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BIOLOGY EDUCATION, CREATIVITY & CAREER

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ABSTRACT

The growth of biological thought during the last 500 years has been analyzed conceptually in the context of education at school, undergraduate and post graduate levels. Again in the context of creativity, the near absence of creativity in the Indian scientific enterprise has been explored and the factors which contribute to that have been discussed. The natural goal of biology would be Human Biology which will bring back creativity while it is being pursued. Biology would become the most fascinating frontier of all natural sciences in near future. What does it mean to have a successful career in Biology has been explained. Career opportunities in India for young people having aptitude for Biology have been discussed.

KEYWORDS: Biology Education, Creativity, Human Biology, Career in Biology

INTRODUCTION

Education

Education should liberate the young mind from false perceptions and values. It should enable the human mind think for itself. It should bring forth a mind-set of reflective mood. Education should empower each human consciousness to reach its highest level [1]. The goals of higher education were different in the colonial era when compared to those for the post-Independent India These were spelt out clearly by Jawaharlal Nehru and in the reports of both Sir Radhakrishnan and Prof DS Kothari led education commissions. Even these have undergone changes in the post-globalization era. The University Grants Commission had long back issued a set of guidelines in the form of Professional Ethics in Higher Education Career [2].

Nature of Science

Post-renaissance Europe defined and formulated 'Natural Science' or Natural philosophy [3].. Scientific understanding of the structure and functioning of the material nature became 'Natural Science'. No value was attached to the practice of natural science. Science in the words of Vannewar Bush was supposed to be amoral i.e. neither moral nor immoral! In a way Philosophy and Science are similar in that both seek the 'TRUTH'. For sheer convenience natural science was artificially divided into Physics, Chemistry and Biology to arrive at the Physical, Chemical and Biological reality of this world.

That nature functions and manifests as a 'whole' and is a resultant of all the three interactions-physical, chemical and biological has been realized only recently. More unfortunate was the pursuit of Biology in mutually exclusive forms of botany, zoology and later microbiology. It is obvious that structure rather than function was emphasized initially in biology, and this lasted for a long time. Structural description requires identification and hence taxonomy became the dominant biology for hundreds of years. Darwin's ideas about Organic Evolution by Natural Selection in the mid nineteenth century became the Philosophy of Biology [4, 5]. Biological systems are evolving structures sharing a common genetic material to varying extent and hence are all related.

Nature of Biology- *in Vivo, in Vitro* and *in Silico* Biologies

During and after the seventeenth century, functional aspects of biological systems got noticed and described. Physiology and experimental anatomy took birth. When the language and description became increasingly cellular and molecular, reductionist biology got established. A useful and correct outcome was the increasing influence and application of Physics and Chemistry to understanding biological structures and functions.

Molecular and Cellular Physiology, Biochemistry and Biophysics became the dominant Biology for more than a century. Description of molecular processes going on inside the living organisms became an obsession and a passion [6]. Since the days of Rene des Cartes, the utility value of natural science has been getting emphasized. The purpose of science itself was restated as not only understanding of nature but also controlling nature [3]. Nature included everything except 'man'. Even woman was included in nature. Exploitation of natural resources became developmental index and a mark of civilizational progress. Application of science to human affairs became more important than basic science. As it was linked to employability, professional education in technology or 'applied science' (electronics, medicine etc) was given more importance than basic, pure and fundamental science. Somewhere down the line, pursuit of science and technology became an end itself and not a means to educate ourselves. Specialization and vocationalisation started at younger age than ever [7]. Added to this was an undercurrent of middle class thought that cerebral work is superior to manual work (6). A deep scission among natural sciences and between sciences and humanities or even social sciences occurred in university curricula. Educational values were delinked from pursuit of science and technology for career prospects. Structural alterations in the educational systems messed it up further. Single discipline institutions were elevated to the status of deemed to be universities. Impressive architectural wonders and air-conditioned laboratories replaced curricular content in science not to speak of non-science subjects. The final blow came with the establishment of 'applied science laboratories and institutions' across the country (CSIR, DST, DBT, ICMR etc).

