities" delivered at Centre for Cellular and Molecular Biology (CCMB), Hyderabad, India on 29 September 2010.

6. Invited talk on the topic titled "Gold nanoparticle exposure promotes enhanced cardiomyocygenesis and favor non-invasive molecular probing of embryonic stem cell differentiation", 2010 Fall Meeting on

Bio-functional Chemistry organized by the Chemical Society of Japan, September 24-26, 2010, Toyonaka campus, Osaka University, Japan.

7. Invited talk on the topic "Microfluidic system for on-chip high-throughput antigen-specific single B-lymphocyte screening and cell functional analysis", at Pacific RIM Meeting (PRiME 2008), October 12-17, 2008 at Hilton Hawaiian Village, Honolulu, Hawaii

8. Invited talk on the topic "Microfluidic devices for selective single B-cell sorting, screening and analysis in the nano and picoliter volume compartments", PACIFICHEM-2005 Congress December 15-20, 2005, Honolulu, Hawaii.

9. Young Scientist Award Lecture, on the topic "Microarray and microfluidic chips in genomics, proteomics and cellomics research", ICFOST December 12-14, 2002, CFTRI, Mysore, India.

Academic meetings

10. A lecture given on the topic "Single-cell micro biochip devices for screening antigen-specific B-cells for development of antibody medicine" to the International Press covering the cutting edge research developments at JAIST, Japan on February 16, 2006.

11. A talk given on the topic "Development of micro chamber array based platforms for screening of bioactive molecules with anticancer activities using human cancer cells", to the Canadian delegation from Queen's University, Canada visited JAIST, Japan on November 4, 2004.

12. A talk delivered on the topic "High-throughput screening of anticancer drugs by microchamber array based cell-chips" to the World Technology Evaluation Center Panel on International Research & Development in Biosensing for assessment of European, Japanese & US Research development in Biosensing, January 31, 2003, JAIST Japan.

13. Research presentations were delivered on several occasions to the distinguished International Guests visited Prof. Tamiya Laboratory at JAIST, Ishikawa, Japan.

14. The following lectures were delivered at the workshops and short-term courses in the year 1998

a. Biotransformation of plant cells for synthesizing valuable metabolites
b. Immobilization of plant cells for production of secondary metabolites
c. Biotransformation of precursor mediated biotransformation using capsicum plant cells

Public and administrative experience

Public experiences

1. Research demonstration on "Selection of target single cells from a single cell arrayed platform using silicon nanoneedle array" given to the general public on "**AIST Open Campus**" (**Ippan Kokai**) at Cell Mechanics Research lab, Biomedical Research Institute, Central 4 AIST July 20 2013.

2. Research demonstrations on "Nanoneedle array device operation by piezomotor system for single cell manipulations in petri dishes" given to the general public on "**AIST Open Campus**" (**Ippan Kokai**) at Cell Mechanics Research lab, Biomedical Research Institute, Central 4 AIST July 21 2012.

3. Research introduced to the public on "Development of novel single cell sorting technology using nanoneede array" in the form of poster was presented to common public at **BioJapan 2011**, **World Business Forum** held in Pacifico Yokohama October 5-7, 2011 Yokohama Japan at AIST Booth.

4. Demonstration on murine iPS cell derived cardiomyocytes beatings and measurement of electrophysiological recordings to the general public & High school students at the **Osaka University Open Campus** at Department of Applied Physics, Osaka University, Suita Campus, **2009**.

5. Presentation on nano, bio-devices for high-throughput biomolecule analysis and cell-based assays in drug discovery research towards screening of biomarkers to general public at **BioJapan 2008**, Pacifco Yokohama, Yokohama October 15-17, 2008 at Osaka University booth.

6. Single-cell screening and analysis in early disease diagnosis and for development of antibody medicine presentation to the public at the booth of Toyama New Industry Organization at **BioJapan 2006** (World Business Forum) at Osaka, September 13-15, 2006.

7. Research presentation on the topic `multifunctional biochips for single-cell screening and analysis in disease diagnosis` to the public at **BioExpo 2005,** Tokyo Big Sight, 2005.

8. Demonstration on "compartmental microfluidics for ultra-small volume based single-cell assays" to the public on the **JAIST Open campus 2003**, Tamiya Lab, school of Biomaterials Science Ishikawa, Japan.

9. Demonstration on the production of high-value bio-functional molecules from bacterial cultures to the public on the **JAIST Open Campus 2002**, Tamiya Lab, School of Biomaterials Science, Ishikawa, Japan.

Activities in academic meetings and training programs

10. Organizing Committee member of 2nd International Conference on Sensing Technology 2007 (**ICST 2007**) especially in selection of abstracts to be presented at the ICST 2007, Massey University, Palmerston North, November 26-28, 2007 New Zealand.

11. Organization of DBT sponsored **Short-term training course** on "Biotechnological Applications of Plant Tissue & Cell Cultures for the Production of Phytochemicals and Plant Improvement" & delivered lectures and Practical demonstrations on research topics- Immobilization of *Capsicum* cells and placenta for capsaicin production; biotransformation of ferulic acid to vanilla flavor metabolites in capsicum cells; methods for plant cell biomass estimation and their viability, February 2-22, 1998, CFTRI, Mysore, India.

12. Preparation of abstracts manual & compilation of proceedings volumes for the **Indian Science Congress Annual Meeting**, July 1997, CFTRI, Mysore, India.

13. Active role in the organization of National Conference on **All India Symposium** on the Recent Advances in Biotechnological Applications of Plant Tissue and Cell Cultures, June 22-24, 1995, CFTRI, Mysore, India.

14. A lecture and practical demonstration on the topic "Immobilization of *Capsicum frutescens* plant cells in calcium alginate matrix for capsaicin production" given in the Department of Biotechnology (DBT) sponsored Short-term training course on "Whole Cell and Enzyme Immobilization Techniques" Organized by the Biotechnology Division of Regional Research Laboratory (CSIR), May 12-28, 1993 Trivandrum, India.

15. **Invited Peer reviewer** for Nature Publishing Group, American Chemical Society, Oxford, Elsevier, Springer and Humana Press journals in evaluating the manuscripts suitability for publication in- Nature Communications, Analytical Chemistry, Biotechnology Progress, Journal of Biochemistry (Tokyo), Applied Microbiology Biotechnology, Applied Biochemistry and Biotechnology, Nanobiotechnology, Chemosphere, Journal of Bioscience Bioengineering, respectively.

16. Serving as an external examiner or expert in evaluating Ph.D. Thesis's.
17. Invited Peer reviewer of conference abstracts and book chapters from different publishers.

Membership in Professional Organizations

1. Electrochemical Society (ECS)
2. The Japan Society of Applied Physics (JSAP)
3. Society for Chemistry and Micro-Nano Systems (CHEMINAS), Japan
4. Phytochemical Society of Europe (PSE) 1996-1999 (3 years)
5. The Chemical Society of Japan (CSJ), Japan
6. The Society for Biotechnology, Japan

Countries visited:

USA (mainland), Hawaii; Mexico, Germany, Italy, Sweden, France, Denmark, Netherlands, South Korea and Singapore and Japan.

Research grants/funds received

1. A research grant of **1.0 million JPY** sanctioned towards support for carrying out research under **Monbusho Scholarship** towards advanced research program titled "screening of novel microbes for biodegradation of environmental pollutants" at JAIST for the year April 2000-March 2001 (Principal Investigator).

2. A research grant of **4.0 million JPY** obtained towards **JSPS Postdoctoral program** for carrying out research on "Moleculear catalytic and genetic mechanism of degradation of benzo(a)pyrene by degrading bacteria: Development of gene sensor and smart bioremediation" for the period April 2001-March 2003 (Principal Investigator).

3. A research grant of over **250 million JPY** received under Toyama Medical Bio-cluster program for the "development of Integrated and multifunctional chip devices for single-cell analysis" for a period of five years from April 2003-March 2008 funded by MONBUKAGASHO, Japan (Role: Representative researcher)

4. A research grant of **200 million JPY** from JSPS on "developing the novel single cell sorting technology using nanoneedle array" for the duration 2011-2014 (Role: Representative researcher)

Conference presentations (International)

1. K. Ohto, R. Mizuki, Y.S. Kurniawan, **R.R. Sathuluri**, S. Morisada, H. Kawakita,W. Iwasaki, M. Miyazaki, M. Maeki, Jumina, Separation of Pb(II) metal ion with tetraacetic acid derivative of Calix[4]arene by using droplet-based microreactor System, to be presented at 7th International Conference on Ion Exchange 2018 (ICIE 2018) September 10th – 13th, 2018, Gadjah Mada University, Yogyakarta, Indonesia.
2. Y.S. Kurniawan, **R.R. Sathuluri**, K. Ohto, H. Kawakita, S. Morisada, W. Iwasaki, M. Miyazaki, Rapid and efficient recovery of precious metals from real metal waste with calix[4]arene derivatives using the droplet microfluidic reactor system, presented at the Tri-University (Dauegu-Saga-Soochow University) Joint International symposium 2017, November 19-22, 2017, Daegu University, Gyeongsan, South Korea (**Best poster award**)
3. K. Ohto, Y.S. Kurniawan, **R.R. Sathuluri**, M. Maeki, H. Kawakita, S. Morisada, W. Iwasaki, M. Miyazaki, Stepwise Extractive Separation of Precious Metals with Macrocyclic Compounds Using Microreactor System, to present at The 21st International Solvent Extraction Conference, (ISEC 2017), Nov. 5-11, 2017, Miyazaki Convention Center Miyazaki, JAPAN
4. K. Ohto, Y.S. Kurniawan, **R.R. Sathuluri**, H. Kawakita, S. Morisada, W. Iwasaki, M. Miyazaki, Recovery of precious metals with calix[4]arene derivatives as extraction reagents using the droplet microreactor system, to present at The 5th International Symposium & Exhibition on Aqua Sciences & Water Resources (ISASWR'17) held at August 8-11, 2017, Fukuoka University, Fukuoka, Japan.

5. Y.S. Kurniawan, **R.R. Sathuluri**, K. Ohto, H. Kawakita, S. Morisada, W. Iwasaki, M. Miyazaki, Droplet microreactor system for an efficient lithium ion recovery with calix[4]arene derivative, to present at The 5th International Symposium & Exhibition on Aqua Sciences & Water Resources (ISASWR'17) held at August 8-11, 2017, Fukuoka University, Fukuoka, Japan.

