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SAMAY

A BI-ANNUAL NEWSLETTER

INDIAN SOCIETY FOR CHRONOBIOLOGY

PREPARING FOR FLIGHT

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MESSAGE FROM THE PRESIDENT

Dear colleagues,

Warmest wishes to you all as we begin the New Year 2026. May the coming year bring you much energy, brilliant ideas and many possibilities for growth. Wishing also, good health to you, your research teams and family members. I am happy to join the energetic team of fellow chronobiologists and fellow members of the Executive Committee of Indian Society for Chronobiology (InSC) - Shalie Malik, Sandipan Ray, Aakansha Sharma and Sanjay Kumar Bharadwaj along with several younger colleagues from across the country, as we plan out exciting new activities for the coming year.

The year 2025 was eventful for our community - we saw many academic activities with conferences, symposia, pedagogical workshops and meetings. At a personal level, I was fortunate to be able to meet several of you and hear about your exciting science directly, or from your enthusiastic students and other lab members. These events reassure us that rhythms research remains vibrant in India. Further it reminds us, that the InSC can make significant contributions towards forging new collaborations, supporting fledgling ideas, and providing new perspectives for ongoing research projects.

I take this opportunity to place on record our gratitude, as a community, to the untiring efforts of our past President of the InSC, Prof Vinod Kumar in ensuring that the field gets recognition both at the national and global levels. His enthusiasm and energy to encourage the growth of biological rhythms research in India by engaging with granting agencies, governmental policy makers, scientists, teachers and students is exemplary.

Please join me in congratulating several of my colleagues and student members who have received recognitions for their outstanding contributions to our field. I am happy to point out to you that our new editor of Samay, Shaon Chakrabarti, has introduced a section in the newsletter, that celebrates the many successes of our community.

MESSAGE FROM THE PRESIDENT

As you are all aware, there is an increasing tilt towards support of multi-institutional and multi-disciplinary research from almost all granting agencies. In recent discussions with leaders of various granting bodies and institutions such as the ANRF, DBT, ICMR and ISRO, I have come to realise that there is a lot of interest in biological clocks and rhythms research as a fundamental biological phenomenon along with the recognition of its immense translational potential. Considering this, I urge each one of you to think about how you might be able to leverage your own individual strengths and benefit from collaborating with other InSC members with complementary expertise to come up with research verticals that could be then taken forwards as a consortium to federal granting agencies. If you think that the Society can in anyway facilitate to strengthen your grant applications, please reach out to me or other EC members.

One of the goals of the InSC is to increase awareness about chronobiology research in the country in the form of schools and workshops. The aim of such events is to draw undergraduates and Master's students towards a future in chronobiology research or at the very least consider the impact of biological rhythmicity in behaviour, physiology and cellular processes in their chosen areas of research. I am hopeful that some of you will conduct such events in your respective institutions or collaborate with institutions in your neigbourhood. The InSC is happy to support such ventures for outreach activities.

To enable all of us to remain up-to-speed with the latest findings in the field and to foster a sense of community, we could also meet online for journal-club style discussions of recent papers or classical papers in chronobiology. If any of you are interested in coordinating such an activity, please do get in touch with me. In this era of digital connectivity, we welcome the creation and support of such networks which can surely be rewarding both in the short and long-run.

I look forward to hearing suggestions from you to make InSC stronger and a more effective body.
With best regards,
Sheeba Vasu

EDITOR'S NOTE

Dear all,

Here's wishing all of you a very happy New Year 2026. May this be a year of new ideas and exciting research – a very successful one for all of us in the Indian Society for Chronobiology.

I must however begin with my sincere apologies for this very delayed edition of our magazine, SAMAY. This edition is meant for developments and activities during the period January – June 2025, but we are already in the new year! As the new Editor of SAMAY, it took me a while to warm up to my new role, and take over the big responsibility from my colleague and former Editor, Aakansha Sharma. I would like to take this opportunity to thank Aakansha for all the hard work she put in to set up this magazine, and for hand-holding me through this transitionary period – especially helping me out with collecting articles for the magazine. I am excited to take up this responsibility, and hope to build and take forward the work that Aakansha started.

With this edition, we are bringing in a new look magazine, which we hope you will enjoy. A big shout out to Anjoom Nikhat, who helped me develop this new version. We are also starting a new section on publications from our chronobiology community as well as grants/awards won by our members. As our community grows, it is becoming increasingly difficult to keep up with all the exciting work going on, and I felt that this would be a nice way to stay informed. This hopefully will also pave the way for more collaborative efforts within our community, as we stay better informed of the research going on across the breadth of the country.

