AN INTERVIEW WITH DR. SATISH KHURANA

This article in an interview with Dr. Satish Khurana, who is currently working as a Research Associate at University of Leuven, Belgium. His research interests include exploring intrinsic and extrinsic (HSC "niche") factors regulating hematopoietic stem cell (HSCs) function, HSC homing, proliferation and ageing. Before this, Dr. Khurana was completing his doctoral work, also on HSC's, from the National Institute of Immunology, New Delhi, India.

1. What sparked off your interest in science?

In many cases, it is hard to pick an event that moulds one's interest. I am not sure if I can put my finger on any event that happened in my life and made me interested in science. Actually, when I think of it, many events were contrary to it and threatened my stay in academics. Sometimes you are born with an interest or a bent of mind or a nature for which some things suit you and others don't. Science suits me and I just hope that I am suitable to do it. I was always interested in watching and observing things happen. When you think about it, stuff as simple as boiling and frying and floating and sinking, all involve science. If you try to understand why and how these happen, you are interested in science. I think interests are very natural and personal "fires", which burn without spark.

2. Could you tell us a couple of things that your school did that got you interested in science?

In my view, schools need to do a lot more to let students follow their own path. More often than not, teachers are not actually aware of the career (or even non-career) paths that can be taken in order to follow your interests or dreams. First, it is very important to have a curiculum to encourage independent thinking. Second, teachers have the responsibility to guide their students towards their goal. A huge proportion of Indian students might not have access to well trained teachers, who at best can guide them to conventional ways of earning livelihood. Although, research is more conventional than it used to be, students are still not really enthusiatic about it or aware of that path.

3. Tell us something about what you are working on currently.

I have been interested in Stem Cells (Stem cells are undifferentiated biological cells that can differentiate into specialized cells) and I started my PhD in order to understand how they function. My early days in research dealt with the problem of liver repair and the role of hematopoietic stem cells (HSCs; the cells that make blood cells, and live in the marrow of the bones) in this process. They are the best-known stem cells and have been in clinical use for a very long time now. By the end of my PhD, I developed interests in several related questions, the answers to which could be important in making better use of these stem cells in clinical practice. For instance, cord blood is a waste product when a child is born and it contains HSCs, which can be transplanted for the treatment of several diseases. But, HSCs in cord blood are few and their overall function is delayed as compared with the normal bone marrow HSCs. I am interested in making the cord blood derived HSCs better suited for clinical transplantations. So, that's the target, and we are trying to achieve that by studying the factors that help in the development of blood system during fetal life, using small animal models.

Another important alternative source of HSCs could be the use of embryonic stem cells (ESCs), the cells, which can make any type of cell that you find in a human body. But, the HSCs derived from ESCs are not fully functional. For the derivation of HSCs from ESCs, we need to follow the pathways taken during fetal development. Therefore, the studies on fetal development can give important insights to this process as well.

4. What experiences have shaped the choice and nature of your current work?

I did my Masters from the Department of Botany in Delhi University. I enjoyed the old-style science taught there. And I have to say that it is an inspiring place because of the great science done by several generations of scientists in the past. I chose plant tissue culture as my special paper and working in that field made me curious about the potential of animal cells to repair tissue damage. You know that animal organs have limited potential to regenerate unlike plants. I started my PhD in 2003 and the stem cells field moved so fast that in 2006 Shinya Yamanaka and colleagues published ground-breaking research showing that all cells in our body could be made pluripotent and can generate any kind of cell type. For instance, you cannot make a liver cell from a skin cell. But, if you take the skin cell and induce it to become an ESC like cell (called as induced pluripotent cell or "iPSC") by forcing it to revert to an earlier stage in its development, you can generate any kind of cell. So, theoretically and for most practical purposes, you can take any cell from the body and generate any other cell type. If you have a disease related to liver cells, theoretically, you could take any other normal cell of the body and generate normal liver cells.