6. W. Iwasaki, M. Ryu, **R.R. Sathuluri**, R. Kurita, O. Niwa, M. Miyazaki, Fabrication of electrochemical detector with various microperiodic structure for electrochemical immunochromatography, Presented at 8th International symposium on Microchemistry and Microsystems (ISMM2016), May 30-June 1 2016, Hong Kong (poster).

7. W. Iwasaki, M. Ryu, **R.R. Sathuluri**, R. Kurita, O. Niwa, M. Miyazaki, Development of electrochemical detecting platform for quantitative immunochromatography, presented at 26th World Congress on Biosensors (Biosensors 2016), May 25-27, 2016, Swedish Exhibition and Congress Centre, Gothenburg, Sweden (poster).

8. D. Matsumoto, M. Saito, **R.R. Sathuluri**, Y.R. Silberberg, F. Iwata, T. Kobayashi, C. Nakamura, Macromolecule transfer by mechanoperforation using nanoneedle array for single cell analysis, presented at 26th World Congress on Biosensors (Biosensors 2016), May 25-27, 2016, Swedish Exhibition and Congress Centre, Gothenburg, Sweden (poster).

9. M. Miyazaki, K. Ohto, M. Maeki, **S. Ramachandra Rao**, An efficient recovery of rare metal ions with calix[4]arene derivatives from acidic media using droplet-based microreactor system, presented at the PITTCON Conference 2016, March 6-10, 2016, Georgia World Congress Center, Atlanta, USA (poster).

10. W. Iwasaki, R. Mizuki, **S. Ramachandra Rao**, R. Kurita, O. Niwa, M. Miyazaki, Development of electrochemical detection system combining with nitrocellulose membrane for quantitative immunochromatography, presented at PITTCON Conference & Expo 2016, March 6-10, 2016, Georgia World Congress Center, Atlanta, USA (Poster).

11. **S. Ramachandra Rao**, M. Maeki, J.Y. Kim, Y. Ueda, K. Ohto, M. Miyazaki, An efficient recovery of rare metals ions with calix[4]arene derivatives employing droplet-based microreactor system in nitric acid media, presented at the International Chemical Congress of Pacific Basin Societies 2015 (PACIFICHEM 2015), December 15-20, 2015, Honolulu, Hawaii (Poster).

12. **S. Ramachandra Rao**, D. Matsumoto, C. Nakamura, Nanoneedle array for efficient delivery of macromolecules into living cells, presented at International Conference on Bioelectronics, Biosensors, Biomedical devices, BioMEMS/NEMS Applications (Bio4Apps2015) at Shiiki Hall, Ito Campus, Kyushu University, December 9-11, 2015 (oral).

13. **S. Ramachandra Rao,** M. Maeki, K. Ohto, M. Miyazaki, Droplet-based microfluidic reactor for efficient recovery of metal ions, presented at International Conference on Bioelectronics, Biosensors, Biomedical devices, BioMEMS/NEMS Applications (Bio4Apps2015) at Shiiki Hall, Ito Campus, Kyushu University, December 9-11, 2015 (poster).

14. **S. Ramachandra Rao**, M. Maeki, J.Y. Kim, Y. Ueda, K. Ohto, M. Miyazaki, Droplet-based microfluidic system as an efficient recovery of rare metal ions with calix[4]arene derivatives from acidic media, presented at 2015 Taiwan/Korea/Japan Joint meeting on Chemical Engineering, November 5-7, 2015 at E-Da Royal Hotel, Kaohsiung, Taiwan (poster) (**Best poster award**).

15. **S. Ramachandra Rao**, M. Maeki, J.Y. Kim, Y. Ueda, K. Ohto, M. Miyazaki, Droplet-based microreactor system for an efficient recovery of rare metal ions with calix[4]arene derivatives from acidic media, to present at APCChE 2015 Congress, Melbourne Convention and Exhibition Centre, 27 Sept-1 Oct. 2015, Melbourne, Australia (Oral).

16. **S. Ramachandra Rao**, M. Maeki, J.Y. Kim, Y. Ueda, K. Ohto, M. Miyazaki, Droplet-based microreactor System for an efficient extraction and recovery of silver ions with calix[4]arene Derivatives, presented at 7th International Symposium on Microchemistry and Microsystems (ISMM 2015) June 8-10, 2015, at Funai Tetsuro Auditorium / Katsura Hall, Kyoto University, Kyoto, Japan (poster).

17. W. Iwasaki, R. Mizuki, **S. Ramachandra Rao**, O. Niwa, M. Miyazaki, Development of microperiodic array based electrochemical sensor for quantitative immunochromatography, presented at 19th International Conference on Miniaturized Systems for Chemistry and Life Sciences (MICROTAS 2015), October 25-29, 2015, Gyeongju, Korea (Poster)

18. W. Iwasaki, **S. Ramachandra Rao**, O. Niwa, M. Miyazaki, Fabrication of microperiodic structure and its application to electrochemical detection for paper fluidics, presented at 5th International Conference on Optofluidics 2015, July 26-29, 2015, Taipe, Taiwan (Oral).

19. W. Iwasaki, **S. Ramachandra Rao**, O. Niwa, M. Miyazaki, Electrochemical Immunochromatography Integrated with Microperiodic Array-based Sensor for Bioanalyses, presented at The International Chemical Congress of Pacific Basin Societies 2015 (PACIFICHEM 2015), December 15-20, 2015, Honolulu, Hawaii (Poster).

20. W. Iwasaki, R. Mizuki, **S. Ramachandra Rao**, R. Kurita, O. Niwa, M. Miyazaki, Fabrication of electrochemical detector with microperiodic structure by maskless grayscale lithography, presented at The 6th Japan-China-Korea Joint Conference on MEMS/NEMS 2015, China 24 September 2015 (**Best presentation award**).

21. W. Iwasaki, **S. Ramachandra Rao**, O. Niwa, M. Miyazaki, Development of a Micropyramid array-based sensing platform for electroanalyltical measurements employing paper-based diffusion, to present at 7th International Symposium on Microchemistry and Microsystems (ISMM 2015) June 8-10, 2015, at Funai Tetsuro Auditorium / Katsura Hall, Kyoto University, Kyoto, Japan (Poster).

22. **S. Ramachandra Rao**, M. Maeki, J.Y. Kim, Y. Ueda, K. Ohto, M. Miyazaki, An efficient and continuous extraction of metal ions by using droplet-based microreactor, presented at RSC Tokyo International Conference 2014 organized by Japan Analytical Instruments Manufacturers Association (JAIMA), September 4-5, 2014, Makuhari Messei, Chiba, Japan (Poster) .

23. M. Miyazaki, **S. Ramachandra Rao**, R. Kawamura, T. Kobayashi, M.Iijima, S. Kuroda, F. Iwata, C. Nakamura, Mechanical cell sorting using antibody-immobilized nanoneedle array, Presented at Biosneosrs 2014 Congress, May 27-30, 2014, Melbourne, Australia (poster).

24. **S. Ramachandra Rao**, M. Shimooku, M. Miyazaki, R. Kawamura, T. Kobayashi, F. Iwata, C. Nakamura, Development of high-aspect-ratio silicon nanoneedle array for single-cell manipulations, presented at 3rd Nano Today Conference, Dec. 8-11, 2013, BIOPOLIS, Singapore (Poster).

25. M. Miyazaki, **S. Ramachandra Rao**, M. Shimooku, R. Kawamura, T. Kobayashi, F. Iwata, C. Nakamura, Development of high-aspect-ratio silicon nanoneedle array for living cell manipulations, presented at 2013 MRS Fall Meeting & Exhibit, December 1-6, 2013, Boston, Massachusetts (Poster)

26. **S. Ramachandra Rao**, M. Shimooku, M. Miyazaki, R. Kawamura, T. Kobayashi, F. Iwata, C. Nakamura, Development of high-aspect-ratio silicon nanoneedle array for single-cell manipulations, presented at 86th Japan Tissue Culture Association (JTCA), AIST, Tsukuba May 30-31, 2013 (**Invited talk**).

27. **S. Ramachandra Rao**, T. Kobayashi, M. Shimooku, R. Kawamura, C. Nakamura, Development of high-aspect-ratio silicon nanoneedle array for single-cell manipulations, presented at International workshop on Nanosensor Science and Technology (IWNST-2013), at NIST, Feb 27-March 1 2013, Berhampur, Odisha, India, (**Invited talk**).

28. M. Shimooku, **S. Ramachandra Rao**, R. Kawamura, K. Ishihara, K. Fukazawa, C. Nakamura, Development of a Method to Modify Nanoneedle Arrays with Molecular Probes for the Analysis of Living Cells, presented at PRiME 2012, The Electrochemical Society, October 7-12, 2012, Honolulu, Hawaii (Poster).

29. **S. Ramachandra Rao**, Y. Amemiya, T. Kobayashi, M. Shimooku, C. Nakamura, Development of a silicon nanoneedle array with high-aspect-ratios for analyzing cell response, presented at Biosensors 2012 conference May 15-18, 2012, Cancun, Mexico (Poster).

30. **S. Ramachandra Rao**, Y. Amemiya, T. Kobayashi, C. Nakamura, Development of high-density ordered cylindrical silicon nanoneedle array for high-throughput single-cell screening and manipulation

studies, presented at 2nd International Conference on Bio-Sensing Technology 2011, October 10-12, 2011, Amsterdam, The Netherlands (Poster).

31. Y. Amemiya, M. Okose, S. Mieda, **S. Ramachandra Rao,** C. Nakamura, Analysis and control of cell adhesion force to substrate for the basis of a novel mechanical cell sorting, presented at IV International meeting of AFM in Life Sciences and Medicine, 23-27 August 2011, Paris, France (Poster).

32. E. Tamiya, **S. Ramachandra Rao,** H. Yoshikawa, Gold nanoparticle-based SERS for non-invasive molecular probing of mouse embryonic stem cell differentiation process, presented at PACIFICHEM 2010 Congress, December 15-20, 2010, Honolulu, Hawaii (Oral).

33. **S. Ramachandra Rao**, H. Yoshikawa, E. Tamiya, *In vitro* molecular probing of embryonic stem cell differentiation based on SERS from gold nanoparticles, presented at 5th-PARC symposium-Photonics in Asia, September 7-8, 2010, Kashikojima, Japan (Poster).

34. M. M. Hossain, **S. Ramachandra Rao**, E. Tamiya, Electro-active cells on Microfluidic cell chips: Culture, Stimulation and Manipulation, presented at 5th International Stem Cell School and Regenerative Medicine, Oct. 20-28, 2008, Berlin-Rostock, Germany (Poster)

35. **S. Ramachandra Rao**, M. Saito, E. Tamiya, Microfluidic system for on-chip high-throughput antigen-specific single B-lymphocyte screening and cell functional analysis, presentation delivered at Pacific RIM Meeting (PRiME 2008) on Electrochemical and solid-state science meeting October 12-17, 2008 at Hilton Hawaiin Village, Honolulu, Hawaii (**Oral, invited**).