Wishing you all the very best, and I hope to see everyone engaging with this magazine in many different ways in the future!

Best wishes,
Shaon Chakrabarti

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How migratory birds build muscle for an epic migratory journey

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Avian migration has fascinated countless bird watchers and scientists over ages. It is an exceptional feat of endurance exercise that billions of birds undertake twice a year. As the seasons change and time for migration approaches, migratory birds start preparing for their flight. This involves changes in their physiology and phenotype including changes in oxidative capacity, hormone levels, weight gain, fat storage and individual organ sizes. The pectoralis muscle which powers the avian flight also starts changing itself in anticipation of high demand during migration (Marsh, 1984; Dietz et al., 1999; Landys et al., 2004a; McFarlan et al., 2009). There are two major flight muscles supporting avian flight: one is pectoralis muscle that generates powerful downstroke and accounts for 90% of flight muscle and the other is supracoracoideus muscle which is responsible for upstroke and forms the remaining 10% of flight muscles (Hartman, 1961).

Several studies have shown seasonal changes in flight muscles in birds to support their migratory phenotype. For example, snow buntings (Plectrophenax nivalis), show increase in their pectroalis muscle mass and fiber diameter as they prepare for migration (Vézina et al., 2021). In white-throated sparrow (Zonotrichia albicolis), migrant sparrows had 8% greater flight muscles mass than the wintering sparrows (Price et al., 2011). Evans et al. (1992) quantified muscle fiber hypertrophy in three species of shore birds and reported two of the three species exhibited concomitant increase in mitochondrial concentration as muscle fiber diameter increased. Eared grebes (Podiceps nigricollis) also demonstrated hypertrophic muscle growth with increases in aerobic capacity prior to the autumn migration (Piersma and Lindstrom, 1997). An ultrastructural study in catbirds (Dumetella carolinensis) found that muscle mass increased via hypertrophy in migrating birds; however, their aerobic capacity remained constant (Marsh, 1984).

The mechanisms underlying avian seasonal muscle hypertrophy are, however, not clearly understood. There are certain evidences from different species such as myostatin, a growth inhibitor which is highly conserved in birds and mammals, is likely suppressed during skeletal muscle growth (Piersma and van Gils, 2011). A study on white-throated sparrows compared the wintering and migratory phenotypes and suggested a role for insulin-like growth factor 1 (IGF-1) in regulating muscle phenotypic flexibility during endogenous seasonal preparation for migration. However, these changes were observed only in captive birds and did not hold true for wild individuals (Price et al., 2011). Interestingly, birds are also considered to be insulin resistant (Satoh, 2021). This raises further questions about the role of IGF-1 in birds, as its regulation in mammals is closely linked to insulin, making its function in avian physiology potentially more complex and controversial. Fudickar et al. (2016) reported several genes related to lipid transport, energy metabolism and mitochondrial function to be upregulated in blood and flight muscles during pre-migration stages in Dark-eyed junco. A study by Singh et al. (2015) on blackheaded buntings (Emberiza melanocephala) further revealed that core circadian genes- per2, cry1, bmal1 and clock undergo changes in their phase and amplitude under different photoperiodic conditions in muscle tissues. Earlier studies in zebrafish myotome (Kelu et al, 2020) and in mice (Schiaffino et al., 2016) have discussed the role of clock genes in muscle growth, this hypothesis needs to be tested in migratory birds especially when they show a distinct change in the expression pattern of core clock genes between wintering and migratory state.

Past research has uncovered many patterns — from changes in muscle mass to shifts in gene expression — but the exact molecular mechanisms behind these transformations remain poorly understood. Hormones like IGF-1, gene networks involved in metabolism, and even internal circadian clocks may all play roles, but their interactions is still not fully understood. As we continue to investigate how these feathered athletes fine-tune their bodies for an endurance flight, we not only gain insight into migration but also uncover clues that could inform muscle biology and metabolism across species including humans.

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Light as a management tool in broiler poultry production

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Over past few decades, the Indian poultry industry has evolved dramatically. Poultry farming which was considered as a backyard venture before the 1960s has now become a full time agri-business (Mehta and Nambiar, 2013). This shift is driven by a rapidly increasing population and a rising demand for animal proteins like chicken meat. Before 1960, it took around 84-112 days (12-16 weeks) or more for broilers to reach a weight of 2.2 kg. By the 1990s, this time had reduced to 42-49 days. Fast-forward to the current era, and modern broilers can reach the same weight in just 30-35 days. This hugereduction in growth time is achieved by the help of advances in genetics, nutrition, and management practices.

