MEETING REPORT

SERC school in chronobiology – A value addition in DST's programme on animal sciences*

SERC schools: Genesis

In 1985, based on the concept of training schools (summer/winter schools) organized from the early sixties by Tata Institute of Fundamental Research (TIFR) for generating future S&T manpower, the Science and Engineering Research Council (SERC) started supporting a programme in physical sciences[1] for the benefit of young scientists in the country. Each school (called SERC School) is a five-year cycle, centres on a chosen area of physical sciences, and makes young scientists aware of the exciting developments and encourages them to take up research in the identified areas. In its policy document of 1988, SERC decided to extend the concept of 'School' to other disciplines, viz. life, chemical and engineering sciences. These SERC schools are activities of the Programme Advisory Committee (PAC) in the subject area. PAC on animal sciences is responsible for strengthening the basic research activities in animal sciences, primarily across the universities and academic institutions.

SERC schools in life sciences

SERC schools in life sciences were initiated in neurobiology, which is now a part of the health sciences programme. In the year 2000, PAC on animal sciences agreed to a proposal for a SERC school in chronobiology, an identified thrust area since 1980 (refs 2 and 3). Chronobiology is the study of biological timing (biological rhythms) in organisms. Clocks are a fundamental property of almost all organisms, from prokaryotes to eukaryotes. Such an activity in the area of chronobiology was consistent with the global efforts of raising scientific activity in this area. For example, the Centre for Biological Timing (CBT), USA and Erasmus Socrates School in European countries offer annual schools on biological clocks where students and young researchers come to learn and share recent concepts and methods in chronobiology. In India, we are far from having a good scientific base in this field, although there has been some initiative, mostly at the individual level, for studying biological rhythms. Therefore, PAC felt that the proposal for a SERC school in chronobiology from Vinod Kumar was a timely one.

SERC school in chronobiology

The PAC approved to hold a five-year cycle of Indian School in Chronobiology, and constituted a planning committee to oversee the school. Since a recent study on R&D projects on animal sciences has found that the research proposals on animal sciences for funding were weak on several counts[4], it was logical to remain skeptical until at least the first school was conducted and the progress closely monitored. This report is a post-school account, and is based on evaluation of the first school of the five-school cycle of activity. This report may be a catalyst for similar activities in other frontier areas of life sciences.

First school in chronobiology – Year 2002

The first school was conducted at the University of Lucknow with Vinod Kumar as the course director. Twenty applicants (out of 49) were selected to attend the school. There were five Indian and two foreign faculties for the first school.

The syllabus for the course was structured by the planning committee for the first year, and included from the basics, through molecular aspects to applications of chronobiology. Each lecturer was allotted a portion of this syllabus to be covered in-depth in his/her 2–3 lectures. After each lecture, students had some time to interact among themselves to formulate probing questions, and this was followed by a discussion. There were four laboratory courses for students to have some hands-on experience regarding chronobiological techniques, and there were also presentations by student participants.

Lectures were evaluated anonymously by the students, and were rated on a scale of 1–5, 1 being average, and 5 being excellent. At the end of the course, all the participants assessed this school on several other counts, e.g. (i) selection of the lectures, (ii) quality of the lectures, (iii) content of the lectures, (iv) lecture sequence, (v) laboratory work, (vi) interaction with faculty, (vii) study material provided, (viii) duration of the school, (ix) accommodation and hospitality, and finally (x) overall evaluation and suggestions. The evaluation responses from students and the critical remarks will be considered while planning the next school.

Each lecturer covered the most exciting and latest information regarding the subject. The most exciting information relevant to a general reader of *Current Science* can be summarized as follows: Cloning and characterization of clock genes reveal that clock-like property is present in many tissues of the body, since these tissues express 'clock genes' in a circadian (circa – about; dian – daily) manner. However, the generation of rhythmicity appears still to be localized in specialized tisues, like lateral neurons in insect brains or bilaterally arranged suprachiasmatic nucleus (SCN) within anterior hypothalamus of the brain in mammals. There are some independent oscillators, like the avian pineal gland, which are self-sustained. It is still unclear how the peripheral oscillators are linked to the central clock components, albeit humoral signal appearing crucial. The biological clock is composed of three components. The first is the core oscillator that generates rhythmicity. At the molecular level, the core clock element comprises a set of clock genes involved in autoregulatory feedback loops with positive and negative factors. Positive factors stimulate the transcription of clock genes, and their translational products negatively regulate the transcription of their own clock genes. The loop also appears