36. **S. Ramachandra Rao**, M. Kitamura, S. Yamamura, Y. Takamura, E. Tamiya, Single-cell picoliter microfluidic systems for high-throughput screening and analysis of antigen-specific B-cells from bulk suspensions, presented at Engineering Cell Biology-The cell in context, August 5-8, 2007, MIT, Boston, USA (Poster).

37. S. Yamamura, Y. Shimizu, **S. Ramachandra Rao**, Y. Takamura, E. Tamiya, High-throughput single-cell analysis systems for antigen-specific B-cells, presented at 2nd International Workshop on Approaches to Single-Cell Analysis, September, 6-7, 2007, Waseda University, Tokyo, Japan (Poster).

38. S. Yamamura, Y. Shimizu, **S. Ramachandra Rao**, Y. Takamura, E. Tamiya, Single-cell microarray for high-throughput analysis of dioxin-specific B-cells, presented at Engineering Cell Biology-The cell in context, August 5-8, 2007, MIT, Boston, USA (Poster).

39. **S. Ramachandra Rao**, M. Kitamura, S. Yamamura, E. Tamiya, Novel picoliter compartmental microfluidic chip devices for high-throughput single-cell sorting and analysis, presented at 10th International Conference on Miniaturized Systems for Chemistry and Life Sciences (MICROTAS 2006), November 5-9, 2006, Tokyo, Japan (Poster).

40. **S. Ramachandra Rao**, M. Kitamura, S. Yamamura, E. Tamiya, Development of high-throughput compartmental microfluidic devices for multiplexed single-cell sorting, manipulation and analysis, presented at 5th IEEE SENSORS 2006, October 22-25, 2006, Daegu, Korea (Poster).

41. **S. Ramachandra Rao**, S. Yamamura, Y. Takamura, E. Tamiya, Microfluidic devices for selective single B-cell sorting, screening and analysis in the nano and picoliter volume compartments, presented at PACIFICHEM-2005 Congress, December 15-20, 2005, Honolulu, Hawaii (**Oral, invited**).

42. S. Yamamura, **S. Ramachandra Rao**, M. Omori, E. Tamiya, Novel high-throughput screening and analysis for dioxin-specific single B-cell using microarray, presented at the PACIFICHEM-2005 Congress, December 15-20, 2005, Honolulu, Hawaii (Poster).

43. **S. Ramachandra Rao**, S. Yamamura, Y. Takamura, E. Tamiya, Multiplexed microfluidic device for single-cell manipulation and analysis, presented at 8th International Conference on Miniaturized Chemical and Biological Analysis Systems, September 26-30, 2004, Malmo, Sweden (Poster).

44. S. Yamamura, **S. Ramachandra Rao**, M. Omori, Y. Tokimitsu, S. Kondo, H. Kishi, A. Muraguchi, Y. Takamura, E. Tamiya, High-throughput screening and analysis for antigen specific single-cell using microarray, presented at 8th International Conference on Miniaturized Chemical and Biological Analysis Systems, September 26-30, 2004, Malmo, Sweden (Poster).

45. Y. Akagi, **S. Ramachandra Rao**, Y. Morita, Y. Takamura, E. Tamiya, Screening of a novel neurotrophic factor using microarray cell-based chip and its response on PC12 cells neurosignaling pathway, presented at 8th International Conference on Miniaturized Chemical and Biological Analysis Systems, September 26-30, 2004, Malmo, Sweden (Poster).

46. Y. Akagi, **S. Ramachandra Rao**, Y. Morita, E. Tamiya, Combinatorial peptide beads array combined with PC12 cell chip for screening of neurotrophin factors, presented at 11th European Congress on Biotechnology, August 24-29, 2003, Basel, Switzerland (Oral).

47. **S. Ramachandra Rao,** Microarray and microfluidic chips in genomics, proteomics and cellomics research. *AFST (I) Young Scientist award Lecture delivered at ICFOST* December 12-14, 2002, Mysore, India (**Oral, invited**).

48. **S. Ramachandra Rao**, S. Yamamura, Y. Morita, E. Tamiya, Lutein biosynthesis in *Stenotrophomonas* bacterial cultures: Channeling of carotenoids to lutein biosynthesis by light irradiation and its cytotoxic effects, presented at Metabolic Engineering IV: Applied system biology, October 6-11, 2002, Il Ciocco, Castelvecchio Pascoli (Tuscany), Italy (Poster).

49. **S. Ramachandra Rao**, Y. Akagi, Y. Morita, E. Tamiya, High-throughput screening of anticancer drugs using microarray based cell chip, presented at 6th International conference on Micro Total Analysis Systems (μTAS-2002), November 3-7, 2002, Nara, Japan (Poster).

50. Y. Morita, H. Onishi, **S. Ramachandra Rao**, T. Sakaguchi, Y. Murakami, K. Yokoyama, E. Tamiya, Biodegradation of n-alkanes by psychrotrophic bacteria for cold environment, presented at Enzyme Engineering Conference XVI, October 7-12, 2001, Potsdam, Germany (Poster).

51. **S. Ramachandra Rao**, T. Sakaguchi, Y. Morita, K. Yokoyama, E. Tamiya, Profile of Benzo(a)pyrene degrading bacterium and its potential for bioremediation applications, presented in *Biochemical Engineering XII: Back to the future: Application of Biochemical Engineering fundamentals to modern problems*, June 10-15, 2001, Sonoma, California (Poster).

52. T. Sakaguchi, S. Okano, Y. Morita, **S. Ramachandra Rao**, K.Yokoyama, E. Tamiya, Characterization and benzo(a)pyrene degradation of a gram-positive bacterium isolated from a natural oil-producing well, presented at International Chemical Congress of Pacific Basin Societies, December 14-19, 2000, Honolulu, Hawaii (Poster).

53. **S. Ramachandra Rao**, G.A. Ravishankar, Biotransformation of phenylpropanoid compounds to vanilla flavour metabolites in immobilized cell cultures of *Capsicum frutescens,* presented at International Food Convention (IFCON-98), November 19-23, 1998, CFTRI, Mysore, India (Poster).

54. **S. Ramachandra Rao,** G.A. Ravishankar, Production of vanillin and capsaicin in immobilized cell cultures of *Capsicum frutescens,* presented at International Symposium on "Principles Regulating Biosynthesis and Storage of Secondary Products" organized combindly by both Phytochemical Society of Europe and Martin-Luther-University of Halle, Wittenberg, September, 26-28, 1996, Halle, Germany (Poster).

55. R. Madhusudhan, **S. Ramachandra Rao,** G.A. Ravishankar, Osmolarity as a measure of growth of plant cells in suspension cultures, presented at MICON INTERNATIONAL- 94, Defence Food Research Laboratories (DFRL), November 9-12, 1994, Mysore, India (Poster).

56. **S. Ramachandra Rao**, T.S. Johnson, G.A. Ravishankar, L.V. Venkataraman, Biotransformation of capsaicinoid intermediates to vanillin and capsaicin in immobilized cell cultures of *Capsicum frutescens*, presented at the International Food Convention (IFCON-93), Central Food Technological Research Institute (CFTRI), September 7-11, 1993, Mysore, India (Poster).

Conference presentations (National)

1. Y. S. Kurniawan, **R. R. Sathuluri**, K. Ohto, H. Kawakita, S. Morisada, W. Iwasaki, M. Miyazaki, Evaluation of precious metal ion recovery with p-tert- octycalix[4]arene derivatives with droplet-based microreactor, preseted at the 54th Chemistry related branch joint Kyushu convention, July 1, 2017

2. **S. Ramachandra Rao**, M. Maeki, K. Ohto, M. Miyazaki, Efficient recovery of rare metal ions from acidic media using droplet-based microfluidic system with calix[4]arene derivatives, presented at the 32nd Meeting on Chemistry and Micro-Nano Systems (32nd CHEMINAS), held at KitaKyushu International Conference Hall, Kitakyushu City, Fukuoka, Japan November 26-27, 2015 (poster)

3. S. Hirao, M. Maeki, **S. Ramachandra Rao**, M. Uehara, M. Miyazaki, Effect of cooling rate on the polymorphism control of organic crystal using the micro droplet, presented at the 32nd Meeting on Chemistry and Micro-Nano Systems (32nd CHEMINAS), held at KitaKyushu International Conference Hall, Kitakyushu City, Fukuoka, Japan November 26-27, 2015 (poster).

4. **S. Ramachandra Rao**, J.Y. Kim, M. Miyazaki, K. Ohto, Droplet-based microfluidic reactor for precious metal ions recovery with calix[4]arene derivatives, presented at 3rd International Symposium on host compounds for separation and functionality in Saga, Saga University, July 29-30, 2015 (poster)

5. S. Hirao, M. Maeki, **S. Ramachandra Rao**, K. Yamashita, M. Miyazaki, Influence of supersaturation and onset of nucleation inside microdroplets on organic crystals purification, presented at Japan Chemical Society Meeting held at KitaKyushu International Conference Hall, KitaKyushu City, Fukuoka, Japan, June 10-12, 2015 (poster).

6. **S. Ramachandra Rao**, M. Maeki, J.Y. Kim, Y. Ueda, M. Tokeshi, K. Ohto, M. Miyazaki, Optimization of rare metal separation process by calixarene derivatives by using microreactor, presented at 30th Chemistry and Micro-Nano systems Society Meeting (CHEMINAS), Hokkaido University, Sapparo, October 2-3, 2014 (poster)

7. **S. Ramachandra Rao**, T. Kobayashi, M. Shimooku, R. Kawamura, C. Nakamura, High aspect ratio silicon nanoneedle array fabrication for single cell manipulations, presented at 12th Life Science-Biotechnology (LS-BT) joint research Conference held at AIST, Tsukuba, February 5-6, 2013 (poster).

8. R. Kawamura, M. Miyazaki, **S. Ramachandra Rao**, T. Kobayashi, M. Iijima, S. Kuroda, K. Fukazawa, K. Ishihara, F. Iwata, C. Nakamura, Functionalization of nanoneedle with antibody and adhesion control of cell culturing substrate for mechanical cell separation, to present at 7th Symposium on Bio-relevant Chemistry CSJ at Nagoya University, Higashiyama Campus, Nagoya, September 27-29 2013 (poster).