Duration of light exposure is one such lesser-known but powerful management tool in poultry production. The physiology and behavior of birds are significantly influenced by light exposure. In the poultry industry, lighting regimens with extended photoperiods are commonly used to optimize the growth and productivity of broiler chickens. Photoperiodism(the response of an organism to the duration of day or night) affects feeding behavior, growth performance, welfare, and physiological responses. The duration of light exposure directly impacts feed intake, growth rates, and stress levels, making it a key factor in efficient broiler production.

While extended photoperiods such as 24 hours of continuous light (24L:0D) can enhance growth, they may also increase stress and the risk of skeletal and metabolic disorders. These issues can lead to poor welfare outcomes and higher mortality rates. Conversely, shorter or intermittent photoperiods reduce stress and physical strain but may slow down growth. Striking a balance is therefore crucial.

A study by Kim et al. (2022) compared different light schedules i.e. 24 h continuous light (24L:0D), 18 h light (18L:6D), 8 h light (8L:16D), and intermittent light (4L:2D). They measure several physiological parameters including body weight gain, feed intake, heterophil-to-lymphocyte ratio and interleukin-6 (immune status), aspartate aminotransferase (liver health) and corticosterone levels (stress). The overall results suggestedthat the photoperiod of 18L:6D recommended by the welfare standard is appropriate, considering the performance parameters and stress of broilers. When the performance of broilers improved with the prolonged photoperiod, it resulted in increased stress, whereas when the stress levels decreased with the reduced photoperiod, the performance also decreased.

Lewis and Gous (2007) further showed that shorter photoperiod (6L) is associated with reduced mortality and skeletal health, while Lewis et al. (2008) noted increased nocturnal feeding in shorter-light schedules (≤12 hours), adding nuance to the timing strategy.

There is no one-size-fits-all solution. The optimum photoperiod for broilers likely varies by age, genetic line, and production goals. However, 18 hours of light followed by 6 hours of darkness (18L:6D) appears to offer a practical and ethical balance between productivity and animal welfare. Poultry producers and farm managers should consider age-specific photoperiod schedules that support both bird welfare and economic viability, moving away from the outdated idea of more light equals better growth.

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3 Temporal Regulation in Birds through Multiple Clock Centres

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Circadian rhythms are ubiquitous in nature and they allow organisms to anticipate and adapt to daily environmental fluctuations (Kumar and Sharma, 2018). In vertebrates, these rhythms are typically governed by a system of interlinked oscillators, which may be organised in a hierarchical structure or operate as interconnected units. In mammals, this system is hierarchical: the suprachiasmatic nucleus (SCN), located in the anterior hypothalamus, serves as the central pacemaker that synchronises peripheral clocks. In contrast, birds exhibit a more distributed system, with at least three distinct pacemaking centres: the hypothalamus (avian SCN), the pineal gland, and the retina (Gwinner et al., 1997). These avian clocks remain functionally interconnected, working together as an integrated system known as the central clocking system (CCS) (Kumar et al., 2004). The clocks in the retina, pineal gland, and hypothalamus are capable of detecting light, generating self-sustained rhythms, and regulating a broad range of physiological and behavioural processes (Kumar and Sharma, 2018).

During vertebrate evolution, mammals and birds diverged in their circadian organisation due to differences in their ecological histories and photic environments. Early mammals are thought to have passed through a "nocturnal bottleneck", a period during which they were primarily nocturnal, likely as an adaptive response to predation by dominant diurnal reptiles. In these dim-light conditions, only the retina provided reliable photic input, rendering extraretinal photoreceptors such as those in the pineal gland or deep brain redundant. In contrast, birds remained largely diurnal or crepuscular, retaining multiple light-input channels, including the retina, pineal gland, and deep brain photoreceptors (Menaker et al., 1997). This multi-oscillatory system supports the precise timing required for complex behaviours such as migration and seasonal reproduction. Moreover, in birds and other non-mammalian vertebrates, photoreceptors are often co-located with circadian oscillators, allowing localised light entrainment and tissue-specific rhythmic control. Thus, the differences in circadian architecture between birds and mammals reflect adaptive evolutionary responses to distinct environmental and behavioural demands (Menaker et al., 1997).