5. What is a typical day at work for you like?

For a researcher a typical day depends upon what stage of career you are at. For almost a decade of your initial research life, you are mostly in lab doing experiments. For me, life is changing now and I believe that I am going through a transition phase where I want to design new experiments and scientific projects rather than spending all my time in performing experiments that answer one question. In our field you need to perform so many experiments to prove a point. So, basically even if you know where your experiments are taking you, you will have to spend a lot of time in finishing the project. And I am at a stage where I have more questions that I can answer on my own so I look to make my own team and have a lab that can work on those questions. I am trying to spend less time on the bench and more time in learning how to write projects, arrange for funding, publishing my research to share with my peers. But, this is not always possible as I am still not a fully independent scientist. My work load on many days becomes very heavy with all the different things I would like to accomplish. So I would just say that balancing experiments with strategizing your future scientific life needs a lot of focus and many hours of work.

6. What are the positives of being a research scientist in biology?

I have no idea about that. The most important thing is that I should be satisfied by my work. It is extremely hard for me to think of any other field of work that can satisfy me other than what I am doing right now. There cannot be any bigger positive than this.

7. Are there some character traits that are a natural fit for scientific research? What would these be?

I believe that observation, curiosity and a quest for knowledge are required. And then, you need perseverance in this field. Scientists, as you know them today, were not like this always. Many of them were ordinary people who were just curious, liked to observe, and wanted to know. My favorite scientist - Gregor Mendel, the father of genetics, was a monk and what he could do with simple observations and meticulous recording was incredible. Similarly, Antonie van Leeuwenhoek was a draper, and today, we know him as the father of microbiology. He used hand-made microscopes to observe and know what we couldn't even see at that time with naked eyes. Therefore, there has to be something in you that makes you choose to be a scientist.

8. What are the most frustrating aspects of being a research scientist?

Scientific work needs a lot of experimentation on your working hypothesis on the problem that you work with. Biological systems are very smart and not easy to decode. Therefore, work hypotheses fail more ofte than you would imagine. This is the most frustrating part of the work. About the life of a research scientist, the most common answer is that it takes a lot of time and you get very little financially. If you are very lucky and perform really well starting from your school, you get a job when you are around 35. And as compared with high performing individuals in other professions you get very little money so it can be discouraging for many. Both these factors are understandable but many will not have much of a problem with this.

There is one thing that is very frustrating for me, and that is, how you judge a scientist. What I mean by this is: how do you determine that your science is better than mine. The criteria of judging science can be very subjective, and objective criteria are very tricky. This can make your life, as a scientist, difficult.

9. Has your choice of profession shaped the person you are? If yes, in what way?

Research is one of those professions that in most cases, will bring changes to one at a personal level. You have to learn how to focus, how to let go of certain things at a certain time. Resources available for research are limited, especially in developing countries, so you tend to learn how to manage things well.

You get to train young researchers, who are not really very young. This can bring a lot of contradictions at the work place as it is very difficult for people to change after a certain age. And, in most places, researchers at different levels are colleagues and sense of seniority is lesser, so you may need to mend your ways in order to keep any personal feelings that contradict this in check.

10. For someone finishing higher secondary school, what is the typical course of higher education to be pursued to become a researcher in biology?

Becoming a researcher in Biology is a long process. After a higher secondary school education, you enrol in a bachelors' programme, followed by Masters, and then look for PhD positions in various research institutions or Universities. Getting a position or a fellowship can be difficult. Also, your specific interests can limit the choice of laboratories where you can go. With a PhD position, doors open for full time research. Industrial research can be taken up after Masters but for academic research you need a PhD, which certifies that you are an expert in the field. A PhD might make things easier in some ways, but even this does not ensure a smooth path. There are limited positions in most academic institutions, and you have to constantly prove your credentials as an independent researcher.

11. Can someone WITHOUT an undergraduate background in biology pursue higher studies in embryology or stem cell research?

It can be done, provided you spend some time in understanding the basics of this science. Without a background in biology, most research institutions may not be open to giving you a research position. Some places have biology-based entrance tests, which can be tricky for someone with no background in the subject. But it's not the same with all of them. To me, the most important thing would be that the candidate should know why he/she is taking up that course. Biological systems also work on the principles of physics and chemistry so there is scope to understand embryonic stem cells, for example, in a different light. For instance, in a recent project, we are trying to understand how the mechanical properties of the local microenvironment could change the functions of stem cells. In this project, we are collaboratng with other laboratories and trying to learn from each other. Similarly, research groups in biology can consist largely of biologists or bio-engineers, but also need experts in mathematical and computational modeling.