9. M. Miyazaki, R. Kawamura, **S. Ramachandra Rao**, T. Kobayashi, M. Iijima, S. Kuroda, K. Fukazawa, K. Ishihara, F. Iwata, C. Nakamura, Mechanical cell separation using antibody-immobilized nanoneedle, to present at 7th Symposium on Bio-relevant Chemistry CSJ at Nagoya University, Higashiyama Campus, Nagoya, September 27-29 2013 (poster).

10. M. Miyazaki, R. Kawamura, **S. Ramachandra Rao**, T. Kobayashi, K. Ishihara, K. Fukazawa, F. Iwata and C. Nakamura, Preparation of single cell array using micro pillar by microcontact printing, presented at Annual meeting of Chemical Society of Japan, Ritsumekan University, March 23-25, 2013 (oral).

11. M. Shimooku, M. Miyazaki, R. Kawamura, **S. Ramachandra Rao**, T. Kobayashi, N. Tsujimura, F. Iwata and C. Nakamura, Development of a method for DNA transfer to the cell using nanoneedle array, presented at Spring Annual Electrochemical Chemical Society meeting, Tohoku University, Sendai, March 29-31, 2013 (oral).

12. M. Shimooku, Y. Amemiya, **S. Ramachandra Rao**, K. Ishihara, K. Fukazawa, C. Nakamura, Development of a method to modify nanoneedle arrays with proteins for cell manipulation, presented at Spring Chemical Society of Annual Meeting, March 29-31, 2012 (oral).

13. **S. Ramachandra Rao**, Y. Amemiya, T. Kobayashi, C. Nakamura, High-density silicon nanoneedle array fabrication for single-cell studies, presented at the 5th Symposium on Bio-relevant Chemistry CSJ at Tsukuba International Congress Center, 12-14 September 2011 (poster).

14. M. Shimooku, Y. Amemiya, M. Uda, **S. Ramachandra Rao**, K. Ishihara, K. Fukazawa, C. Nakamura, Investigation of a method to modify nanoneedle arrays with antibodies, presented at the 5th Symposium on Bio-relevant Chemistry CSJ at Tsukuba International Congress Center, 12-14 September 2011 (poster).

15. M. Okose,Y. Amemiya, S. Mieda, S**. Ramachandra Rao**, C. Nakamura, Analysis and control of a cell adhesion force to the substrate as a basis for development of a novel mechanical cell sorting system, presented at the 5th Symposium on Bio-relevant Chemistry CSJ at Tsukuba International Congress Center, 12-14 September 2011 (poster).

16. **S. Ramachandra Rao**, J. Naruse, M. Saito, H. Yoshikawa, E. Tamiya, Effects of the CNT-AuNP hybrid exposures on embryonic stem cell viability, proliferation, embryoid body formation and subsequent cardiomyogenesis, presented at 58th Annual Spring meeting of Japan Society of Applied Physics, Kanagawa Institute of Technology, Kanagawa, March 24-27, 2011, Japan (oral).

17. **S. Ramachandra Rao**, H. Yoshikawa, M. Saito, E. Tamiya, Gold nanoparticle exposure promotes enhanced cardiomyogenesis and favor non-invasive molecular probing of embryonic stem cells, invited lecture delivered at the 2010 Fall meeting of Bio-functional Chemistry organized by Chemical Society of Japan at Toyanaka campus, Osaka University, Sept. 24-26, 2010, Osaka, Japan (**invited oral**)

18. M. M. Hossain, **S. Ramachandra Rao**, M. Saito, Y. Yamaguchi, E. Tamiya, Multi walled Carbon Nanotubes (MWCNT) and mouse Embryonic Stem (mESC) cell interaction: Towards novel opportunities, presented at 2010 Fall meeting of Electrochemical Society of Japan, Kanagawa Institute of Technology, September 2-3, 2010, Japan (oral).

19. H. Yoshikawa, **S. Ramachandra Rao**, M. M. Hossain, E. Tamiya, Development of gold nanoparticle based SERS method for investigating embryonic stem cell differentiation, presented at 71st Applied Physics Society meeting, Nagasaki University, September 14-17, 2010, Japan (oral).

20. E. Shimizu, M. M. Hossain, **S. Ramachandra Rao**, M. Saito, Y. Yamaguchi, E. Tamiya, Evaluation of cardiotoxicity of drugs on mouse ES cell derived cardiomyocytes based on cardiomyocyte beating video method, presented at 2010 Fall meeting of Bio-functional Chemistry organized by Chemical Society of Japan on Toyanaka campus, Osaka University, Sept. 24-26, 2010, Osaka, Japan (oral).

21. **S. Ramachandra Rao**, M. M. Hossain, M. Saito, H. Yoshikawa, E. Tamiya, Gold nanoparticle-based SERS profiles for analyzing embryonic stem cell differentiation process, presented at the 77th Electrochemical Society of Japan, March 29-31, 2010, Toyama University, Toyama, Japan (oral).

22. **S. Ramachandra Rao,** S. Yamamura, Y. Takamura, E. Tamiya, High-throughput compartmental microfluidic systems for antigen-specific B-cell analysis, presented at the 10th Biotechnology Symposium of Chemical Society of Japan, September 5-6, 2007, Waseda University, Tokyo, Japan (poster).

23. M.U. Ahmed, M. Saito, M. Chikae, **S. Ramachandra Rao**, S. Furui, A. Hino, S. Yamamura, Y. Takamura, and E. Tamiya, Electrochemical hand-held integrated sensor system for rapid detection of DNA, presented at 10th Symposium on Biotechnology of Chemical Society of Japan, 5-6, September, 2007 Waseda University, Tokyo, Japan (poster).

24. M. Kitamura, **S. Ramachandra Rao**, S. Yamamura, Y. Takamura, E. Tamiya, Development of novel high-throughput single-cell analysis using two-phase compartmental microfluidic systems, presented at the 87th Annual meeting of the Chemical Society of Japan, March 25-28, 2007, Kansai University, Osaka, Japan (oral).

25. M. Kitamura, **S. Ramachandra Rao**, S. Yamamura, Y. Takamura, E. Tamiya, Single-cell analysis employing novel picoliter compartmental microfluidic systems, presented at the Biofunctional Chemistry and Biotechnology symposium organized by the Chemical Society of Japan, September, 28-30, 2006, Kyoto Institute of Technology, Kyoto, Japan (poster).

26. M. Kitamura, **S. Ramachandra Rao**, S. Yamamura, Y. Takamura, E. Tamiya, Picoliter compartmental microfluidic devices for multiplexed single-cell sorting and analysis, presented at the 86th Annual meeting of Chemical Society of Japan, March 27-30, 2006, Nihon University, Chiba, Japan (oral).

27. **S. Ramachandra Rao**, S. Yamamura, Y. Takamura, E. Tamiya, Compartmental microfluidic systems for single B-cell sorting and analysis from bulk cell suspensions in the microchannels, presented at the 12th Chemistry and Nano and Microsystems (CHEMINAS), December 1-2, 2005 Kyoto TERRSA, Kyoto, Japan (poster).

28. S. Yamamura, **S. Ramachandra Rao**, R. Ikeda, Y. Takamura, E. Tamiya, High-throughput single-cell signal response using cell microarray chip, presented at the 12th Chemistry and Nano and Microsystems (CHEMINAS), December 1-2, 2005 Kyoto TERRSA, Kyoto, Japan (poster).

29. **S. Ramachandra Rao**, S. Yamamura, Y. Takamura, E. Tamiya, Multiplexed single-cell manipulation and analysis using two-phase microfluidic systems, presented at the 85th Annual meeting of Chemical Society of Japan, March 26-29, 2005, Kanagawa University, Yokohama campus, Yokohama, Japan (oral).

30. S. Yamamura, **S. Ramachandra Rao**, M. Omori, Y. Tokimitsu, Y. Kondo, H. Kishi, A. Muraguchi, Y. Takamura, E. Tamiya, Screening and analysis for antigen-specific single B-cell using microarray chip, presented at the 85th Annual meeting of Chemical Society of Japan, March 26-29, 2005, Kanagawa University, Yokohama, Japan (oral).

31. M. Omori, S. Yamamura, **S. Ramachandra Rao**, M. Okuyama, Y. Morita, Y. Takamura, E. Tamiya, Analysis for dioxin specific single B-cell using microarray chip, presented at the 85th Annual meeting of Chemical Society of Japan, March 26-29, 2005, Kanagawa University, Yokohama campus, Yokohama, Japan (oral).

32. **S. Ramachandra Rao**, Y. Akagi, Y. Morita, E. Tamiya, On-chip high-throughput cell-based drug screening using nano-liter biochips, presented at the 1st Joint Symposium on Biofunctional Chemistry and Biotechnology organized by Chemical Society of Japan, October 12-13, 2003, Kumamoto University, Kumamoto, Japan (oral).

33. **S. Ramachandra Rao**, Y. Akagi, Y. Morita, E. Tamiya, High-throughput quantitative cytotoxicity of carotenoids by using microchamber array cell chip, presented at the Japan Society for Bioscience, Biotechnology and Agrochemistry, April 1-3, 2003, Yokohama, Japan (oral).

34. M. Koji, **S. Ramachandra Rao**, T. Sakaguchi, Y. Morita, E. Tamiya, Purification and characterization of benzo(a)pyrene degrading enzyme from *Paenibacillus* sp. B2-1, presented at the Japan Society for Bioscience, Biotechnology and Agrochemistry, April 1-3, 2003, Yokohama, Japan (oral).

35. **S. Ramachandra Rao**, S. Yamamura, Y. Morita, E. Tamiya, Light acting as a switch in channeling carotenoids towards lutein biosynthesis and accumulation in cultures of *Stenotrophomonas* sp. D-1, presented at 6th Biotechnology symposium organized by Japan Chemical Society, September 27-28, 2003, Osaka, Japan (oral).

36. **S. Ramachandra Rao**, Y. Morita, E. Tamiya, Zeaxanthin biosynthesis in the psychrotrophic bacterium *Flavobacterium balustinum* P104 in response to light, temperature, salinity and nutrient stress, presented at Annual meeting of The Society for Biotechnology, Japan, October 28-30, 2003, Osaka, Japan (oral).

37. **S. Ramachandra Rao,** K. Murakami, Y. Morita, E. Tamiya, Enhanced benzo(a)pyrene biodegradation by *Paenibacillus* sp. using different strategies, presented at Hokuriku Nikka, Toyama University, November 15-16, 2002, Ishikawa, Japan (poster).

38. **S. Ramachandra Rao**, Y. Morita, T. Sakaguchi, K. Yokoyama, E. Tamiya, Benzo(a)pyrene biodegradation under the influence of β-cylcodextrin and nonionic surfactants, presented at Japan Society for Bioscience, Biotechnology and Agrochemistry, March 23-27, 2002, Sendai, Japan (oral).