The retina in birds exhibits multiple circadian outputs that have been characterised. Firstly, rhythmic electrical activity from retinal neurons can be recorded as electroretinograms (ERGs), showing a pattern that reflects an internal circadian drive (McGoogan and Cassone, 1999). Secondly, cells in the outer nuclear layer of the retina exhibit circadian rhythms in the activity of arylalkylamine N-acetyltransferase (AANAT)—the enzyme responsible for a key step in melatonin synthesis (Bernard et al., 1997; Kumar et al., 2004). The pineal gland in birds contains opsins capable of detecting light, confirming its role in photoreception (Cassone, 2014). Among its circadian outputs, melatonin secretion is the most prominent and well-studied. In light–dark (LD) cycles, melatonin levels remain low during the day and rise at night; a similar increase occurs during the subjective night under constant conditions such as dim light (LLdim) or constant darkness (DD). Notably, the environmental LD cycle influences both how long and how strongly melatonin is secreted by the pineal gland (Kumar et al., 2004). Further, in early efforts to localise a circadian centre in the avian hypothalamus, two experimental strategies were employed: selective lesions of specific hypothalamic areas and neuronal tract tracing from the retina (Kumar et al., 2004). These approaches identified two potential SCN structures in birds. The first, referred to as the medial SCN (mSCN), is activated by light, as shown by immunoreactivity studies (Norgren and Silver, 1989). However, it does not receive direct retinal projections via the retinohypothalamic tract (RHT), and it remains uncertain whether it receives indirect input either from retinal sources or from other photoreceptive sites (Kumar et al., 2004). The second structure, the visual SCN (vSCN), was identified through RHT tracing studies in species like the house sparrow (Cassone and Moore, 1987). This region lies more laterally and posteriorly compared to the mSCN and is structurally more similar to the mammalian SCN due to its direct retinal innervation (Kumar et al., 2004).

The role of each oscillator within the CCS can be assessed by selectively removing it and examining the resulting changes in behaviour or rhythmic gene expression, thereby revealing its individual contribution to the overall system.

McMillan and colleagues demonstrated that house sparrows without eyes (enucleated) continued to show free-running rhythms under dim LD cycles that normally entrain sighted birds, suggesting that the eyes are at least likely to enhance the circadian system's sensitivity to light cues (McMillan JP, 1975; Kumar et al., 2004). Further support for the retina’s autonomous role in circadian regulation came from studies on chickens and quails (Kumar et al., 2004). Notably, work by Steele and colleagues revealed that the circadian pacemaker cells in the quail retina support the broader circadian system. This was based on several observations: 1) The eyes possess an intrinsic circadian clock that regulates daily melatonin production within the eye, and this ocular clock is believed to influence other physiological rhythms throughout the body. 2) When the eyes are removed, rhythmic patterns—such as those of locomotor activity, body temperature, and pineal melatonin secretion—disappear under constant darkness (DD). 3) Moreover, these desynchronized clocks can quickly re-align when placed under constant environmental conditions (Steele et al., 2003; Kumar et al., 2004). Additionally, the avian retina expresses key clock genes that are integral to the transcriptional-translational feedback loops that drive circadian timing (Kumar et al., 2004).

Experiments by Gaston and Menaker (1968) showed that the pineal of the sparrow is required for maintenance of its locomotor activity rhythm in constant conditions but is not necessary for the entrainment response to the light cycle. When a light cycle entraining a pinealectomized bird is discontinued, the pattern of activity "decays" rhythmically into arrhythmic activity (Gaston and Menaker, 1968). One interpretation of their work was that the pineal functions as a self-sustained oscillator that normally drives another, more weakly rhythmic (damped) oscillator, which directly regulates activity. In this framework, the gradual loss of rhythmicity in constant dark (DD) following pineal removal could reflect the damping of the secondary oscillator. Under light dark (LD) cycles, this remaining oscillator may be directly driven by light, allowing entrainment even in the absence of the pineal gland (Gaston and Menaker, 1968; Cassone, 2014). Another hypothesis proposed was that the pineal acts as a coupling agent in a system composed of multiple oscillators. In this model, the pineal maintains consistent phase relationships among the various circadian components. Once removed, these oscillators may become desynchronized, gradually drifting out of phase and leading to arrhythmic behaviour under constant conditions. The fact that LD cycles can still restore coordinated rhythms without the pineal suggests that external light cues alone can reestablish synchrony among the remaining oscillators (Gaston and Menaker, 1968). Notably, circadian rhythms disrupted by pinealectomy can be restored through transplantation. When a donor pineal gland is grafted into the anterior chamber of the recipient bird's eye, rhythmicity reappears (Zimmerman and Menaker, 1979). This reconstituted system behaved in two key ways: first, its phase aligns with that of the donor gland; second, it continues to function reliably over long durations and responds normally to external light cues (Zimmerman and Menaker, 1979; Cassone, 2014).