These institutions function in isolation without educational context. Education and science got separated. It was only when biology got extended to humans, especially in the areas of brain and immune system functioning, that biologists realized the importance of interactions rather than isolated structural components, creating 'living phenomena'. The whole is different from the sum of the parts! This story was repeated in the area of genetics. Rediscovery of Mendel's laws of heredity in the early twentieth century and the spectacular successes of molecular biology had reduced biology to structure and function of individual genes. It went through the stages of organismic genetics through cyto- and molecular genetics to in vitro molecular biology or molecular biophysics whatever that means! A new dimension of environment was added to understanding brain function, defense mechanisms or gene function. It has been realized now more than ever, that biological phenomena are consequences of interactions between biotic and abiotic factors and that nothing is absolute and everything is relative [9]. Context dictates gene function. Genes should not be studied in isolation. The distinction between 'intrinsic nature' and 'nurture' became blurred. Instinct and learning got clarified. Most of human behavior is learnt phenomenon. Cultural evolution has overtaken biological evolution in the case of humans. Everything is due to genetic and epigenetic interactions. Biological systems are continuously evolving systems. Everything that happens is a chance event. Darwinian ideas took a new meaning. In light of all that has been said above if one were to ask what biology should be taught at Higher Secondary School, Undergraduate and post-graduate levels, the answer would not be simple and straight forward. A number of structures can be proposed. Conceptually it should be Natural Science at School level, Biology major at UG level [20], independent of how many years of study that each level demands. Following all this, there should be only integrated PhD programmes which include advanced level instruction in subjects relevant to PhD programmes.

However till such time as the whole nation comes under one structure, it is not a bad idea to run M.Sc programme. The UGC model given in 2001 does justice to both organismic biology and Reductionist biology [1].

Creativity

What exactly is creativity? A particular reason for lack of creativity in present day a scientist is given by Gurkriwicz and Korngreen [10] who said," the very essence of excellent science resides in non-conformity and multi-disciplinarily thinking------- rules of academic survival will greatly affect the creativity of scientists". They were referring to impact factors and citation indices. Let us list some universally accepted geniuses in human history. Lord Buddha, Adi Sankaracharya, Aristotle, Leonardo da Vinci, Isaac Newton, Michelangelo, Galileo Galilee, Louis Pasteur, Mozart, Graham Bell, Rene des Cartes, TS Eliot, Albert Einstein, Ramanujan, Charles Darwin, Bertrand Russell, Walt Disney, Edgar Allen Poe, Jonas Salk, Tennyson, Rabindranath Tagore, Thomas Alva Edison, Sigmund Freud, SN Bose, Naom Chomsky, Westinghouse, Osho and Richard Feynman. The list is not exhaustive. Intelligence quotient (IQ) has probably nothing to do with creativity. The last great American physicist genius was Richard Feynman who had an IQ of 122. Many run of the mill professors of physics will have higher IQs than this. Hence intelligence is not creativity [11]. Ordinary people solve problems by recalling past experience i.e. reproductive thinking. Geniuses think productively i.e. come up with alternative ideas. If most of doing science amounts to using analytical thinking, there is no room for creativity. If only technology elicits creativity, then creativity has no apparent role in basic science. However this perception is not true or correct. When a new question is raised, or when a new idea comes up, when a new profound phenomenon is observed and reported, there is creativity. A characteristic of geniuses is that they think of alternatives, blind alternative ideas and then select the best. Carolus Linnaeus was a scholarly botanist who gave us the binomial nomenclature in biology. He used similarities among organisms as a basis of grouping or classification. Charles Darwin, saw the same similarities, tested alternate ideas and gave the insight that this due to common ancestry. Darwin was a genius. Linnaeus was a scholar. In fact, creativity operates the way natural selection does. First there are competing alternative ideas through imagination. One out of them is selected by the genius. Creativity evolves due to survival of the strongest alternative idea. Geniuses have more spatial and visual ability than verbal abilities. Da Vinci, Galileo etc more often than not expressed through drawings and not through verbose and scholarly written articles. Einstein is reported to have remarked that words and numbers did not play a role in his thinking process. As we cannot think consciously without a language, he must be referring to subconscious thinking. Hence creativity exists in basic science of the highest quality. Ordinary science or majority of science research does not leave anything to imagination. Those of who have written proposals for extramural funding would have practically given the results also beforehand! On the other hand, technology development, design, performing arts, handicrafts etc directly stimulate creative imagination. Some examples discussed below prove that, courage of conviction, whether it is perceived demand (market), perceived concern for equity, perceived challenge etc can lead to creation of new technologies. The Swiss make the best watches. Around 1970, their research institute invented electronic watch. They did not believe it had any future. Seiko picked it up in a scientific meeting. Seiko made and dominated electronic watch industry. IBM first invented personal computer but thought it had no future as they felt there could be only 5-6 people in the world who would like to have a personal computer! APPLE had conviction and made PC. They dominate the PC world. Philip Reiss of Germany invented a machine that could transmit music in 1861.He was above to make the telephone. Everyone told him that there would be no market for telephone. He gave up. Graham Bell pretty soon invented telephone. Bell became a legend, a genius at that. Chester Carlson invented Xerography in 1938. IBM and KODAK scoffed at it. Since carbon paper is so cheap, they argued, no one will buy a copier. XEROX proved them wrong [12]. Creativity is analogous to biological evolution. There must be a rich diversity of alternatives and conjectures.

