

Curious people

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Curious researcher in biomedicine



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Sudha grew up in India, but now works in Singapore. He has had an insatiable curiosity, and passion for science, since he was a small boy.

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How did you discover that you were a scientist, engineer or mathematician?

Ten key questions

1. What made you curious when you were young, and did you have any heroes who influenced you? For example, is there a person, place, event or moment that influenced or changed your way of thinking?

Scientists are my heroes, and fireflies have influenced my life and my career path. As a growing child, I grew up amongst nature, a lovely environment where interaction with nature was daily part of my life. When I was in primary school, I used to visit our agricultural field, where we had a banana plantation, coconut, and paddy. During one such visit, I went with my mum to my grandma's place. Due to the lack of public transport, it involved a lot of walking. Since, there were no fixed paths, and they were quite forested, we occasionally heard small animals and birds in the background while walking. On that day during dusk, I saw tiny lights sparkling around the bushes, which started to fly towards us. I was fascinated, as that was my first encounter with such a thing. It was intriguing to watch the light flutter, and generated curiosity within me. I immediately asked my mum. She replied, they are 'min-mini' (the Tamil name of 'Firefly'), the meaning of the Tamil name is 'glittering' in my native language. This incident was stuck in my sub-conscious mind and followed the rest of my life.

2. When and why did you decide to choose science/maths/engineering as a career, particularly what or who inspired you? Did you have any family connections to STEM careers?

My father was a school teacher, and both my brothers are masters in biology in their respective specialisations. I was interested in learning Chemistry for my undergraduate studies, as I was heavily influenced by my high school chemistry teacher. He used to explain the principles through examples around us. His teaching was very unique to me.

3. Where did you grow up, and what was your educational path?

I grew up in small town of the southern tip of Indian sub-continent, Kanyakumari. I completed my schooling and undergraduate studies in my native place, and then moved to neighbouring state capital Kerala for my masters in Analytical Chemistry, where I learned more about how Chemistry was applied for the analysis of drugs to food materials. This was an important period of my life, as I had transitioned into a city lifestyle.

4. How has your career developed after university, and how was it funded?

After completing my masters, I moved to a different city called Hyderabad for my first job. I joined India's prestigious Bhabha Atomic Research Centre's (BARC) regional research laboratory, which was based in another central elite research institute in India for Biology, called Centre for Cellular and Molecular biology (CCMB). This environment gave me the complete exposure to science and research. While working in BARC, I registered for my PhD with Professor A. RamReddy, in the Chemistry department at the nearby Osmania University. All my research was funded by the research institutes, and both were the most prestigious research institutes in India, for which I'm forever grateful.

5. Have you had any break-through moments in your research, if so what were they and how did they affect your development?

By now research had become my daily routine. The firefly had once again returned to my life, as in the name of the laboratory where I worked. It was called 'JONAKI' meaning 'Firefly' in one of the regional languages (Bengali) in India. Part of my work was estimating the specific activity of ³²P (radioactive) labelled ATP nucleotide using firefly luciferin-luciferase kit. The radioactive labelled nucleotides were synthesized in our laboratory, hence the laboratory was named after 'Firefly'. Further, I extended this method to estimate other nucleotides, after doing some research in the laboratory, as we had the ATP kits available.

By Mike Lewinski from Tres Piedras, NM, United States (Lupines and Fireflies No. 3) (<http://creativecommons.org/licenses/by/2.0/>), via Wikimedia Commons

During this period, I visited the library after my office hours to read newly arrived journals on a daily basis, and borrow books of my interest. One day, while doing so, I noticed on a bookshelf the cover of a book which had firefly images. The book was written by Professor Anthony Campbell and was entitled 'Chemiluminescence: Principles and Applications in Biology and Medicine'. I would say this was the break-through moment in my research life, as I had been fascinated by fireflies since my school days. I borrowed this book, and read it completely. The book generated more and more curiosity within me on understanding further about bioluminescent species. The book increased my quest for knowledge in this field, and I wanted to register for a PhD with the international Bioluminescence expert Professor Anthony Campbell. At the same time, I was bit reluctant to leave my current job, as it was permanent. So, I delayed my dream to work with Professor Campbell until I began my postdoctoral studies. Then I was looking for a supervisor, who has interest in firefly bioluminescence in India. Fortunately, I found Professor A. RamReddy, who had agreed to take me on for PhD registration in his group. My thesis was the first PhD on Bioluminescence field in India on the biochemical aspects. My thesis was never returned back to University by the thesis examiners, as it was the first in the field there. My thesis was titled 'Bioluminescence studies of few Biomolecules'. After this Professor A. RamReddy also included chemiluminescence in the undergraduate curriculum of Osmania University.

