

Dr Ramray Bhat is an Asst. Prof. with the Dept. of Molecular Reproduction Development and Genetics, at the hallowed Indian Institute of Science. During the summer, he very kindly accepted our request for an interview and shared some of his thoughts with us.

What followed was a deeply instructive, compellingly advocated, eye-opening discussion on a spectrum of topics ranging from synthetic biology, ethical regulations on research, the relation between society and science, the status and importance of undergraduate research, outreach programs, and some expert tips on making collaborations click.

[Sree]: *To start off, could you explain your take on the field of synthetic biology?*

[Ramray]: My personal take on this subject is not a simple one, and that is because of the way the field has moved over the past decade or so. At the beginning, most of the work was directed towards understanding the fundamentals of biology - be it the functioning of cells, bacteria, or entire communities of interacting entities. And some very unique, seminal work came out of all of this. For instance, people showed how noise could affect processes like transcription, translation etc. In all, these helped significantly advance our basic understanding of the world around us in myriad ways.

However, somewhere along the line synthetic biology also began to be seen as a tool, or a set of techniques even, which could help science progress. This idea of harnessing synthetic biology as a medium of technological advancement is something I'm still skeptical about. Of course, some researchers are still using these to investigate purely scientific aspects, and those are the areas I'm more positively disposed towards.

[Sree]: *Following up from the last part of your earlier statement, is it because you are more of a traditional biologist that this seems like the commercialisation of a concept or an idea, and hence something to be avoided?*

[Ramray]: No I do not think so. I believe science should not be kept in isolation from the society that funds science. Infact, society should benefit from science and has every right to do so. Science should have both concepts of understanding the fundamentals of the natural order of things, as well those of helping society get past obstacles.

My skepticism is due to the fact that I feel synthetic biology has moved too fast. A lot of advertisement for this field is being done by biologists who do not always have a very clear conception of the socio-political nature of the world they seek to benefit, or get their technology to benefit. For instance, I was associated at one point of time with an institute that was one of the several synthetic biology "capitals" if you will. A lot of work was devoted towards this, with

very specific aims to benefit the world technologically. But the output was far, far less than what was promised, probably because it was sold way too soon.

[Sree}: *It was overhyped, basically?*

[Ramray]: Yes, it was overhyped. But the hype is of course a medium term dynamic. The problem arises when biologists don the role of being saviours of the Earth but have little conception of whom they seek to benefit and how they plan to benefit, and what are the political inequalities they seek to push their technologies through. So, what might be construed as something to help the community might actually end up destroying even vaster spaces or communities. And that is something biology must be cautious about. This has nothing to do with synthetic biology specifically, but is to do with any kind of biology or any kind of science that seeks to further technology. There has to be a certain precautionary approach towards understanding how it might be used by society.

Any kind of science that has the ability to move the fate of people has to be very cautiously discussed, thought about, and not be advertised too flippantly. In case of synthetic biology, the sheer dynamics at which the field has evolved, progressed, and sought to be used for has been too fast for such a precautionist philosophy to be followed.

[Sree]: *While we are at this, it seems to have a lot of parallels with say, the CRISPR-Cas9. Recently, this was used to engineer babies, without any stringent regulatory mechanisms. Is this the kind of concern that these advancements without appropriate regulations, could elicit?*

[Ramray]: Yes, so this is precisely the reason for my skepticism about any kind of new technology - not just synthetic biology - which seeks to intervene into the fate of human-kind or animal kind. The science that you do is always of a universal nature. For instance, the science that I do here in Bangalore, should be of relevance, or the principles involved should ideally hold true for someone in say, Iceland or Japan.

So potentially, if I create a technology that seeks to benefit people it would also seek to benefit people in Africa or Finland or the US. So science tends to be universal. However, aspects like the access to science, or the potential benefits of science, can never be equal across different countries, different classes, and so on. So that is where, one has to be careful about the kind of science being peddled as being potentially useful to everybody. One has to be careful, or else this can end up bringing out new inequalities or accentuate the existent ones even further.

Now, is this something scientists want to get into? This is what my skeptic side would like to urge people, by asking them to think about these concerns.

[Sree]: *Considering the statement that society funds science, which would you advocate with greater emphasis - a problem that is highly intriguing yet is primarily an intellectual challenge, as compared to something which has a more long-term effect or benefit to society?*

[Ramray]:. I feel that scientists should not be beholden to society just because they are being funded by it, so as to come up with mandates or measures targeted at helping society in one way or another. I also believe that the society in general is aware of this, and various stakeholders have raised this at some point or another.

The impression I have is that society doesn't really expect scientists to come up with deliverables at each and every point of time, and many of the discoveries that have helped society in very meaningful ways did not originally come about with this intent. The fundamentals for many of these were established long before their practical application.