Ninety five percent of evolution ends in extinction! A number of strategies however have been suggested to lead to creativity in science. Collaboration with fellow scientists brings out better ideas than solo research. Finding what you are not looking for (e.g. Alexander Fleming) can lead to creativity. Metaphor is a sign of genius when you link two separate worlds (e.g. creation of atomic bomb but the project leader was an army brigadier). Seeing connection between unconnected leads to creative solutions (e.g. Kekule and Benzene structure). Making novel combinations of disparate ideas gave Einstein his equation E=mc2 from mass, energy and speed of light, on none of which, he contributed anything. Productivity is the hallmark of creative people. Einstein published 248 papers on topics unrelated to relativity. Edison had more than one thousand patents. Very few are world class. They produce both good and bad. They believe that quality comes out of massive quantity. Creativity gives a sense of fulfillment, whether it is fleeting (Music, sex, sports etc) or permanent (Science and Religious ecstasy).

Reasons for Absence of Creativity in Indian Science Especially Biology

Creativity is essentially based on fertile imagination. Clever people who commit robberies and other anti-social crimes especially financial crimes are very imaginative and creative. But we are not referring to this. What we learn from this, however, is that, if the goal is clear, imagination works and automatically results in creativity. In performing arts (dance for example) or fine arts like painting, composing music, weaving, pottery and other handicrafts, one usually comes across creativity of very high order. That means, when subconscious mind works (thinking coupled to manual work or thinking without being conscious of it), creativity arises. The thought process underlying creativity is not known. What drives imagination and creativity is 'the desire to be original' to begin with and a deep involvement with the subject matter. In science too, especially experimental science, creativity comes when we think while doing the experiments. The intense conscious thinking is invariably followed by subconscious level thinking while we are asleep or otherwise engaged. A major reason, therefore why one does not see creativity in Indian science is simply lack of desire to be original on the one hand and no practical experience during undergraduate and post-graduate training on the second. Most Indian scientists are camp followers of western scientists. In science education, blackboard exercises and didactic lectures cannot stimulate creative imagination. "One clean experiment is worth thousand dirty theoretical calculations" said Ephraim Racker [13], a famous biochemist specializing in mitochondrial bioenergetics! I will elaborate a little. There are two problems among many in our education system, which should draw the attention of educational philosophers. One is too much teaching and too little learning!

The second is specialization at increasingly early ages. Policy makers want employability of students and hence vocationalisation is emphasized. Conceptual understanding is sacrificed. However whether it is basic science or vocational stream, hands on experience is very crucial in science. Unfortunately that is what is precisely missing in the curricular activities. One has only to look at the poor state of Biotechnology courses in our country as an example to understand this problem [14, 19]. But even a basic science course has to lay emphasis more on laboratory and field experience than on didactic lectures. In western models science and technology are taught together. It is only in our country that these are separated as basic and professional courses. At the school level the child should learn rather than being 'taught'. Professor Yashpal puts this succinctly in his monumental report on school education as, "empirical experience should precede theoretical construction" [14].