39. **S. Ramachandra Rao**, Y. Morita, Y. Murakami, K. Yokoyama, E. Tamiya, Benzo(a)pyrene biodegradation in cultures of B2-1: A *Paenibacillus* bacterium, presented at Hokuriku Nikka, JAIST, November 11-12, 2001, Ishikawa, Japan (poster).

40. **S. Ramachandra Rao**, Y. Morita, Y. Murakami, K. Yokoyama, E. Tamiya, Bioremdiation of benzo(a)pyrene with *Paenibacillus* bacterium sp. B2-1, presented at 80th Chemical Society of Japan. September 21-23, 2001, Chiba, Japan (oral).

41. **S. Ramachandra Rao**, T.Sakaguchi, Y. Morita, Y. Murakami, K. Yokoyama, E. Tamiya, Biodegradation of polycyclic aromatic hydrocarbon-benzo(a)pyrene by *Paenibacillus* bacterium:B2-1, presented at 79th Chemical Society of Japan, March 28-31, 2001, Kobe, Japan (oral).

42. H. Onishi, **S. Ramachandra Rao**, Y. Morita, Y. Murakami, K. Yokoyama, E. Tamiya, Characterization of psychrotrophic alkane degrading bacteria, presented at 49th Hokuriku Nikka Gakkai, 11-12, 2000, November, Fukui, Japan (poster).

43. **S. Ramachandra Rao**, T. Sakaguchi, Y. Morita, Y. Murakami, E. Tamiya, Mineralization of benzo(a)pyrene by newly isolated bacterium:B2-1, presented at 49th Hokuriku Nikka, 11-12, 2000, November, Fukui, Japan (poster).

44. T. Sakaguchi, S. Okano, **S. Ramachandra Rao**, Y. Morita, K. Yokoyama, E. Tamiya, Benzo(a)pyrene degradation and phylogenetic analysis of a gram-positive bacterium isolated from natural oil-producing wells, presented at National Biotechnological Symposium, August 3-5, 2000, Hokkaido, Japan (oral).

45. T. Rajasekaran, B. Suresh, **S. Ramachandra Rao**, G.A. Ravishankar, Production of thiophenes from hairy root cultures of *Tagetes patula,* presented at 68th Annual meeting of Society of Biological Chemists (India), Indian Institute of Science, December 27-29, 1999, Bangalore, India (poster).

46. **S. Ramachandra Rao**, G.A. Ravishankar, Biotransformation of ferulic acid to vanilla flavor in the presence of reducing agents and β-cyclodextrin in *Spirulina platensis* cultures, presented at 66th Annual meeting of Society of Biological Chemists (India), Andhra University, December 22-24, 1997, Visakhapatnam, India (poster).

47. T. Usha, R. Sarada, **S. Ramachandra Rao**, G.A. Ravishankar, Studies on astaxanthin production from *Haematococcus pluvialis,* presented at 65th Annual Meeting of Society of Biological Chemists (India), Indian Institute of Science (IISc), November 20-23, 1996, Bangalore, India (poster).

48. **S. Ramachandra Rao** and G.A. Ravishankar, Biotransformation of coniferyl aldehyde to vanilla flavor in axenic cultures of *Spirulina platensis,* presented at 65th Annual Meeting of Society of Biological Chemists (India), Indian Institute of Science (IISc), November 20-23, 1996, Bangalore, India (poster).

49. R. Madhusudhan, **S. Ramachandra Rao**, G.A. Ravishankar, Estimation of biomass based on turbidity of cell free medium in plant cell suspension cultures, presented at 64th Annual Meeting of Society of Biological Chemists (India) held at Central Drug Research Institute (CDRI), October 6-8, 1995, Lucknow, India (poster).

50. **S. Ramachandra Rao**, G.A. Ravishankar, Biotransformation of isoeugenol to vanillin in axenic cultures of *Spirulina platensis*, presented at 64th Annual Meeting of Society of Biological Chemists (India) held at Central Drug Research Institute (CDRI), October 6-8, 1995, Lucknow, India, **Selected for the 1st best poster award** (poster).

51. **S. Ramachandra Rao**, R.Sarada, G.A.Ravishankar, Phycocyanin as an elicitor for secondary metabolite production in plant cell cultures, presented at All India Symposium on Recent Advances in Biotechnological Applications of Plant Tissue and Cell Culture, CFTRI, June 22-24, 1995, Mysore , India (poster).

52. **S. Ramachandra Rao,** T.S. Johnson, G.A. Ravishankar, L.V. Venkataraman, Biotransformation of isoeugenol to vanillin in immobilized cell cultures of *Capsicum frutescens*, presented at All India Symposium on Recent Advances in Biotechnological Applications of Plant Tissue and Cell Culture, CFTRI, June 22-24, 1995, Mysore, India, **Selected for the 2nd best poster award** (poster).

53. T.S. Johnson, **S. Ramachandra Rao**, G.A. Ravishankar, L.V.Venkataraman, Biotransformation of ferulic acid and vanillylamine to vanillin and capsaicin in immobilized cell cultures of *Capsicum frutescens,* presented at Society of Biological Chemists (India), Mysore chapter, India, **Selected for the 1st best poster award** (poster).

Research supervision

Ph.D. Thesis's supervised (jointly)

1. Mr. Mohammed Mosharraf Hossain, Carbon nanotube for differentiation of mouse stem cells and a non-invasive characterization method for cardiomyocytes, Osaka University, Japan 2007-2010, Year of award: September 2010.

2. Mr. Tsuyoshi Nakayama, Continuous-flow PCR based microfluidic chip devices for the quantitative determination of genetically modified foods, JAIST, Japan, 2004-2007, Year of award: March 2007

3. Mr. Yoshinori Akagi, Microarray chips for high-throughput screening of combinatorial peptide libraries to identify neurite outgrowth inducing peptides and neurosignaling studies, JAIST, Japan, 2001-2003, Year of award: September 2003.

4. Mr. Shohei Yamamura, Screening and identifying psychrophilic bacterium producing proteinase and thioreductases and their characterization keratin degradation, JAIST, Japan, 2000-2002, Year of award: September 2002.

5. Ms. Usha Tripathi, Biotechnological approaches for Astaxanthin, a ketocarotenoid production from microalga-*Haematococcus pluvialis*, CFTRI, Mysore, India, 1996-1999; Year of award: 2001

Master Thesis's supervised (jointly)

1. Mr. Kurniawan Yehezkiel Steven, Microreactor-based metal ion extractions and recovery (2016-2018 (on going), Saga University

2. Ms. Shifumi Hirao, Effect of cooling rate on the L-glutamic acid crystal polymorphism control using droplet microfluidic device, April 2014-March 2016, Year of award, March 2016.

3. Mr. Masahito Kitamura, Development of two-phase compartmental microfluidic devices for single-cell screening and analysis, July 2005-March 2007, year of award, March 2007.

4. Mr. Masahiro Omori, Single-cell microarray for high-throughput analysis of dioxin-specific B-cells, July 2003-March 2004, Year of Award, March 2004.

5. Mr. Koji Murakami, Biodegradation of environment recalcitrant-benzo(a)pyrene and identification of an enzyme responsible and elucidation of degradation pathway, August 2001- March 2003, year of award, March 2003.
6. Mr. Hirotsugu Onishi, Identification of novel alkane degrading bacteria and its use in biodegradation of n-alkanes, August 2000- March 2001, year of award, March 2001.

Teaching experience

Courses taught

Course Number & Title	UG Level/PG Level	Years taught
1. Immobilization and biotransformation of plant cells for secondary metabolites (Theory & Lab experiments)	PG Level	Aug.1997- March 1998 (Univ. Mysore, India)
2. Screening of microbes for biodegradation of pollutants (Lab experiments)	PG level	April 2001-March 2003 (JAIST, Japan)
3. Microfluidic chip devices for single-cell analysis, high-throughput screening etc. (Lab experiments)	PG level	April 2005-March 2007 (JAIST, Japan)
4. Microfluidic reactors for chemical synthesis and Bioanalysis studies (special lectures)	PG Level	December 2014- March 2015 (Saga University, Japan)
5. Droplet microfluidics for crystal polymorphism mechanism	PG Level	April 2015-March 2016 (AIST Kyushu, Japan)

Laboratory experiments

Laboratory	**Experiment**
Plant cell encapsulation	Different substrates (sodium alginate, carrageenan), Hollow fiber for plant cell immobilization, capsaicin biosynthesis, downstream processing, Analysis .
Biotransformation studies using plant cell cultures	Biotransformation of Ferulic acid into vanilla, and other vanilla flavor metabolites by Capsicum immobilized cells in shake flask cultures.
Biodegradation of environmental pollutants	Environmental pollutants-Naphthalene, Anthracene, pyrene and benzo (a) pyrene degradation by Paenibacillus sp. B2-1 strain, analysis of metabolites of B (a) P by HPLC
Microfabrication of PDMS-based devices	Fabrication of SU-8 mold, Soft lithography of PDMS based devices, B-lymphocyte preparation from mouse spleen, single B-cell sorting using two-phase microfluidics, real-time imaging of single-cell sorting in the aqueous compartments, Image analysis etc.
Droplet-based microfluidics for controlling crystallization of small molecules, proteins	PDMS based microfluidics, controlled size of picoliter volume droplets preparation, crystallization of L-glutamine & proteins etc.

1. Experimental skills

Expertise in bio-analytical and molecular biology techniques

Immobilization of plant cell cultures in calcium alginate gel matrix; biomass estimation in immobilized plant cells; viability assays; biotransformation of externally fed precursors by plant cells, micro algal cells, microbial cultures; separation of secondary metabolites, metabolic pathway elucidations by UV-Vis spectrometry, Spectrofluorimetry, HPLC, GC, MALDI-ToF-MS, FTIR, LC-MS, Circular Dichroism (CD), NMR, biosensor construction, BIACORE SPR biosensors, LSPR biosensors, fluorescence mediated chemical sensing, DNA-protein interactions, protein-protein interactions based on fluorescence microscopy; enzyme purification and characterization. Molecular biology experiments such as plasmid isolation, cloning, gene expressions, expression of protein in live cells, and DNA sequencing etc.