6. What do you regard as your most important discoveries and inventions, and why?

I would rate my first research publication is very important to me, as it opened up a new area of research showing 'Firefly luciferase was acting as a mu-opioid receptor model', since firefly luciferase was having interaction with analgesics. This work was published in the 'Biochemistry' journal of American Chemical Society.

7. Can you think of anything that could have done better, and do you have any regrets?

In science there will be always ups and downs, and we have to learn to cope up with these, whatever hard work we do. Ultimately this is measured by output in the form of publications, and products or patents, especially in recent times. This kind of expectation will be in a different form for other

disciplines. I could have done chemical engineering instead of science. But I am sure, I would have lost interest in that after sometime, as my curiosity was always pushing me to know new things in life. I am happy to be in science, as it is my passion and I am doing what I most like to do. Most importantly, this passion gives me new information in my every day life without repeating the already known facts. I can say I have no regrets in continuing my passion of science.

8. What other stories do you have about your curious life, including any entrepreneurial and commercial activities, and your other interests?

From childhood I was interested in gardening, I did lot of gardening work at home back then. I am still keen to develop some technology based on bioluminescence, so that it becomes part of life. Though currently I do more applied work on fluorescent proteins and microscopy. As part of my passion, I did my Post-doctoral work at Professor Campbell's lab at Heath Park, Cardiff, UK. There I was involved in the development of 'Rainbow Proteins', which gave me a chance to work with many bioluminescent and fluorescent proteins. During my stay at Cardiff, Professor Campbell arranged one night for glow-worm hunting along with school kids, which gave a chance for my kids also to take part in curiosity developments. In fact, upon my return back to India from Cardiff, I arranged many such trips on the outskirts of the city where I lived, to collect fireflies, which resulted in first publication of 'Indian firefly luciferase' extraction. Even today the fireflies we collected are still stored in -80°C freezer.

9. List six key publications (not necessarily yours), and explain why you have chosen them?

1. Muthukumar, T., KrishnaMurthy, N.V., Sivaprasad, N. and Sudhaharan, Thankiah 2013. Isolation and characterization of luciferase from Indian firefly, *Luciola praeusta*; Luminescence January 31.
2. Sudhaharan, Thankiah & Reddy, A Ram 1999. A bifunctional luminogenic substrate for two luminescent enzymes: Firefly luciferase and horseradish peroxidase. Anal. Biochem. 271, 159-167
3. Sudhaharan, Thankiah & Ram Reddy, A. 1998. Opiate analgesics dual role in firefly luciferase activity. Biochemistry 37, 4451- 4458.

4. Waud, J.P., Bemudez-Fajardo, A., Sudhaharan, Thankiah, Trimby, A.R., Jeffery, J., Jones, A. & Campbell, A.K. 2001. Measurement of proteases using chemiluminescence resonance energy transfer (CRET): Chimeras between GFP and aequorin. Biochem J. 357, 687-697.
5. Sudhaharan, Thankiah & Ram Reddy, Annadi 2002. A chapter titled 'Assay of diversified niomolecules with a luminogenic conjugate substrate: 5-(5'azoluciferinyl)-2,3-dihydro-1,4-phthalazinedione', Chapter 8, in the book entitled 'Luminescence biotechnology: instruments and applications', edited by Knox Van Dyke, Christopher Van Dyke and Karen Woodfork, CRC Press, USA.
6. Liu, P.*, Sudhaharan, Thankiah*, Koh, R.M.L., Hwang, L.C., Ahmed, S., Maruyama, I.N., & Wohland, T. 2007. Investigation of the dimerization of proteins from the epidermal growth factor receptor family by single wavelength fluorescence cross-correlation spectroscopy. Biophys J. 93, 684-98.

I have chosen a few of my publications though all are my favourite ones. The first one is the publication of my early years curiosity, and the rest are testing new ideas.

10. What advice would you give a curious young mind? Imagine your ten year old self, if you started again! Is there a big unanswered question today?

I strongly believe nature has many unexplored things in it. Curiosity is the one thing driving today's world. We should know how to ask the right question, and that knowledge can be applied to other things. One simple example is the jelly-fish which has one fluorescent protein and one chemiluminescent protein. As long both are together, its emission is in longer wavelength. But, if we remove the fluorescent protein, GFP, then the emission shifts to a shorter wavelength. That means there is kind of resonance energy transfer happening, meaning the chemiluminescent protein is giving its energy to fluorescent protein, GFP, in jelly-fish. After understanding this principle, scientists have started to apply this principle to many cell biology applications. Given a chance with funding support, I would spend my life investigating the origin of bioluminescent species. Though such investigation is going on, I think it is still inconclusive, and has more potential to explore.