Is this the only reason for lack of creativity? The answer is no. The very nature of fundamental science is to understand the structure and functioning of nature-biotic and abiotic. It is akin to problem-solving for the most part. Analytical thinking, just like in the mind of a detective solving a murder mystery, is what is necessary. Arthur Koestler calls it convergent thinking [15]. Divergent thinking is the basis of creative imagination, necessary in explaining a

phenomenon or in developing a technology or designing a structure. A creative idea put up to explain a phenomenon may be disproved later and is replaced by another creative idea. The problem of origin of Life on earth is an example where man has given many a hypothesis. A creative idea in developing a technology or design would never go wrong by definition. A technology is something that works. It can be replaced by another better technology but never disproved. The normal scientific investigation does not need imagination but intelligence. Imagination is a prelude to creativity. In rare cases of scientific problem solving, sub-conscious thinking leads to a solution in an imaginative way. Is this creativity? For example, is Kekule's formula for benzene a product of creativity or sub-conscious analytical thinking? Same argument holds for the famous Archimedes principle. But let us take a look at the statements of celebrated scientists and educationists. We will get confused. "In questions of science, the authority of a thousand is not worth the humble reasoning of a single individual" said Galileo Galilee long back! That is because; in pure reasoning there is a path. Philosophers analyze the thinking processes' metaphorically as walking on a path. They make statements like 'we arrived at a solution', 'we were at crossroads, 'it was illuminated by the light of his sayings, 'it did not lead us to anywhere', 'that line of thinking led to a road block' etc.

One cannot teach creativity but one can stimulate it by change in the ambience of learning, examination system. Science should be constructed by the learner as a system of Ideas/hypotheses into which the present data fits in. New data can change the idea or a new idea can fit the data better. The structure of scientific revolutions is only that says Thomas Kuhn [16]. Rene des Cartes said in the seventeenth century that, "except our own thoughts there is nothing absolutely in our power". As creativity is not a result of Conscious thinking process, it is not in our power. Hence it cannot be taught. Science is about conscious thinking and hence can be taught. Students of science should be made to develop curiosity. Then, they will pursue and do good science. Albert Einstein is reported to have said, "It is a miracle that curiosity survives formal education".

HUMAN BIOLOGY AND RETURN OF CREATIVITY

Human Biology is a frontier branch of science where integration of all natural sciences, humanities and social sciences occurs. Nothing is absolute in isolation or permanent. Everything is momentary and ephemeral. Everything about 'Nature' including humans is only a perception and not an absolute reality. Science is leading to philosophy. Science is reinventing educational context. Continuous social stress is making people seek value education now more than ever. Creativity is a fundamental feature of human mind. Mind is an epigenetic phenomenon. It works in a context. Creativity comes only when there is coordinated functioning of mind and body. The practical aspects of science are more important than theoretical constructions. More and more science teaching was made a black board exercise without exposure to laboratory and field.

All of us realize that creativity is observed in sculpture, handicrafts, and performing arts rather than in theoretical religious discourses. When natural science, experimental science, reductionist science especially biology was overemphasized, understanding nature became a casualty. Intelligence in solving problems took precedence over imagination and creativity.

The latter give joy and happiness. With the integration of all branches of knowledge- natural sciences, social sciences and humanities, especially at school and undergraduate levels [17] and strengthening of practical exercises, learning will again become a joy. Education will once again become a voyage of discovery of 'self'. Creativity will automatically get expressed in a stress-less education as that is a fundamental property of human mind. We need to bring curricular and contextual reforms in our educational systems to achieve this [18, 19, and 20].

Career in Science (Biology)

The 2009 Chemistry Nobel Laureate, VENKATRAMAN RAMAKRISHNAN said at Bangalore, "You go to science to solve a problem, not to find ingredients of success". This in essence tells that the word 'CAREER' as is popularly understood is not strictly applicable to academic people who pursue science. Then what is a career? Career is a way of earning a living in a formal and organized system of hierarchical salaried positions or jobs. How to become an employee and rise in the professional social ladder is referred to as shaping a career. In this narrow definition there are no constraints admitted by the employer. Pursuing science is not a career. It is a passion. It is a compulsive work habit. It is an obsession. India is a civilized country. It has institutionalized pursuit of a passion or hobby so people who are addicted to doing science can do so without worrying about how to feed a family or to take care of ill health. In the very old days, those pursuing academic matters, be he a poet or scientist had to be supported by kings.

In England only the wealthy that did not face any existential problems of earning their daily bread entered science and pursued it like a hobby. Pursuing science was never a job. However, subsequent to the Renaissance period, science and technology became a curricular subject in university education. Consequently, a large number of science graduates and post-graduates found employment in government sector initially. Natural Science, as defined by Francis Bacon and others had the only aim of understanding the structure and functioning of 'NATURE'. Rene Des Cartes, the French mathematician philosopher emphasized the utility value of science and from then onwards, applied sciences with the immediate aim of using science for human welfare including creature comforts euphemistically called 'quality of life', became popular. Civilizational progress of nations was measured in terms of developmental indices which were essentially life style comforts that could be created with the help of science and technology.