12. Can you recommend a few books written at the popular level, which explain the basics of (a) stem cell research and (b) embryology, and are accessible to school/ college students?

There are several good books on both these topics. For stem cells, Harvard Stem Cell Institute launched an online stem book (http://www.stembook.org). This is a nice resource. Langman's embryology is a good book for basic developmental biology. Unfortunately, most of the books on stem cells and developmental biology are pitched at a level, where readers will need some basic biology background.

13. What are some of the research institutes in biology, in India, that schools can visit? (that welcome visits from school children).

I am sure most of research institutes will be happy to host school children. It is certainly a good idea as children will get first-hand experience in how research labs work. Among some of these places, my alma mater, the National Institute of Immunology in New Delhi will definitely be one. The IITs and the new IISERs will be great too.

I think scientists have to visit schools too, in addition to schools visiting laboratories. This will be more economical. Not very many schools can afford to take their students to research institutes, which are mostly in big cities. If every scientist in India starts giving one day per year to schools, I think it would be a good start.

14. What is embryonic stem cell research and why is the ethics of this research often a topic of debate?

Belief and reasoning can clash at times. To derive embryonic stem cells (ESCs), an early stage embryo, which is a potential life form, has to be destroyed. Scientists believe that research on ESCs can lead to strategies that could lead to alleviation of several life-threatening diseases, but the dilemma is that you have to destroy a potential life form. The question that is often debated is whether an embryo really is a human life and at what stage of development can you really call an embryo a human. This is the crux of the matter, but this central argument can be extended to hours of discussion without actually reaching any conclusion. Therefore, different countries have different laws on ESC based research. The good thing is that we have an alternate in induced pluripotent stem cells (iPSCs), which behave like ESCs, but can be derived from cells of the adult human body through a combination of genetic manipulations that change their fate.

15. What are some of the direct benefits (to society) of stem cell research from the last 10 years?

There are three major benefits in studying stem cells. First, you know more about the basic functioning of organisms; second, stem cells have immense potential clinically, and lastly, they are used for drug development. All three are important but we are really looking forward to the development of stem cells as an alternative strategy to curing diseases and other debilitating medical conditions. HSCs have been frequently used in clinical practice since the late 1950s, but other kinds of stem cells are still in limited use. Recent advances have made stem cells more relevant in bone and skin related conditions. Results from tooth and eye related trials have been quite promising. Cord blood derived stem cells are getting more recognition these days, although currently, they are used mostly in blood related diseases. I think there is a lot of promise in this field but, it is going to take some time for this promise to take shape. A very nice resource available at www.clinicaltrials.org provides information about clinical trials undertaken in various fields of biomedicine, including stem cell research.

16. Are there still outstanding questions in our understanding of the development of human embryos?

Oh yes, there are, and I don't think that they will cease to exist anytime soon. Human development is obviously difficult to study but, even if we talk about small laboratory animals, there are many unanswered questions. Obviously the questions that we have today are very different from many of the questions we have been asking in the past, and are aimed at understanding the functioning of stem cells at the cellular, molecular and chemical levels in greater detail.

17. Do you have any suggestions on how science can be taught in schools to encourage more students to pursue a career in biological research?

I do not know much about how school textbooks and teaching strategies look today but, I know it has not been very good in the recent past. There has not been much scope for creativity in classrooms. Not only science, school education, overall, needs to encourage curiosity, innovation, out-of-the-box thinking and critical questioning. Education needs to be more practical, interactive and communicative. Learning is only a part of education. Creativity has to be encouraged and rewarded. Science is all about observing phenomenon happening in nature and trying to understand it; technology makes this knowledge available for use by the larger society. School children hardly know any Indian scientists, which could be an important aspect to remedy. Local inspirational stories are missing. More frequent conversations with the Indian scientific community can really help students in schools. Scientists could visit schools, tell children their stories, help students identify their interests and inspire them to follow their dreams.