To establish the significance of the SCN in the avian circadian system, Takahashi and Menaker conducted lesion experiments targeting the hypothalamus in house sparrows. They observed that damaging this area caused a notable disruption of circadian rhythmicity, even in birds with intact pineal glands (Takahashi and Menaker, 1982; Kumar et al., 2004). Although SCN-lesioned sparrows were able to synchronise to standard LD 12:12 cycles, they failed to entrain to weaker light signals, such as an LD 1:24 cycle. The effects of SCN lesions were broadly comparable to those of pinealectomy. However, in the case of SCN lesions, they observed ambiguous cases of entrainment in sparrows that were completely arrhythmic. Furthermore, it was difficult to observe a phase lead of the activity rhythm to the light cycle LD 12:12; in LD 1:24, the entraining cycle was too weak to synchronise the system after lesioning (Takahashi and Menaker, 1982). Further analysis of the avian SCN has revealed a functional distinction between its two major subdivisions: the visual SCN (vSCN) and the medial SCN (mSCN). The vSCN receives direct input from the retina via the retinohypothalamic tract (RHT) and demonstrates rhythmic electrical and metabolic activity. It also has melatonin receptor binding sites and responds to exogenous melatonin with reduced metabolic function (Cassone et al., 1995; Lu and Cassone, 1995; Reppert et al., 1995; Rivkees et al., 1989; Cassone, 2014). On the other hand, experiments by Yoshimura and team (2001) have shown that in pigeons, mSCN lesions produce a loss of expression of their circadian free-running rhythm but not of their photoentrainment capability. Lesions of the mSCN resulted in a phase lead in LD cycles and arrhythmicity or disorganised rhythms under dim constant light (LLdim). In these birds, residual rhythms vanished under both LD and LLdim, suggesting that in the absence of the mSCN, the pineal and/or retinal clocks are required to uphold rhythmic behaviour. Notably, the vSCN remained intact in these experiments. Moreover, when the vSCN alone was lesioned in pigeons, locomotor rhythms were unaffected (Yoshimura et al., 2001).

Despite significant advances in understanding the avian circadian system, there are several gaps in our knowledge. While birds are known to possess a distributed circadian architecture involving the retina, pineal gland, and SCN (especially the mSCN), the precise mechanisms of communication and coordination among these oscillators are still poorly understood. It remains unclear whether these components act as independent oscillators or as semi-autonomous units coupled through yet-uncharacterized feedback loops. Moreover, although lesion and transplantation studies have shown the individual contributions of these oscillators, the molecular pathways underlying their interaction and redundancy, particularly how compensation occurs following damage or loss of one oscillator, remain to be fully elucidated. Finally, integrating behavioural, molecular, and neuroanatomical data into systems-level models of avian circadian timing could illuminate principles of oscillator coupling and plasticity that are relevant across vertebrates, including humans. Birds maintain a multi-oscillatory but highly integrated system, thus, they offer a valuable comparative framework for understanding the evolution and robustness of circadian networks.

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CLOCK CROSSWORD

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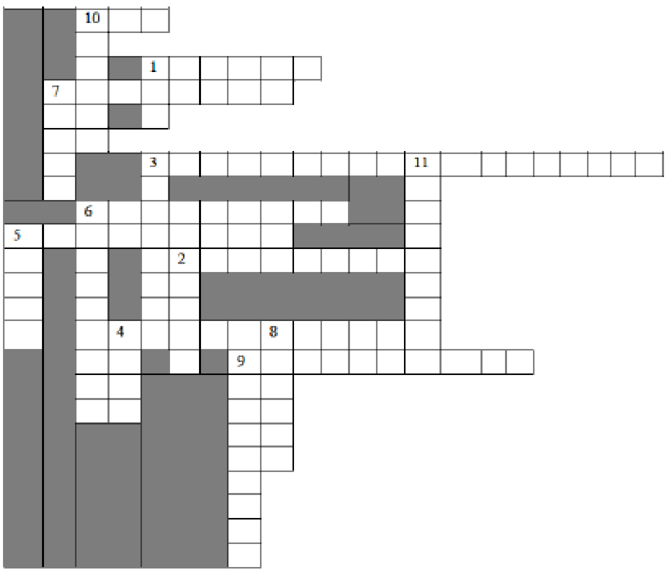
ACROSS