In due course of time when university scientists were pursuing 'blue sky research' and not bothering about solving societal problems be it in the health sector or manufacturing industry or in general, nation building, Indian government created institutions like CSIR, ICMR, DBT etc to attack relevant problems of disease, food security, nutrition etc. These institutions were better funded than the universities. As science became cost intensive, research and teaching got separated. Universities emphasized good teaching and middle class research, more consolidative than creative. Institutions, in their turn, emphasized applied research than fundamental science research.

The net result was declining quality of first rate discovery research. With frightening 'knowledge explosion', scholarship was becoming increasingly difficult. Conceptualization being conspicuous by its absence in educational training, scientists and teachers were drowned in information. With increased funding to higher education and science, middle class people flooded this sector with the sole aim of grabbing the jobs rather than to take it as an opportunity to create knowledge. All the ills of middle class mind set of love for social approval in the form of recognitions and awards are also present in the community of scientists today. In the last ten years, India became a science and technology driven nation. With increasing globalization superior economies are blessed with superior science and technology.

The ground scenario in educational institutions is however a case for concern. Students are running away from science. A major reason could be that incompetent and uninspiring teachers who are appointed for reasons other than academic worthiness have contributed to this miserable condition. Hence we are in an unenviable situation. We want more scientists to take care of national growth (economic) and health (physical and mental). The demand is real in the form of unfilled positions. Hence this discussion of career opportunities, creativity and constraints. Then what are the constraints? Strictly speaking there are no constraints except your talent. In a lighter vein Watson talks of some thumb rules for establishing a successful career. These are as follows:

- Avoid dumb people
- Be prepared to get into deep trouble
- Have a god father who will save you
- Never do anything that bores you
- Get out of science if you cannot stand up to your peers.

Although this sounds like a cynical piece of advice, there is some element of truth in these words. However youth should not be guided by these words of wisdom. But let us examine some of these.

Funds can be a Constraint to Creativity

Funds are required for doing research. Formal institutional affiliation is required forconducting research. But funding alone does not ensure success. Talent and appropriatelevel of funding ensures that. A superficial analysis of the current scenario of Indian science in the context of "what constitutes 'success'?" might give us the impression that those who manage to get huge funds are considered successful. It is interesting to note that during the early years of Christian era, the word 'talent' actually meant 'coins'. Jesus Christ is reported to have asked one of his disciples, "How many talents did you bring today?" He meant coins of course. It is only in later years that we refer to a bunch of cerebral qualities like intelligence, knowledge, creativity, aptitude etc as talent. In recent years, we are unwittingly using the word talent in its original meaning i.e. how many DBT grants do you have. However this is not a correct perception. Those who pursue original ideas, solve original problems, raise original questions, make original observations are truly 'successful'. In other words, inner satisfaction or even 'intellectual ego satisfaction' in the words of Michael Polanyi is to be taken as success. While funding is necessary for success, it alone does not ensure career satisfaction in the true sense. If one analyses scientific achievements in any area of natural sciences, ninety nine out of hundred great scientific achievements have from poorly funded projects. In general, heavily funded projects have clearly stated technical goals and hence by definition don't have a discovery component. Mega projects, characteristic of modern day 'visible scientists' are suited to technology oriented research but not fundamental science research. I may even venture that planned work would not lead to discovery unless the scientist is observant enough to make serendipitous discoveries. In other words a keen and observant mind makes discoveries. Planned mega research projects do not ensure fundamental discoveries.

Constraints of Space and Work Force

We all work in a research paradigm where research out put is measured in terms of PhDs produced euphemistically called 'capacity building' or manpower generation. This in turn is directly related to number of publications in peer reviewed journals. Even institutions under the various ministries like CSIR etc have fallen into this trap. The true reason is that, the only workforce in science research in this country is PhD students. There is no post-doctoral work force of any worth in our country unlike in USA.Once we fall into this trap; we are fond of making complaints like:

- Students demand PhD but are not willing to work
- The system does not provide funds and facilities and cooperation
- The System demands standards and compliance with rules and regulations
- Teaching and administrative work does not leave any time for research

- There is no recognition for 'merit'
- The HOD is troubling me
- I do not have enough laboratory space
- HOD has grabbed all the space
- UGC funds are not fairly distributed
- Rules do not permit me to register students of other disciplines as interdisciplinary research is frowned upon.