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to involve several clock-controlled genes. It is worth noting that basic molecular components at this point seem evolutionarily conserved. Still, little is known about the clock mechanisms that control clock-controlled genes, and about the circadian transcriptional cascades from clock genes to enzymes and proteins. The second component is the input that allows the clock to interact with the surroundings, and still not much is known about the cellular and molecular bases of this component. This 'interface' component will remain important since the environment itself can change dramatically. The third is the output component that uses time information for controlling molecular clock works of the clock. We have just begun understanding about this component. In the years to come, the study of circadian humoral, neural, cellular and transcriptional cascades will help us understand how gene expression, physiology and behaviour are influenced by the geophysical environment we experience on the earth.

The uniqueness of this programme was the learning of chronobiology through an intensive mode of interaction. Both the students and faculty seem to be benefited by close academic interactions, since they stayed together for more than ten days. We have to begin intensive research programmes addressing specific questions in all three aspects of the clock (core element, inputs and outputs). An integrated research programme involving experts from different institutions may also be a good idea to keep up with the pace of development in this field at the global level. Additionally, the PAC may like to take up such meaningful schools in carefully identified and more specialized areas of life sciences in future.

1. SERC Schools: Programme in Physical Sciences, General Information, Ministry of Science and Technology, Department of Science and Technology Publication, 1 March 1988.
2. Challenging Areas in Life Sciences, Department of Science and Technology, November 1990, p. 54.
3. Vision for R&D in Life Sciences, Science and Engineering Research Council, Department of Science & Technology, 2000, p. 5.
4. Singh, B. P., Interaction Meetings: Value addition in DST's R&D projects on animal sciences, *Curr. Sci.*, 2001, **81**, 741–742.

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RESEARCH NEWS

In search of the enigmatic plumes beneath hotspots

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Most of the 500 to 600 volcanoes on the earth are major outlets for molten magma from the earth's interior, and these volcanoes are distributed along the earth's plate margins. A few are located away from such margins and are known as mid-plate or intraplate volcanoes, or hotspots. They occur both on the continents and oceans (Table 1). Actually, they represent sites of melting anomaly in the mantle beneath them and this melt ascends through narrow conduits or plumes. These plumes may rise from the top of the mantle or the asthenosphere as in the case of the plate boundary type of volcanoes but, for the intraplate hotspots, they rise directly from the depths of the lower mantle. Not all hotspots are plume-fed. For example, some known as swells and superswells occurring as oceanic plateaus and positive geoid anomalies (Table 1) are thought to be mere buoyant upwellings of the mantle[1]. However, several researchers doubt if these indeed could be devoid of plumes since such sites are observed to be located over partially molten zones present close to the core–mantle boundary (CMB)[2–4] suggesting a connection with this zone[5–10].

Plumes are supposed to begin at a thermal boundary layer, either at the interface region between the upper and lower mantle at a depth of 660 km or from a boundary close to the core–mantle junction (the so-called D″ layer) deeper down at about 2900 km (refs 6 and 7). The movement of the earth's plates over such stationary plumes is one of the widely accepted explanations given for the occurrence of a string of volcanic islands stretching away from the hotspot sites[11] (Table 1). Experiments in fluid dynamics have shown that the hot, less dense, less viscous mantle layer becomes gravitationally unstable and buoyant, and moves upwards as a diapir or a voluminous plume head. A column of magma trails the latter and finally assumes a variety of shapes – domes, waves, mushrooms, teardrops or dikes[1,7,8,12]. The mushroom-headed plume, quite voluminous in size, is known to give rise to flood basalts over the continents (e.g. Deccan basalts in India) and over the oceanic crusts (e.g. Ontong–Java Plateau in the western Pacific Ocean) through rapid eruption (often < 1 m.y.), and this is supposed to mark the initiation of hotspot eruption.

In recent years, considerable rethinking has been going on, in particular, among the geophysicists, about the supposed deep, lower mantle source for the hotpots. Many reject the ability of plumes to rise from depths of more than a few hundred kilometres and deliver the melt to the surface of the earth. The physico–chemical properties of the mantle, the expected phase transition of minerals at 660 km discontinuity, changes in chemistry, thermal structure and geometry of the plumes, all work against the buoyancy of the mantle melt and impede its upward movement. Alternate non-plume routes to hotspot volcanism, like eruptions through rifted or stressed plates,