Expertise in miniaturized platforms for high-throughput cell-based drug screening, iPS and ES cells differentiations; electrophysiology, live-cell imaging, and Surface enhanced Raman scattering etc.
Microfabrication, soft lithography, microarray and microfluidic devices, PDMS devices fabrication, Reactive ion etching for PDMS surfaces; microchambers for chemical and biochemical sensing; DNA, protein, and cell analyses in devices, cell-based assays, single-cell analysis etc. silicon microchamber array fabrication, Anisotropic etching, high-throughput drug screenings Animal cell cultures cultivations–Jurkat, HeLa, PC12 cells, and P19 embryonic stem cells etc. Confocal laser scanning microscopy (CLSM) for live-cell visualizations, real-time imaging of cells using high-speed CCD/CMOS cameras, image analyses, and signal analyses, and microarray scanners to read out signals from single cells etc. surface enhanced Raman scattering (SERS) for live cell assays; nanomaterials (gold nanoparticles, multiwall carbon nanotubes and composites) interactions with ES and iPS cells; nanomaterials influence on electro-active cells (neurons and heart cells) differentiations etc. Multi-electrode array (MED 64 electrode probe) system for *in vitro* extracellular electrophysiology of cardiomyocytes derived from ES, and iPS cell differentiations etc.

Expertise in nanofabrication, scanning probe microscope, nanomaterials handling MEMS technology (Top-down nanofabrication technique), Deep reactive ion etching (Bosch process), thermal dry/wet oxidations, wet etching, High-aspect ratio silicon micron pillar and nanopillar array fabrication, silicon microchamber array fabrication, Ultratech Stepper lithography; Mask Aligner based lithography, metal thin film sputtering, piezomotors, actuators, microcontact printing, FE-SEM, HRTEM, HRTEM-EDS for silicon surfaces, nano features; HRTEM imaging of nanomaterials (gold nanoparticles, CNTs and their composites) uptake by cardiomyocytes etc.

2. High-end Equipment handled:
HPLC with UV, Fluorescence and Photodiode array detectors, LC-MS, GC-MS, MALDI-ToF-MS, FTIR-ICR-MS, Circular Dichroism (CD), NMR, BIACORE SPR biosensors, LSPR biosensors, Real-time PCR apparatus, Zeta sizer for nanomaterial characterization, ELISA readers etc. Raman microscope for SERS measurements.
Inverted epifluorescence microscope, stereo microscope, Confocal Laser scanning microscopy, CCD, CMOS cameras from various companies-Axiocam, Hamamatsu, Vision, Photron NAC etc. have been used for high-speed and high-sensitive image acquisition purpose. Micro particle imaging velocimetry (μPIV) for fluid dynamics in the microchannels, YAG lasers, He-Ne lasers etc. Microelectrode array for Electrophysiology of neurons and heart beating cells etc.
Nanoliter dispensing robots, Hitachi Chip array scanners for measuring signals in nanoliter volumes in few microliters chambers etc.
Mask Aligner, UV lithography, Stepper Lithography, Top-down nanofabrication technique, Deep-reactive ion etchers (Bosch process), Metal sputtering, automatic thermal dry/wet oxidation furnace for Si-wafers etc. Imaging of fabricated nano structures by FE-SEM, HR-TEM and HRTEM-EDS.

3. **Software skills gained**: Adobe Photoshop, Adobe illustrator, Microsoft Office, Corel video Studio Pro, Chem Draw, Accelrys Draw, GIMP, Sigma-Plot, Image J, Zeta Sizer, MEMS Pro L-Edit program etc.

4. **Language proficiency**: English-fluent; Japanese-fluent (communication); Indian languages-few (fluency)

Summary of research contributions

Research carried out at AIST Kyushu (June 2014-December 2016)

1. Droplet-based microreactor system for an efficient recovery of precious metal ions with Calix[4]arene derivatives from a real metal waste

Precious metals are of important rare metals for advanced materials. The supply, however, has been inconsistent due to its poor natural abundance and geopolitical situations. Recycling from spent home appliances, i.e. urban mine is complicated as it contains several other metals. Therefore, a technique that enables recovery metal ion selectivity is required. Calix[4]arenes are phenolic oligomers, which has the ability to discriminate metal ions making them suitable as specific receptors. However, the slow extraction rate has to be resolved by using calix[4]arene solvent extraction. We proposed a droplet-microfluidc reactor with larger surface/interface area per unit volume than the conventional macroscale system. In this study, we investigated the potential of droplet-based reactors for the recovery of silver and palladium from aqueous solution as well as extracted from commercial metal waste. We fabricated a microreactor (0.2×0.2 mm^2) by micromachining process for a droplet-based recovery. $AgNO_3$ and $Pd(NO_3)_2$ dissolved to a desired conc. in 0.1M HNO_3 as aqueous solution, while the organic solution is prepared by dissolving methylketonic, quinolone, pyridyl calix[4]arene derivatives in chloroform. We evaluated the extraction percentage of metal ions by ICP-AES from the aqueous phase by varying the extraction time (2-10 s). As a result, the time required to reach equilibrium for Ag ion extraction was 4 s in the droplet-based microreactors, which is over 90% against 72 h in batch method. Methylketonic calixarene is selective for silver, while quinolone, pyridyl types for palladium and platinum, respectively. These results show that increasing liquid-liquid interface per unit volume is effective in the solvent extraction of metal ion with calixarene derivatives.

1b. Droplet microfluidics for mechanism of controlling the crystallization of small molecules or biomolecuels (April 2015-March 2016)

Precisely, we are working on the mechanism of control of the crystallization polymorphism of chemicals including amino acid (L-glutamic acid) and biomolecules such as proteins in the droplet microfluidic devices. Each molecule either chemical or bio has different crystal forms, for example L-glutamic acid has functional alpha (metastable), and stable beta forms. But it is hard to control the functional alpha (metastable) state. Same is with other pharmaceutical or bioactive molecules. In order to unveil the mechanism of crystallization polymorphism, we studied the effect of cooling rates and concentration of L-glutamic acid (supersaturation), and we could able to control the functional alpha (metastable) state crystals of L-Glu in the aqueous droplets containing few sub nanoliter volumes of liquids in the few tens of micrometer channels. Fluorinert from 3M served as an organic phase in the droplets establishment. We also employed the combined DLS/Raman to understand the mechanism of crystallization of L-glutamic acid.

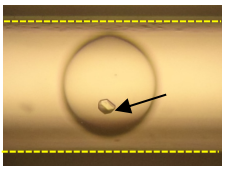

Figure. L-Glu crystal in side droplet

Researches carried out at Biomedical Research Institute, AIST, Tsukuba (April 2011-March 2014)

2. Development of a novel single cell sorting using antibody-immobilized silicon nanoneedle array

Cell sorting is a key step to realize regenerative medicine that utilizing pluripotent stem cells e.g. iPS cells. Flow cytometry is a technique that allows high-throughput cell separation recognizing antigens on the cell surface. However, there are many markers inside the cells to identify a cell type. Utilization of these markers could greatly benefit cell sorting in accurate cell separation. And we motivated to develop a method that sort cells by detecting the intracellular markers using nanoneedle probes. Here, we separate cells by fishing up from adhesion-controlled

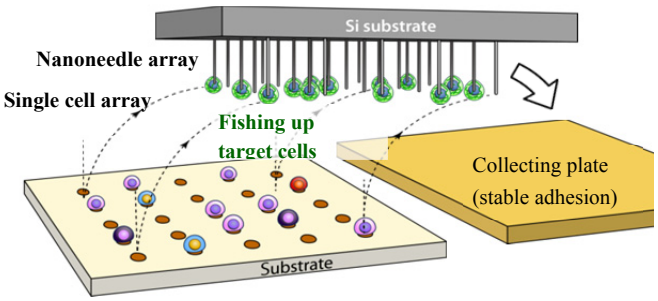

Figure Schematic showing the cell sorting by intracellular protein detection using nanoneedle array.

substrates which tether cells in a cell-type independent manner. To realize high-throughput cell sorting, we fabricated high-aspect-ratio silicon nanoneedle array (200 nm diameters, over 20 μm lengths), in which 10,000 nanoneedles aligned on a 5 mm square Si-chip, by harnessing MEMS technology. To achieve one-to-one contact of the cells and nanoneedles, the cell array was prepared by microcontact printing, in which cells were tethered to patterned spots of adhesive (Biocompatible anchor for membrane, BAM) that anchors the lipid bilayer of cell plasma membranes. By tuning the adhesion force of the cell arrays [P19 (nestin +ve) and NIH 3T3 cells (nestin –ve)] against the affinity of antibody-immobilized (anti-nestin) nanoneedles on the array, cell separation was realized. As a result, 60% of the target cells (P19 cells, nestin +ve) were selected from a heterogeneous population of P19 and NIH 3T3 cell array. Thus, successful cell separation by the nanoneedle array was achieved. Further, we employed this method in selection of successful separation of neural progenitor cells prepared from mouse iPS cells demonstrating clinical sorting application. This technology is of its first kind in the scientific knowledge for selecting cells by targeting intracellular proteins in a naïve cellular state.

2a. Nanoneedle array enables efficient delivery of functional bio-macromolecules into living cells
Furthermore, we employed nanoneedle array device to deliver bio-macromolecule delivery. Nanoneedle array delivery system assured both high efficiency and high-throughput insertion and delivery of plasmid DNAs and Cre recombinase into both cells and nuclei. We attribute these successful results to the unique features of the system, which include the high-aspect ratio and uniformity of the nanoneedles across the array, allowing efficient insertion with controlled active approach. We believe this system could contribute to efficient delivery of various functional biomolecules such as site-specific nucleases for genome editing among other promising applications.

Researches carried out at Osaka University (April 2008-March 2011)

3. Induction of cardiomyogenesis in induced pluripotent stem (iPS) cells by small molecules (April 2008-June 2010)
Differentiation of ES and iPS cell is a complex process which needs physical, chemical or biological clues to get accomplished. The differentiation process starts with the organization of ES/iPS cells into three dimensional aggregates known as embryoid bodies (EB). Subsequent treatments dictate EBs differentiate into different cell lineages which needs to be characterized properly for clinical and research applications. Most of the current researches focused on the development of novel and safer methods to create iPS cells, So far, little progress made on the differentiation of stem cells into specialized cells (heart cell, neuron or blood cell etc.) for cell-based therapies. Differentiation can be induced by the external addition of certain growth factors, mainly transcription factors, proteins or small molecules to undifferentiated cells or EBs into a specific lineage cells. There is a great deal of interest in search of small molecules that induce efficient differentiation of stem cells into specific lineages.