1. CIRCADIAN DISRUPTION DUE TO CHANGE IN TIME PERIOD. (6 LETTERS)
2. OSCILLATION RATE OF CIRCADIAN RHYTHM. (9 LETTERS)
3. EXTERNAL CUES WHICH SYNCHRONIZE BIOLOGICAL CLOCK. (9- -LETTERS)
4. WHO IDENTIFIED THE PERIOD (PER) GENE. (6 LETTERS)
5. HORMONE WHICH CONTROLS YOUR SLEEP- WAKE CYCLE. (9 LETTERS)
6. SIGNAL PROTEIN FOR CIRCADIAN CLOCK DEGRADATION. (9 LETTERS)
7. STRESS HORMONE WHICH HELPS IN WAKING UP. (8 LETTERS)
8. MELANOPSIN, WHICH REGULATES CIRCADIAN CLOCK IS PRESENT IN (6 - - LETTERS)
9. INDIVIDUAL DIFFERENCES IN CLOCK BEHAVIOUR. (10 LETTERS)
10. BLUE LIGHT-SENSITIVE CIRCADIAN CLOCK PROTEIN. (3 LETTERS)
11. BIOLOGICAL RHYTHM LONGER THAN 24H. (9 LETTERS)

DOWN

1. METHOD OF IDENTIFYING RHYTHMIC COMPONENT ___ CYCLE .(3- LETTERS (ABBREVIATION))
2. FATHER OF MODERN CHRONOBIOLOGY. (5 LETTERS)
3. BLUE LIGHT PHOTORECEPTOR IN *Arabidopsis thaliana*. (9 LETTERS)
4. CRY AND PER GENES ARE REGULATED BY ------- PROTEIN . (4 LETTERS)
5. ANIMAL MODEL WHICH IS USED IN CHRONOBIOLOGY RESEARCH. (5 LETTERS)
6. BIOLOGICAL RHYTHM SHORTER THAN 24H. (9 LETTERS)
7. A GENE THAT MAINLY CONTROL CIRCADIAN RHYTHM – (5 LETTERS)
8. REPETITIVE ENDOGENOUS TEMPORAL PATTERN. (6 LETTERS)
9. AN ENDOGENOUS RHYTHM. (9 LETTERS)
10. STUDY OF CIRCADIAN CLOCK IS KNOWN AS ______ BIOLOGY. (6 LETTERS)
11. DISRUPTION OF RHYTHMS DUE TO SHIFTWORK CAN CAUSE THIS) DISORDER. (8 LETTERS)



InSC in action : Events of the year

Understanding Biological Clocks – theoretical framework to cellular basis

INDIA | EMBO
LECTURE COURSE

Neeti, Vimal, Kamakshi – JNCASR; Anjoom, Thanmayee – NCBS

28TH FEBRUARY TO
9TH MARCH 2025

Introduction

Chronobiology school (or chronoschool), a lecture course for training students in the field of chronobiology was initiated in 2002. Since then, it is being organized regularly by various chronobiology labs in India. This year's lecture course titled as "Understanding Biological Clocks – theoretical framework to cellular basis" was organized by Prof. Sheeba Vasu (Jawaharlal Nehru Centre for Advanced Scientifi Research, JNCASR, Bengaluru) along with co-organizers Dr. Shaon Chakrabarti (National Centre for Biological Sciences, NCBS, Bengaluru), Prof. Aarti Jagannath (University of Oxford, UK), Prof. Gisele Akemi Oda (University of Sao Paulo, Brazil) and Prof. Eun Young Kim (Ajou University, South Korea). The course was supported by India-EMBO lecture series and funded by European Molecular Biology Organization (EMBO) and International Brain Research Organization (IBRO). Additional funding was received from and Anusandhan National Research Foundation (ANRF) as well as the Indian Society for Chronobiology (InSC). The school was held in JNCASR campus and student accommodation support was provided by NCBS. Over a span of eight days, from 28 Feb to 7 March, 2025, the course was designed to cover basic concepts in the field of chronobiology along with hands-on laboratory exercises.

The course was aimed to impart training in chronobiology to master's and PhD students, early career scientists, teachers and clinicians. It taught core principles of biological clocks at theoretical, cellular and circuit levels, ensuring exposure to the latest methods for time-series analysis of behavioral and molecular data along with hands-on laboratory exercises.

Along with commonly used methods for data collection for biological variables (ABPM for blood pressure), course also employed use of wearable device called Ultrahuman ring AIR in collaboration with Ultrahuman company for high-throughput, automatic data collection and later used for data analysis. The school also took a step towards reducing carbon footprints by providing pens made from recycled cardboard, metal bottle and cloth bags instead of using plastic.

More than 18 chronobiologists from India and across the world participated in teaching using traditional lecture-based as well as innovative interactive sessions. Around 31 students including 3 international students took part in school making this chronobiology school in India, one with the largest participation to date. In addition to the registered participants, several volunteers from the local institutions – JNCASR and NCBS engaged in various aspects of conducting the lectures, lab sessions and overall organisations and thus benefitted from the academic atmosphere and activities of the event.

