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Guest Editorial

CREATIVITY IN BIOMEDICAL RESEARCH

Great ideas, it has been said, come into world as gently as doves. Perhaps then, if we listen attentively, we shall hear amid the uproar of empires and nations, a faint flutter of wings, the gentle stirring of life and hope. (1)

For more than two thousand five hundred years of its long scholarly history science has relied as much on the subjective experience of inspiration, intuition, ideation and insight as it has on objective experiments, techniques, theories and reasoning. Only over the past few centuries has subjectivity been progressively undermined, leaving an essentially secular and sterilized analytical paradigm. Science is taken to be objective, possessed of certitude, untainted by relatives and subjectivity. But biomedical science is not simply a cataloguing of hard facts, it is a scholarship of integration permeated with supposition, uncertainties and ambiguities in approach as well as outcome. The biomedical scientist can range as unduly or as deeply in his study of phenomena of current interest as his imagination and acumen will allow. This probably is the reason why the very best brains in medicine tend to be drawn into the basic fields and the vast majority of Nobel Prizes in medicine have gone to workers in biomedical and allied disciplines.

Nature has endowed all human beings with sublime creative potential. Intelligence, knowledge, an alert mind, strength of character, motivation and a proper nurturing environment are elements that suffuse creative vigour and influence innovation. The outstandingly creative have often been described as possessing a childlike innocence or sense of wonder, and they ask seemingly naïve questions. They recognize problems that others do not see. Both the men of science and men of art live always at the edge of and surrounded by mystery but creativity tends to be associated with artistic, musical and literary activities much more frequently than with scientific endeavor. In the Wikipedia, *creativity* is defined as “a human mental phenomenon based around the deployment of mental skills and or conceptual tools, which, in turn, originate and develop innovation, inspiration, or insight”. As a faculty of human mind, creativity can pervade and drive any human activity (2). The seeds of great discoveries are constantly floating in and around us but they only take root in minds well prepared to receive them and in soils well nourished both by elements of nature and nurture.

The goal of every scientific research is the epiphanic achievement of *eureka moments* the ineffable experience of discovering some of the truths of nature, of finding the unity of variety. Usually scientists apply inductive meditative thinking up to the moment when they get a hunch and then immediately their minds change to deductive thinking. This switch form meditative to deductive thinking, from holism to reductionism, in effect from right to left brain hemisphere activity, is crucial for fructification of the creative act. Many men of science are widely read and versatile with more than a passing interest in the liberal and the fine arts. Musings and music, rest and recreation as well as silence and sabbaticals are also important for seeds of imagination and insight to incubate and germinate. Scientists not only remain in a continuous dialogue with nature and with the scientific literature and their own mental faculties, but are also continuously talking to one other. The challenge and the stimulus of human engagement during informal interactions in campus, coffee rooms and corridors kindles productive collisions and serendipitous cross fertilization of ideas and avoids detours or dead ends. Basically two kinds of collective scientific work can yield creative products: a pyramidal organization, with a creative thinking mind and a team of collaborators to carry out the tasks according to his her instructions or, alternatively a more horizontal organization, with a sharing of tasks and responsibilities according to capabilities and skills of each member of the group, thus allowing everybody for their own space of creativity (2).

The romance of research beckons many a young mind but going about research is no less agonizing and no less ecstatic than a pilgrim's progress. The major obstacle in the path is not ignorance but knowledge. The closed doors and cubicled approach breeds rigidity and kills spontaneity. To explore is to discover. Our school system emphasizes single correct answers and provides few opportunities for exploratory learning, problem solving, or innovation. Suddenly, when one becomes a graduate student, however, it is expected that one is automatically an independent thinker and a creative problem solver. It has been said that the primary function of the schools is to impart enough facts to make children stop asking questions. Some, with whom schools do not succeed become scientists! A certain cult of mediocrity pervades all science. Today conformist compliance overtakes creative competence. Reasonable young principal investigators are quick to get the message to stay within the confines of known systems and proven technologies and not to challenge existing beliefs and practices. As a result discovery, creativity and innovation are particularly imperiled (3). The very scientific research funding organizations and systems that are ostensibly there to promote discovery also serve to frustrate the emergence of creative thinking and work. If everything has to be double-blinded, randomized, and evidence-based, where does that leave new ideas ?

Creative work is both like skimming the surface as well as immersing in an iterative, tinkering type of research. Today's highly competitive climate has led to the misconception that the quality of proposed work and its outcome is predictable from a detailed grant proposal. Few if any really surprising discoveries get explicitly funded

this way. In today's age of evidence based medicine a Darwin or an Einstein may not get their grant proposal approved and funded! Are research workers geese that lay golden eggs of marketable research? One cannot predict or control what the creative person will do, but he or she can be encouraged by adequate support. One cannot schedule creative breakthroughs, budget for them, or prove them in advance to a review panel. Does research environment lead to erosion of creative ethos? Does it turn brilliant A-grade holders into dried up technocrats who grab the test tube and data spread sheets with nary a thought for creativity-the origin of all new science? We should focus less on production of Ph.D.s and more on production of scientists. Research wedded to creative ethics is what makes it a science other than a mere technical skill.

The writer Arthur Koestler developed a complete theory of human creativity, embracing both the arts and the sciences. In his view, scientific discoveries do not create anything wholly *de novo* but integrate pre-existing facts and ideas in novel way. He noted, "The history of discovery is full of arrivals at unexpected destinations, and arrivals at the right destination by the wrong boat" (4). In his recent book, *Creativity in Science*, Dean Simonton argues similarly that scientific creativity is essentially stochastic and combinatorial in nature, in other words, new ideas emerge by generating chance combinations (5). Vague and nebulous beginnings often advance to concrete breakthroughs. Few researchers will be in the right place at the right time to experience the spark of creativity that wins a Nobel Prize or forces a paradigm shift. Nevertheless creativity underpins all scientific success (6). Pioneers whose work engenders paradigm shifts are rare. Even prosaic puzzle solving research needs out-of-the box lateral thinking scientists to rethink experimental protocols, modify hypotheses and strengthen theoretical frameworks, Challenging the consensus is the *sine qua non* of science. Even the lone article published by an otherwise unknown scientist may stimulate the thinking of the most illustrious scientist in the same discipline. The odds are not high but they are not zero either.

Currently, cutting edge biology is becoming big science, dominated by the different *-omics* empowered with strong technological components. However, today we need another kind of less directed more redeemed neo-science where subjective-meditative as well as objective-deductive aspects stand together in mutual respect and constructive complementarity. The biggest dogma in science should be that there need be no dogma. A more robust and inclusive science that welcomes alternatives, tolerates ambiguities and rewards novel approaches needs to be pursued. As far as research is concerned we are students all our life, seeking solutions for life's problems. Knowledge is not static but ensures free and unfettered progress on an empirical, experiential and experimental basis. The goal of good research is to keep alive instincts and insights and to allow adequate scope for engaging in intuitive creativity. The specific charge of a mentor is to foster in his student open mindedness, critical thinking, value analysis and self-reflection. All great physiologists combined in their person, scientific excellence with the grace

of humility, candor of self-doubts and the wisdom of knowing their limitations. Soul searching in research seeks the aspiring scientists to navigate the laboratories with their creative clocks ticking and moral compasses providing desired directions to meandering scientific ideas. In creatively seeking small personal truths lies the grandeur and wonder of original research. If we define *creativity* as the *putting together of things in original ways* then evolution is *creativity par excellence* (2). Ultimately the origin of life and its diversity is by itself the sign of creativity of biology.

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