We identified small molecules that induce efficient differentiation of iPS cells into cardiomyocytes compared to cells that did not receive. We have optimized various parameters such as concentration and time of administration of differentiation inducers enabled to achieve over 70% cardiomyocytes differentiation. We confirmed the cardiomyocytes by visual rhythmic beatings and beating functionality was evaluated electrophysiologically using Panasonic MED Probes with agonists and antagonists (drugs) etc. Further, we also confirmed iPS and ES cell cardiomyocytes by measuring the expression of genes and proteins specific to cardiomyocytes by qRT-PCR and immunohistochemistry studies. HR-TEM imaging, furthermore confirmed the presence of myofibrillar protein bundles and gap junctions, as well as other characteristic features of cardiomyocytes derived from the iPS and ES cells.

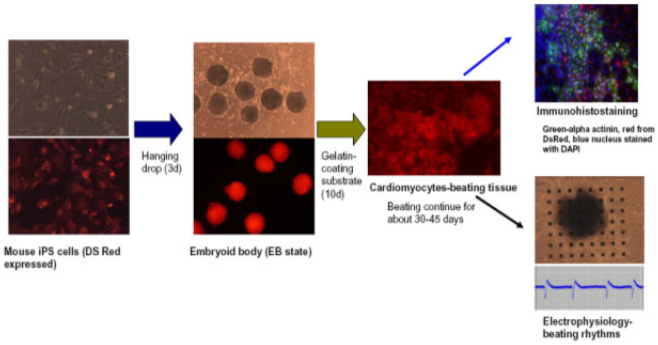

Figure Flow of iPS cell differentiation into cardiomyocytes

4. Nanomaterials interactions with ES cells towards novel opportunities: with reference to carbon nanotubes (CNTs), gold nanoparticles (AuNP) (Jan. 2010-March 2011)

Several approaches towards controlling the epigenetic events for guiding the pluripotent cells into desired lineage have been reported. We believe that nanomaterial interaction with pluripotent cells worth exploring in stem cell research. In this regard functionalized carbon nanotubes (CNTs) worth special attention owing to the exceptional properties they possess– the high-aspect-ratio with a unique mechanical strength which helps CNTs in nano-scale mechanical modification of growth environments, the metal-like conductivity of CNTs makes them favorites for being used in stem cell differentiation studies where electro-active cardiac muscle cells or neuronal cells are the targeted terminal cells.

For modulating cell differentiation, the interaction between mouse ES cells and functionalized multiwalled carbon nanotubes (f-MWCNTs) have been studied by using two different approaches. In the first approach, we used direct interaction of f-MWCNTs from embryoid body formation stage and followed the cytotoxicity, cell proliferation, cell organization and differentiation. We observed strongly beating cardiomyocytes in f-MWCNT exposed cells with traces of neuronal differentiation. In the second approach we created a composite cell culture substrate by dispersing f-MWCNT homogeneously with gelatin and we observed the state of differentiation on this substrate. We found the f-MWCNT-substrate biocompatible and it promoted concurrent differentiation of mES cells into electro-active cardiac muscle cells and neuronal cells. Further, we extended studies using AuNPs favored the cell proliferation and promoted the cardiomyogenesis in murine ES cells compared to control, in addition to facilitate prolonged duration of beatings of cardiomyocytes compared to control cultures.

5. Non-invasive molecular probing of embryonic stem cell differentiation using gold nanoparticle based surface-enhanced Raman scattering (SERS) (October 2009-Sept. 2010)

This study reports the use of gold nanoparticle-based surface-enhanced Raman scattering (SERS) for probing the differentiation of mES cells, including undifferentiated single cells, embryoid bodies (EBs), and terminally differentiated cardiomyocytes. Gold nanoparticles (GNPs) were successfully delivered into all 3 mES cell differentiation stages without affecting cell viability or proliferation. TEM confirmed the localization of GNPs inside the following cell organelles: mitochondria, secondary lysosome, and endoplasmic reticulum. Using bright- and dark-field imaging, the bright scattering of GNPs and nanoaggregates in all 3 ES cell differentiation stages could be visualized. EB (an early differentiation stage) and terminally differentiated cardiomyocytes both showed SERS peaks specific in metabolic activity in the mitochondria and to protein translation (amide I, amide II, and amide III peaks). These peaks have been rarely identified in undifferentiated single ES cells. Spatiotemporal changes observed in the SERS spectra from terminally differentiated cardiomyocyte tissues revealed local and dynamic molecular interactions as well as transformations during ES cell differentiation.

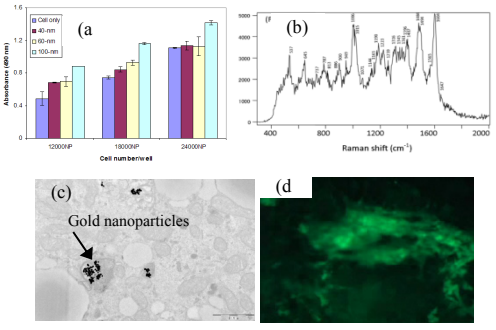

Figure SERS-based molecular probing of cardiomyocyte differentiation, gold nanoparticle cytotoxicty on mES cells (A), SERS spectrum derived from cardiomyocytes (B), TEM image showing GNP accumulation in ES cells (C), and fluorescence image of matured cardiomyocyte tissue derived from ES cells in the presence of GNP (D).

Researches carried out at JAIST under Toyama Medical Bio-cluster project (June 2003-March 2008)

6. Single-cell picoliter compartmental microfluidic device for high-throughput screening and analysis of antigen-specific cells in disease diagnosis (June 2003-March 2008)

Most of the current clinical diagnosis is based on analysis of large cell populations, which provide averaged information on the diseased state. In addition, many diseases like cancer start with a single or small number of mutated cells that herald the inception of a disease; then cells must be examined individually. Though flow cytometry has been known for its efficient cell sorting, they lack analysis of the same cell before and after stimulation. In addition, they cannot detect unhealthy cells that are present at 0.1% of the total cell population. This prompted us to develop a chip devices that can screen low frequency, number of cells, therefore, we have constructed a PDMS (polydimethyl siloxane) microfluidic device using soft lithography, which combined with two-phase liquids capable of generating picoliter compartments of oil and aqueous liquids alternately, continuously in a fast flowing single microchannel, which suits sorting and analysis of single-cells from bulk suspensions before and after stimulation with an antigen of a choice. The detection of a positive cell is based on increased intrinsic calcium levels after stimulation with an antigen.

PDMS microfluidic chip devices with Y-shaped microchannel established high-throughput compart-mentalization of two-phase liquids under pressure-driven microsyringe pump. Characterization of compartmental microfluidics revealed these devices generate over 30 compartments per sec with a size of 70 pL volumes as tiniest reactors, which are highly suitable for single molecule and single-cell assays. In addition, this chip system has the ability of sorting up to ~13 cells per sec demonstrate its high-throughput characteristic (Fig. 2). Further, we have built the on-chip cell stimulation device enabled us to perform on-chip high-sensitive β-galactosidase assay, single cell lysis, and screening of a positive B-cell specific to Anti-mouse IgM as antigen before and after stimulation in the picoliter aqueous compartments and identified the positive B-cells with 10 times as active.

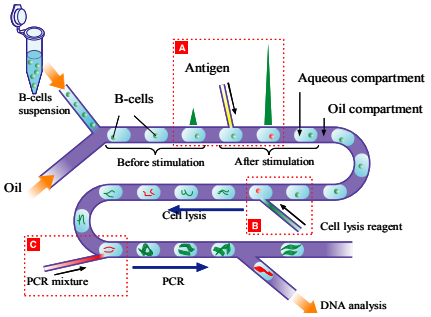

Figure Schematic of compartmental microfluidic devices for single-cell encapsulation, screening, analysis of active cell against a stimulant, (b) single cell lysis, (c) PCR and retrieval of antibody DNA of positive cell from a specific compartment.

7. Single-cell microarray for high-throughput analysis of antigen-specific B-cells (June 2003-March 2008)

The analysis of antigen-specific single B-cells from a bulk cell suspension contribute to the development of highly specific monoclonal antibody. In this research, we have developed a novel high-throughput screening and analysis system for single-cell on the microarray. The single-cell microarray chip is made from polystyrene with over 200,000 microchambers, which can accommodate only single-cells. Lymphocytes derived from mouse spleen or human blood were spread on the microarray, and over 80% of the microchambers achieved single-cell status. Only 0.4% of the total B-cells population showed over ten time's higher activity after stimulation with antigen, anti-mouse IgM antibody. In addition, this novel method demonstrated retrieval of positive single B-cells from microchambers by a micromanipulator and achieved antibody DNA analysis. This high-throughput single-cell microarray system is capable of analyzing antigen-specific single B-cells before and after stimulation with antigen for developing highly specific monoclonal antibody as antibody medicine.

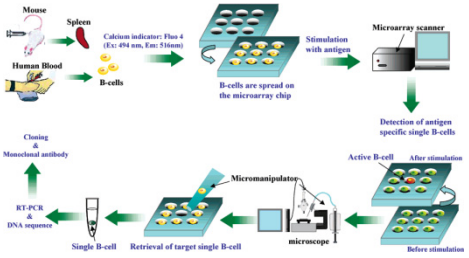

Figure Schematic illustration of single-cell microarray system for screening of antigen-specific single cells.

Researches carried out at JAIST under JSPS Program

8. High-throughput screening of small molecules using silicon-based microchamber array chips with nano-liter volumes (April 2002-April 2003)

A simple and high-throughput method to screen and determine the cytotoxic effects of carotenoids and bacterial derived carotenoids as small molecules against human cervical cancer cells-HeLa 229, using a silicon microchamber array accommodating nanoliter volumes was developed. Screening and cytotoxic

effects of carotenoids and bacteria derived carotenoids was measured quantitatively by using a fluorescent based cell proliferation assay. First, we fabricated a silicon microchamber array chip (1 in. ×3 in.) with 1248 microchambers (24×52 pattern). Each chamber with parallelepiped, accommodating 50 nL of reaction volumes. We robotically dispensed twenty nanoliters of HeLa 229 suspension followed by 20 nL of carotenoids or chemicals to be screened and incubation was performed at 37°C for overnight. The cytotoxic activity of carotenoids was monitored by a fluorogenic substrate-Calcein-AM and scanning of the chamber array was carried out by a CRBIO IIe microarray scanner and determined the anticancer activity which was expressed as a percentage of cell death. The newly developed high-throughput screening using the nanoliter chamber array platform is cost-effective in screening drugs with anticancer activities.