We can go on listing more complaints in the garb of constraints to bring out quality research. But one must realize that these are existential problems characteristic of a mediocre system that we have put up. These are symptoms of underlying bigger issues of leadership and ethics that the universities are facing starting from Vice- Chancellors to colleagues. Universities in general are made for mediocrity, but not by design or intention. In a democratic set up, mediocre people hijack the agenda along with the institutions to serve their selfish ends. All institutions of modern nations are started with ideals and good intentions. An institution is as good as the people manning it. As universities are perceived as source of middle class perks of jobs and salaries, 'middle class' people with poor or no commitment to values, ideals and to institutional goals hijack them to serve their intentions and agenda. **There is a deep crisis of good and self less leadership today in our educational institutions.** There are more commanders than leaders. There are exceptions of course. **The advice is that when you wish to start your career, study the different institutions and choose the one that fits your ambitions.** Automatically mediocre will come together as are the bright ones with ideals. Incidentally only truly talented people possess and practice ideals. Science is alien to us as it is of western origin. We practice natural science which came during the postrenaissance period in Europe. While we have imported this science, thanks to the British rulers, we forgot to import scientific temper and scientific method with rigor. Hence like in all other spheres of activity, there is no premium for quality nor is there insurance against institutional collapse by implosion due to wrong people manning the institutions.

Three Systems of Employment Opportunities

There are three distinct spheres of our society which offers employment to young scientists to pursue their careers. One is the ubiquitous university system set in an educational background. The second is the R&D institutions set up by the union and state ministries and the third is the stratetegic research institutions of the ministries of Defense, Space and Atomic Energy. Each of these has clear, distinct and unambiguous mandate. There is no overlap. Each suits a particular type of scientist. When there is mismatch between the qualities of the appointed people and the professed institutional goals andideals, existential problems of the kind mentioned above arise. **Hence the most important activity is to select proper scientists in each of these types of institutions. Once you make a wrong appointment, present rules of employment do not allow any corrective action later, at least for thirty to forty years.** Hence once again the advice is to choose and enter institutions matching with one's own ambition and expectation than to accept any offer and regret later. The consequence of such conscious decision making would be that good institutions will continue to be good and bad institutions will never become good. The inertia will frustrate any individual effort to mend the institution. **In addition it is also good to remind the scientists that they should support good leadership and not fear bad commanders.**

Causes for Frustration

There are more mismatches between mandate and manpower in the university sphere than in the other two

national spheres of employment mentioned above on both positive and negative sides. On the one hand 'academic aristocrats', in the words of Arthur Koestler, have invaded the university system and are increasingly visible. These scientists, sitting on huge funds and behaving like institutions have less than contempt for teaching. They are above the university norms and violate the rules and regulations with respect to teaching and also research. **They are not the true mentors**. They manage research, men and resources. On the negative side a significant fraction of the faculty are academically incompetent and unworthy. But they, through trade union tactics, dictate terms, have their own perception of what constitutes 'success' in career and breed clones. As the breeding rate of the latter is higher than that of the academic aristocrats or the good and quality conscious scientists, pretty soon they outnumber and out populate the good ones. The inevitable decline in 'academic atmosphere' begins. What you see is nth rate mediocre constantly feeling insecure, antagonizing 'talent & character' and inevitably destroying the institution. Such people cannot nurture departments and universities. There is thus a pathological destruction of the university system both by implosion and surprisingly by external reasons like indiscriminate funding. Let us remember what Shanti Swarup Bhatnagar said long back i.e. "**neither art nor science can ever flourish in conditions dominated by the primitive instinct of self preservation**". When talented but idealistic people are hurt, the institutions get destroyed. Look at what happened to one of our most respected scientists and a true genius, Professor GN Ramachandran. I quote Subodh Mohanty who wrote, "Sundaravadivelu, the Vice Chancellor, instead of supporting started creating obstacles and finally Ramachandran resigned from Madras University". Of course the gainer was Indian Institute of Science, Bangalore and the loser was Madras University. Academic campuses should not be allowed to get politicized. The nation needs leaders like Satish Dhawan and Homi Bhabha. About Homi Bhabha, I quote Dasannacharya who wrote in Current Science that, " he was restlessly creative, enhancing life because he lived all forms of it--- scientist, engineer, master builder and administrator, steeped in humanities, in art and music, Homi was truly a complete man". Many people believe that funding will solve all problems. They have diagnosed the reason for the 'poor quality' of University research as due to lack of funds and infrastructure. While the diagnosis is partially wrong, the solution is totally wrong. MK Bhan, former secretary of Department of Biotechnology, one of our premier government funding agencies writes in Biotech News that, " when I went to BHU, I was hugely inspired by the sheer scale of what has been created in India long ago---we had gone off to sleep for so long. So you are looking at some of those glorious universities that had had great past but had not been nurtured well in recent times". He meant only funds. Funding agencies have to be educated. Indiscriminate funding is not the answer to how to improve standards and work culture. Sixty years after independence, we have not put in institutional mechanisms to discourage mediocrity. Peer review system is either honest or competent but not both. If the functioning of the funding agencies is made transparent and open to academic auditing things will improve.