Dedicated sessions were arranged to provide registered participants with the valuable opportunity of informal interactions with eminent researchers from across the globe and at different career stages. These sessions enabled discussion on a range of topics from career counselling to mental health and advice on work-life balance.

After completion of the school events, a two-day satellite meeting titled "Ultimate and proximate forces shaping biological rhythms – cell-cycle to seasonality" was organized, where speakers of the course and other Indian chronobiologists from across the country presented their latest research findings. Selected student participants also got an opportunity to present their ongoing research or their research plans via oral presentations and posters.

Details of the teachers and the attendees

The workshop's attendance included students from vastly different academic backgrounds and varying years of research experience. PhD students and master's students made up much of the student population. The lectures were conducted by experts from various disciplines of chronobiology, with experience of working with either humans or different model organisms. The topics covered in about 25 classes were extensive and included several basic concepts that laid the foundation for several upcoming advanced topics that followed them in the later classes. The first few classes, conducted by Dr. ShaonChakrabarti and Dr. Sheeba Vasu, set the stage by talking about the history of the field and how initial discoveries were made. This was followed by a session by Dr. Sheeba, where she discussed the adaptive significance of having a circadian clock. Dr. Shaon also discussed the theoretical modelling of a sine wave oscillator, and these calculations were further used to understand several critical concepts of a clock, such as entrainment and range of entrainment. These lectures were followed by talks on neuroanatomy and the historical findings and functional importance of the brain region that dictates the circadian rhythms, conducted by Dr. NK Subhedar and Dr. Aarti Jagannath, respectively. These sessions then led to talks by Dr. Charlotte Forster on the molecular framework of the clock and insect circuitry, which has historically been utilized to understand the neuronal underpinnings of the clock. This led to sessions by Dr. Abhishek Chatterjee on understanding the importance of synchronisation of oscillators, with examples from insect behaviour and fly neuronal circuitry. We also had a session by Dr. Eun Young Kim on the post-translational modifications that modulate the central transcription translation feedback loop. These sessions led to talks on human circadian rhythms by Dr. Christian Cajochen and Dr. Shantha Wilson. Dr. Christian discussed the rhythms in human sleep and what are the different models in the field that have tried to understand this behaviour. On the other hand, Dr. Shantha discussed various sleep disordersand how shift work and other social paradigms can exacerbate or lead to diseases. We also had sessions by Dr. Katja Lamia, who discussed the important findings related to the role of circadian clocks in metabolism and cancer. These sessions were followed by an interesting session by Dr. Shahnaz Lone on findings associated to social cues which can also be utilised as a time cue by the clocks. We had a few final sessions on understanding new and advanced techniques for looking at circadian rhythms and on rhythms which occur on a yearly basis by Dr Sandipan Ray and Dr. Vinod Kumar, respectively.

In addition to these, the school conducted three special lectures on microscopy techniques by Mr. Ganesh Kadasoor, modelling behaviours by Dr. Mewa Singh and presentation skills by Dr. Anand Krishnan.

Mr. Ganesh talked about how various microscopic techniques could be employed to visualize biological samples and how some of these could be used to study rhythms and rhythmic patterns in neuronal firing. Dr. Mewa Singh explained various social behaviours exhibited by individuals, how natural selection shapes these behaviours and compared the effect of selection at individual and group level. Dr. Anand Krishnan held a very interactive session on how to present research to a wide range of audiences and general rules of presentation. His talk would help in a crucial skill development among the attendees.

Hands-on Laboratory activity sessions

The lectures delivered by experts in the field were further supported by multiple hands-on laboratory activity sessions. These sessions were conducted to help participants understand circadian rhythms across different organisms, as well as methods for estimating and quantifying these rhythms. The laboratory activities began with a lecture by Ms. Mansi Rathi, a PhD student under Prof. Sheeba Vasu, who introduced various rhythm parameters and markers used to characterize and quantify biological rhythms.

Following this, Ms. Rathi, along with Mr. Surajit Dawn, conducted a hands-on session on eclosion rhythm and activity–rest rhythm assays in Drosophila melanogaster, which were among the first circadian rhythms to be studied and characterized, in establishing the field. The laboratory session included demonstrations of setting up both assays, followed by data collection for the eclosion assay at 4-hour intervals by each group, and subsequent data analysis. Additionally, all participants were asked to complete a chronotype questionnaire, based on which their chronotype were assessed. Dr. Abhilash Lakshman analyzed the responses and identified three early and three late chronotype individuals. Salivary melatonin levels from these selected participants were estimated every 4 hours using melatonin assay kits. The data were analyzed under the guidance of Dr. Akansha Sharma, with support from Ms. Kamakshi Tomar, to assess differences in melatonin rhythms between early and late chronotypes.

