APS honours Indian physicist

Murugappan Muthukumar, 46, Professor of Polymer Science and Engineering at the University of Massachusettes at Amherst, has been chosen for the 1998 American Physical Society Prize in High Polymer Physics, also known as the APS Ford Prize. Among the theoreticians to win this award in recent years are P-G. de Gennes, a Physics Nobel Laureate from France, and Sir Sam Edwards of the UK.

Muthukumar is well known for his contributions to the theory of polymer physics. The APS has honoured him for outstanding theoretical contributions to the fundamental understanding of the statistics of isolated chains, chain dynamics, critical phenomenon and polymer self-assembly.

Muthukumar graduated from the Christian College, Madras, and after a short stint as a lecturer in Chemistry in Christian College and Loyola College at Madras, he went to the Department of Physics, University of Chicago, where he was awarded the doctoral degree in 1979.

Muthukumar joined the faculty of the University of Massachusettes, Amherst, after a two-year stint at the Cavendish Laboratory in Cambridge and is currently a Visiting Professor at the Institute of Mathematical Sciences, Chennai.

Events on and on... in cellular differentiation: Aspirations and the rationale

Sribir Sen and H. K. Majumder

A century has already passed since a German biologist, Wilhelm Roux started working on developmental biology (1894). Plant biologists, meanwhile, used the essence of totipotency of the somatic cell and even the germ cell to develop and differentiate several plants *in vitro* using the knowledge of basic components of cellular growth regulator[1]. However, in the mammalian system the scenario is quite different. Nonetheless, *in vitro* fertilization and later differentiation *in vivo* have been standardized in the human system (Patrick Steptoe of Oldham and District General Hospital, Oldham, UK). *In vitro* transgenic regeneration in human system has not been practised so far particularly and exclusively due to ethical and many other reasons. Such study of embryonic differentiation in human species is highly desirable due to a variety of diseases that cause deformation, by the dysfunction of different organs – in particular lung, pancreas, heart, liver, kidney, eye and blood-related diseases such as thalassemia, immune deficiency, osteopetrosis, aplastic anemia and leukaemia. *In vitro* morphogenesis of different organs is yet to be experimentally manipulated. But it is good enough to use cellular totipotency for regeneration of different organs from targeted embryonic stem cells or from cells of the same organ. This context has come in the arena of thinking due to several reasons in terms of human suffering[2,3]. This concept in humans had come as early as 1940 when Joseph E. Murray, Professor of Surgery at Harvard Medical School, performed the first successful kidney transplantation on a pair of identical twins later in 1962 between two unrelated donors. Another breakthrough was perhaps the work of E. Donnell Thomas of Fred Hutchinson Cancer Research Center who transplanted bone marrow in 1954. The mechanism of subsequent hazards in the recipient system makes this field of science a challenging one. The signalling cascades of graft rejection events have been well understood in the mammalian system[1,5].

Immunologists, however, have begun to unravel the nature of the major histocompatibility complex (MHC) that is not only important in rejecting foreign tissue but also plays a key role in many immune reactions as later research has shown. Graft implantation followed by associated problems toward the recipient system has made this biotechnique the kind of avenue where one has to encounter many other problems. A lot of immunosuppressive drugs, namely, cyclosporin A, methotrexate, azathiporine, rapamycin, misoribine, etc., many corticosteroid and now-a-days even different cytokinin like IL 10 have been efficiently used in transplantation processes. Heresy of solvation in a better way perhaps may be possible by making bridges between transplantation biology and developmental biology, even though genetically engineered systems are now highlighted[6]. Knowledge of hormonal regulation, growth factors activation, studies of transcription factors and morphogenic factors and their coordinated regulation till date in gene regulation are not sufficient to differentiate an organ from embryonic stem cells or from the cells from organ itself. Investi-

gators, of course, are far off to achieve such goals and in the juvenile stage.

Understanding *Drosophila* developmental genetics and embryonic differentiation in particular segmentation, pattern formation, identification of wingless gene (*wg*), heart development (*tinman*), several others (*armadillo*, *engrailed wnt*, etc.) and *Fgf 8* for limb development in chick are very premature to speculate or design a model for *in vitro* complete organogenesis. It is worthy to note that Herzlinger and Brown have shown the use of *wnt1* gene which activates in differentiation of embryonic mesenchymal cells to aggregate and differentiate into kidney epithelial cells in culture. McMohan and his colleagues find *wnt4* gene functions in kidney differentiation. Many more groups are engaged in unraveling the real picture of cellular differentiation and thereby *in vitro* organogenesis[7,8] (Table 1). Receptor mediated and non-receptor mediated cell to cell signaling and molecular signaling for morphological changes in cellular system follows a definite cascade of regulation such as tyrosine kinase-oncogenic activation-Rec 1/2; CDC 42 Hs-PAK-MEKK-JNKK-JNK; P38; and intermediate activation of morphological changes is now in the dim light in human understanding. A lot is awaited[9]. It is also important to mention that some growth and differentiation factors such as erythropoietin, insulin-like growth factor, platelet-derived growth factors, transforming growth factor β, osteogenic proteins and others are now undergoing clinical trials[10,11]. Even though cellular differentiation and morphogenesis constitute a plethora of events and how they orchestrate with growth factors, differentiation factors, transcription factors and morphogenic factors[12] need several years of study. Construction of organ banks and study of preservation and maintenance[13,14], however, will be possible immediate solvation for humans till the proper availability of technique and knowledge in *in vitro* complete organogenesis are feasible. To shed more light on these aspects, one can address utilization of *in vitro* fertilization followed by *in vitro* differentiation of specific organ by dissecting out the particular stem cell or tissues from embryo that may open a new avenue of studies but one can also think of taking a single cell from patient and *in vitro* differentiation of the desired organ will be a class of science that deserves the attention of developmental biologists.

Recent breakthroughs and actively debatable aspects of human cloning[15] have made this field of science a pearl of understanding in respect to human suffering. The essence is of course, when a blind man is in need of sight, a person having acute pulmonary problem is in need of breath, a person with cardiac problem is in need of better circulation of blood and a person with renal problem is in need of proper functioning of kidney. In that particular arena of understanding the achievement of Wilmut and colleagues[16] in developing and differentiating a complete mammal by changing cytoplasmic environment and adding a nucleus to a enucleated egg has lot of impact to combat human suffering even though ethical problems and aesthetic values may encounter human need.

Table 1. Genes identified for phenotypic differentiation in vertebrate embryo

Phenotypic group	Subgroup	Genes (*N*)	Alleles/genes
Organs	Blood	15	2.0
	Heart morphology	8	1.1
	Heart beat	14	1.3
	Liver, gut, kidney	6	1.0
	Eye	9	1.3

N, Number of identified genes in zebrafish. In humans, genes related to organ specific differentiation are the central theme for a number of laboratories and a few of them have been identified.

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