Recognition as a Constraint to Inspiration

In every sphere of human activity, be it education or service or career, society wishes to recognize the best and give such rewarded people a special stature in the eyes of the rest. Hero worship is not bad by itself. In the world of science also there is an elaborate system of rewards and recognitions. Starting from best student through best PhD thesis, best research paper, citation index, society medals and academy fellowships etc, all countries have put these in place. The justification for all this is' recognition of merit'. In practice however a recognition or award is as good as the committee that decides to whom the award should be given. When scientific principles are given a go in decision making, it degenerates into mockery of the recognition itself. It transforms as consequence into an incentive to perform. Incentives can be 'purchased' but not true recognitions. In a famous school of chemistry, young recruits were told to plan their work for specific awards and recognitions! Just like funding, mafias operate to grab these. It is for these reasons that successful

careers are measured in terms of number of prizes won or PhDs produced or some such silly measurable criteria. It is worth remembering what Prof Balaram wrote once that "we cannot measure what is important but make what is measurable important". Venkatraman Ramakrishnan in a recent interview at the IISc, Bangalore said as much. He recalled with shock somebody asking him for advice for 'how to get a Nobel Prize!' Excellence in science has to be at global level. It cannot be in the context of a region or gender or area of work. Many young scientists get frustrated that they did not get such and such reward or award or honor. Let us remember the words of Aristotle who is reported to have said, "Dignity lies in deserving the honor and not in possessing it". Never give too much importance to these honors and recognitions. At the same time one should not be cynical about and biased against awardees. Everything has a place. One should be balanced in value judgment. Let us not forget that in the global level history of science, Indian science would not form a foot note.

What is True Success?

Pursuing and succeeding in doing honest and reproducible science is success. Claude Bernard said," those that do not know the torment of the unknown can not have the joy of discovery". Character building is as important as any scientific endeavor. Let us not forget that **philosophy and science have the same goal and that is to 'know the truth'.** There is an often repeated assertion that Indian science is not creative. This statement needs clarification. Creativity is a normal component of human mind. It is more easily exhibited in performing arts, poetry or literature than in normal science. Fundamental science of the highest quality certainly has a major ingredient of creativity. However there is no room for creativity in normal science. Routine science is about problem solving which requires intelligence and a great deal of common sense. Richard Feynman, the last recognized genius had an IQ of 120. Many ordinary professors of Physics would boast of a higher IQ. Hence IQ is not same as creative talent. If one were to list the most creative people in the history of mankind, majority would be inventors like Thomas Edison or Graham Bell, thinkers like Buddha and Sankaracharya and rarely pure scientists like Einstein or SN Bose. Technology development requires innovation and invention which are prelude to creativity. Young scientists should not get frustrated that they have not created any new knowledge. Normal science is not a creative pursuit but an activity requiring patience, hard work and conceptual understanding of the subject. It gives satisfaction and contentment. Discovery or Invention gives joy. Truly creative science gives happiness and is equal to realization of truth in religious context.

CONCLUSIONS

We can conclude that understanding the nature of Biology will enable us to design appropriate course structure for learning of Biology at the School, undergraduate college and at post-graduate/research levels. The relation of Biology to other natural sciences and even mathematics has to be recognized and that would permit design of course structure. Those who enter Biology with the hope of molding a career should understand the meaning and aims of academic career. Academic career is not a job but pure work and that too created and creative. Human Biology is an area where all natural sciences, social sciences and humanities will merge to enable the practitioner to have a glimpse of 'TRUTH'.

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