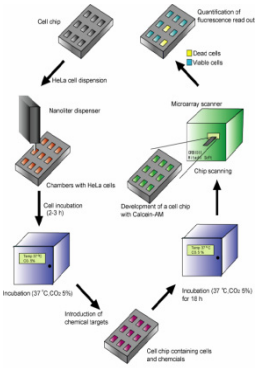

Figure Nanoliter microchamber array for high-throughput screening of drugs

9. Combinatorial peptide beads array combined with PC12 cell chip for screening of novel neurotrophic factors (April 2001-August 2003)

This study describes high-throughput screening assay for novel neurotrophic factors using microarray based cell-chip and the response of newly screened neurotrophic factor on the PC12 neurosignaling pathway. High-throughput cell-based drug screening employing microarray based chip formats play a key role in the development of novel and potential therapeutics at much faster pace with a reduction in the cost of drug discovery as it needs tiny volumes of samples. There have been reports on the use of nerve growth factor (NGF) in the prevention of the neurodegenerative disease–Alzheimer's disease in mice, rats and large primates. The difficulties in NGF crossing the blood-brain barrier prompted us to screen novel neurotrophic factors, by adapting combination of microarray based chips and combinatorial chemistry based peptide library synthesized on beads.

The cell chip used in this study is made from Si wafer. Si-chip with tiny chambers (24 ×52) made by photolithography and chemical etching. Each chamber was about 500 × 500 × 200 μm dimensions. Peptide library X-X-X-X-X (X: Ile, Leu, Met, Phe, Val) was prepared by split synthesis to yield one-bead with one kind of peptide library format. The beads peptide library was added onto the Si chip chambers. The Si chip encased with beads peptides placed on the glass slide treated of PC12 cells. The Whole setup was transferred into a Petri dish containing RPMI 1640 medium and incubated 3 d in a humidified chamber at 37°C. During incubation, communication develops between PC12 cells and peptide on beads. Microchamber array allowed peptide-beads to confine in the microchambers that enabled PC12 cells on the functioned glass slide to interact with the peptide-beads resulted in neurite outgrowths of PC12 cells, which observed microscopically on a bead surface. Then those beads were separated by micromanipulator and determined the peptide sequence. Induction of neurite growths in PC12 cells was confirmed by the addition of screened peptide. Further, neurosignaling pathway of newly screened peptide treatment in PC12 cells through the activations of TrkA-ERK cascade. The Microchamber array platform is ideal for cell-based screenings of one-bead, one-compound libraries to identify peptide-ligands based on affinities with cells. Other advantages include assay miniaturization, high-throughput, ease-of-use, and label-free identification promises our screening system widely accepted platform for various bio-chemical screenings.

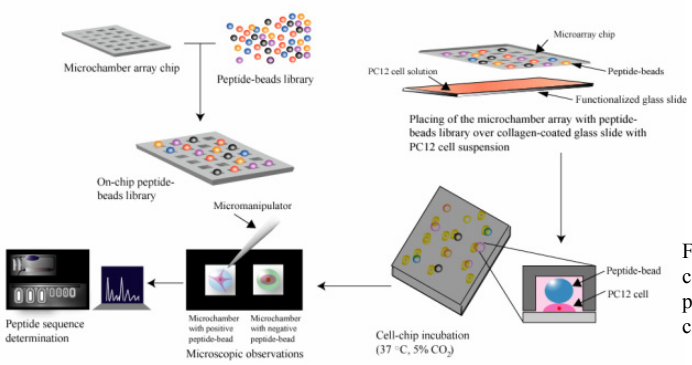

Figure Microchamber array based screening of combinatorial peptide libraries to identify a peptide that induce neurite outgrowths of PC12 cells

10. Induction of neuronal differentiation in P19 mouse embryonic cancer stem cells by small molecules (April 2002-March 2003)

P19 cells are pluripotent embryonic carcinoma cell lines from an embryo-derived teratocarcinoma in mice. P19 cells have the ability to differentiate into all types of cell lineages-neurons, cardiomyocytes, or blood cells, etc. under specific stimulation We report *for the first time* that chemicals belong to carotenoids, favored induction of mouse embryonic carcinoma P19 cell differentiation into neuronal cells. The long neurites emerging from both sides of the neuronal cell body was observed after 6 days in cultures treated with at 1μM concentration. The morphological observations– size & shape of the nucleus and length of neurites of neuronal cells derived from carotenoids induction were comparable to that of all-trans retinoic acid, known to induce P19 cell differentiation into neurons. The confirmation of carotenoids induced neuronal cells by *immunostaining* studies with a mouse anti-neuronal nuclei (NeuN) antibody for the nucleus of neurons, and neurofilaments using mouse anti-neurofilament160 clone NN18 antibodies. The results suggest carotenoid treatments induced P19 cell differentiation into neuronal cells.

11. Light acting as a switch in channeling carotenoids to lutein biosynthesis (April 2001-Dec. 2002)

Bio-functional carotenoid- *lutein*, a xanthophyll, producing non-photosynthetic bacterium-*Stenotrophomonas* sp. strain D-1 was isolated. Further, this strain produces other carotenoids such as astaxanthin, canthaxanthin, β-Cryptoxanthin and β-carotene, which was identified by HPLC and MS analysis. It was the first report that bacteria accumulating lutein as a main carotenoid (Japan patent). We found light acting as a signal in increasing lutein (bio-gold) yields by 10 folds when exposed the D-1 suspension cultures to light irradiation. Further, we found a blue light (400-500 nm) and red light (600-750 nm) exposures favor further accumulation of lutein by channeling other carotenoids- β-cryptoxanthin and β-carotene into lutein biosynthetic pathways in *Stenotrophomonas* D-1 cultures, was confirmed by HPLC analysis. *The process for the bio-gold-lutein was patented.* In addition, carotenoid mix from the bacterium showed cytotoxic effects against HeLa 229 cells as well as DDPH radical scavenging activity, and DNA strand cleavage by exposure to hydroxy free radicals protected.

12. Bio-catalytic mechanism of benzo[a]pyrene biodegradation by *Paenibacillus* sp. B2-1 (April 2000-March 2003)

A novel polycyclic aromatic hydrocarbon (PAH) degrading bacterium-*Paenibacillus* sp. B2-1 strain was isolated from natural oil producing wells, Japan. This strain grows solely on benzo (a) pyrene [B (a) P] as a carbon source and showed degradation of PAHs with 2 to 4 benzene rings (naphthalene, anthracene, Pyrenees) as well as complex PAH -benzo (a) pyrene with 5 benzene rings. *This bacterium was patented for smart bioremediation of complex PAH's.* B(a)P is known for its highly toxic, carcinogenic and endocrine disrupting properties. It is an environmental recalcitrant to degrade by indigenous microflora. Strategies were developed to enhance B (a) P biodegradation by cylcodextrin (α, β and γ) complexation, employment of non-ionic surfactants allowed by (a) P to dissolve easily lead to increasing its availability to the bacterial cultures that resulted in 3 fold increase in its degradation compared to its counterparts 20%. Further, immobilization of *Paenibacillus* bacterium in a calcium alginate matrix favored 80-90% of B(a)P degradation.

B(a)P degradation enzyme was identified in the cell extracts of *Paenibacillus* sp. B2-1 suggests its intracellular nature. Cell extracts, as a bio-catalyst, when treated with B(a)P yields two known metabolites such as B(a)P *trans*-9,10-dihydrodiol and B(a)P *cis*-4,5-dihydrodiol as intermediates indicate the presence of both monooxygenase and dioxygenase type enzymes. Further, the enzyme responsible for B(a)P degradation was purified and characterized. SDS-PAGE and Gel-filtration determined as 440 kDa suggests this enzyme made up of multi-submits. HPLC analysis of purified benzo(a)pyrene degrading enzyme B(a)P metabolism revealed B(a)P *cis*-7,8-dihydrodiol is the only known intermediate of B(a)P metabolism suggest the benzo(a)pyrene degrading enzyme may belongs to benzo(a)pryene 7,8-dioxygenase type.

13. Summary of Ph.D. Thesis (Sept. 1992-May 1998, CFTRI, Mysore, India)
Title of Ph.D. thesis: **"Studies on biotransformation to produce phytochemicals of importance using plant cell cultures" (Research advisor: Prof. Dr. G.A. Ravishankar)**

Plant cell cultures offers a valuable source of high value secondary metabolites that are indispensable in pharmaceutical, flavor, fragrance, food and chemical industries. The production of these compounds from plant cell cultures is in very low amounts and demand for natural compounds urged alternative means of production.

This research has been conducted to explore biotransformation capabilities of cell cultures - *Capsicum frutescens* and microalga *Spirulina platensis* for the production of high value metabolites. They performed mainly oxidation, hydroxylation, methylation, demethylation and glucosylation reactions. Cell and immobilized cultures of *C. frutescens* and *S. platensis* biotransformed externally fed phenylpropanoid compounds.

Biotransformation of phenylpropanoid compounds- protocatechuic aldehyde, caffeic acid, Ferulic acid, coniferyl aldehyde, vanillylamine to vanilla flavor compounds was established, which lead to the proposal of the biosynthetic pathway of vanilla flavor metabolites from various phenylpropanoid precursors in *Capsicum frutescens* and *Spirulina platensis* cell and immobilized cultures. Clove principles such as isoeugenol and eugenol were also bioconverted to vanilla flavor components in the above mentioned cell cultures. These studies lead to the development of an alternative route for the production of high cost vanilla flavor. Other studies include the use of disulfide reagents, elicitors of fungal origin, adsorbents and β-cyclodextrin, which enhanced the accumulation of vanilla flavor metabolites several folds in plant as well as microalgal systems. Selective adsorption of vanilla flavor metabolites was achieved by the addition of amberlite XAD-4 and XAD-7 adsorbents. It was found that vanillin yields are increased in case of XAD-4, while XAD-7 was suitable for p-hydroxybenzoic acid. This approach not only suggests overcoming the feedback inhibition and also demonstrates a selective metabolite increase was possible. In addition, Immobilized *Capsicum* cells showed biotransformation of digitoxin to digoxin and purpureaglycoside A, cardiac glycosides The enzymes responsible for the biotransformation of phenylpropanoids such as CAOMT and PAL enzyme activities were enhanced several folds in cultures treated with precursor in the presence of elicitors and S-adinosyl L-methionine. Biotransformation of phenylpropanoid substrates (Ferulic acid, coniferyl aldehyde, and vanillylamine), clove principles- isoeugenol and eugenol was biotransformed to range of vanilla flavor metabolites in freely suspended and immobilized cell cultures of *Spirulina platensis*. It was found that biosynthetic pathway was similar to that of *capsicum* culture.

DECLARATION

I hereby declare that the above written particulars are true to the best of my knowledge and belief.

Place: New Delhi (SATHULURI RAMACHANDRA RAO)
Date: 1 March 2018