There are also several counter-examples, where there was a need to develop new science to counter certain obstacles and help the world order or humankind in some sense. The best one I can think of is the development of nuclear weapons, where when faced with the need to develop these armaments, scientists rose to the cause - and we know what has happened to the world since then. Hence, I do not believe it is the iron-clad duty a scientist to deliver these, because many a times the kinds of requirements may not necessarily be beneficial to human-kind in general.

[Sree]: *What is your view on undergrad research in India? Especially given that even in most premier institutes, students are required to take extra time-outs from their regular curriculums in order to engage with research projects; and that unlike many institutes in the West, we are usually not given an option to credit undergrad research as a part of the regular curriculum. What's your comment on this?*

[Ramray]: The current status of undergrad research is woeful, in general. With the possible exception of premier research institutes like IITs, IISERs, TIFR etc. and maybe some central universities, there is almost no actual undergrad research taking place. Apart from these, the undergrad generation is largely isolated from the kind of research they should be getting exposed to.

I believe there should at least be some research orientation, or exposure to the kind of research that is happening - not just for undergrads (in fact, it's a bit too late at that stage) - but for even high school, who should be exposed to what research and science is all about.

Ideally, scientists should open their doors not only to undergrads but high school students as well, so that they can get a flavour of this at a very young age itself, develop an aptitude towards science, and actively think about the process of carrying out research and making discoveries.

[Sree]: *So iGEM in this sense is an endeavor whose main goal is not only to promote synthetic biology but to also encourage undergrads and high school students to get a flavour of research. To what extent do you feel such competitions have a long-term effect on people who participate in them?*

[Ramray]: To be honest, I haven't interacted much with students who have taken part in the iGEM. I'm sure they have gone on to do well, and I do believe such students are meritorious enough to begin with, and that iGEM is one of the stepping stones that they deserve. However, I'm not sure to what exact extent it helps them from a future point of view.

However, I do believe that interest or exposure to research cannot be brought down to access to any one competition - rather it's a meditative, tenacious effort which is meant to be undertaken throughout life. That is why I feel that students should be exposed to science right from high school. They should be exposed to science before they get to do it in an independent way, and seven-eight years of this would provide them the right platform to be the scientists we envision them to become.

[Sree]: *As a part of outreach we are expected to reach out to stakeholders who are not engaged in science, so what do you think are some good outreach measures we can take as individuals who have access to established facilities? Specifically, what are the things that can increase effective participation of a non-technical audience in science?*

[Ramray]: The best way one can do it through existing systems, rather than implementing completely new models. For instance, every school must have a science teacher and has kids who are learning science in one way or the other. And if one really has to make a difference, one has to go for the rural schools where structurally science is supposed to be there, but whether it is taught or not depends on place to place. Those systems need to be tapped into.

Take the rural or suburban schools outside the city. You must go there not just once but repeatedly over a long term. Say the same school several times over two-three years. This kind of repeated or sustained outreach has better impact.

Typically in outreach exercises you meet people once and then move over to another place, where again briefly meet a new set of people. But if you engage with a fixed group regularly in rural settings over several years (like a child you interact with all the way from from class 6 to 12), then there's nothing like it. Instead of trying to cover five schools, if you reach out to the same school five times it definitely makes more sense.

[Sree]: *One of the important aspects within iGEM is collaboration between different teams. Would you like to give any advice on how we can make a collaboration work better, wherein rather than being a simple exchange of ideas between both sides which are jotted down and later forgotten, it becomes a much more productive interaction?*

[Ramray]: A productive collaboration needs to be matched on several levels.

The participants should be matched on a level of intentions - not just an aspect of science but an aspect of what they both desire out of the collaborative effort. There has to be a clear understanding of what's the complementarity here between both teams, i.e., what one team brings to the table and the other doesn't. The awareness should be acute and clear.

Second, there should be a sense of equality. No collaboration can stay together if there is a hierarchy in place. The teams should be on equal footing - not a situation where one's more privileged or superior to the other. This is the principle on which such efforts work or fall apart.

Finally, there should be some level of physical engagement, not just interactions across geographical locations. In this sense, the Giant Jamboree is an effective platform, where teams can physically meetup and engage with each other. For me, that's how a collaboration works.

Sometimes, despite all the above being true, collaborations fail when temperaments don't match. How teams work with each other matters. For instance, a team which works very aggressively if paired with a more thinking-and-pondering type of team usually does not gel well. There has to be a certain world-view match. This may sound a bit intangible, but this is what makes or breaks collaborations - Attitudinal compatibility and temperamental compatibility between individuals and teams.