Furthermore, Dr. Babita Pandey conducted a session on assessing blood pressure rhythms using the Ambulatory Blood Pressure Monitor (ABPM). In this session, the blood pressure of voluntary participants was monitored at 2-hour intervals to understand the diurnal variations in this rhythm among humans.
The sessions concluded with hands on estimations of rhythmic molecules such as timeless mRNA, which form a crucial part of molecular loop present within biological clocks, from fluitfly heads by each group. The setup and data analysis for this conducted by Ms. Neeti Badigannavar and Ms. Kamakshi Tomar, PhD students under Prof. Sheeba Vasu.
In addition to these sessions, there was continuous data being recorded for various parameters such as sleep, heart rate, body temperature of all the participants by a wearable device, UltraHuman ring. This ring was provided to the participants upon start of the school and data recording was carried out and displayed on a mobile application by the same company. This data was further extracted and analyzed by one of the groups for their group presentation, where they discussed variability in various parameters being measured and compared them to readings obtained from other lab activities to comment upon the accuracy of the wearable.

Prizes

There were awards for the highest score in daily quizzes and the best group presentation, which were presented at the end of the workshop. Vismaya Prakash bagged the award for the highest score in daily quizzes. The best group presentation award was won by Group Chandrashekaran.

Daily Quizzes

The participants also had daily quizzes based on the topics covered in the session on the previous day. This pushed the participants to revise the concepts after the talks and digest the ideas, and come up with doubts the next day, which could be actively discussed throughout the day. This ensured that there was clarity of concepts to all the participants.

One-on-one discussion sessions with speakers

There were two designated discussion sessions where the participants were allowed to talk to all the speakers freely regarding any topic. Each group was given about half an hour with a particular speaker. Such interactions helped all the participants to get more comfortable with everyone, and they could also discuss things in a more candid fashion. The discussions were free-flowing and were mainly guided by students. The topics ranged from discussing experiences and academic trajectories to talking about exciting things about chronobiology.

Women in Science Session

This was a very special and enriching session in the workshop. The session commenced with Prof. Charlotte talking about her struggles in her academic career, and different challenges that she had faced due to disparity in societal expectations across the genders. The floor was then opened to questions and discussions. People brought on their own experiences, and what sort of amends should be made to make sure that such disparity does not continue to persist. The discussion was moderated by Prof. Sheeba. Several panelists were also invited to lead the discussion.

The panel included Shaon Chakrabarti, Abhishek Chatterjee, Charlotte Forster, Katja Lamia, and Achira Roy. They also added their experiences and thoughts to the ongoing discussion. The women in the panel also resonated with the things brought about by Prof. Charlotte in her talk reflecting how things have not changed much over the past several years. This further necessitates the need for bring amends to make working science more equitable for women. A few interesting thoughts that emerged from the discussion included acknowledging the societal gap in expectations for women and this acknowledgement itself could be a step towards bringing change in the longer run.

Trip to Nrityagram

Nrityagram is a dance village located in Hessaraghatta, Bengaluru. It is inhabited by an ensemble of dancers who cherish the traditional Gurukul style of learning Odissi, which is a 2000-year-old Indian classical dance form. The place offers a tour which includes a tour around the property and a short lecture demonstration from the resident artists. A tour for all the participants, speakers, and volunteers was arranged at Nrityagram. We were graciously

guided throughout the dance village, which now contains several beautiful pieces of architecture. We were also fortunate enough to observe a lecture demonstration by Guru Surupa Sen and her students Ms. Pavithra Reddy and Ms. Anushka Rehman. They began by discussing the history of the Odissi dance form and the region's history. They also performed one of their recent pieces of choreography, which left all the spectators mesmerised. The visitors left Nrityagram with an enhanced enthusiasm and refreshed and energetic minds.

About Kits

We were fortunate enough to have our workshop kits made by Care Factory. This is an initiative to support the mental health causes of MS Chellamuthu Trust and Research Foundation. It strives to support the rehabilitation and provide a livelihood to families and individuals affected by mental disabilities.

Groups and Mentors

We were divided into 4 groups, each consisting of 8 to 9 members, named after the pioneers in Chronobiology - Group A: Aschoff, Group B: Pittendrigh, Group C: Chandrashekaran and Group D: Daan. The groups were mentored and guided throughout the school to help clear any doubts, engage in discussions and assist in experiments. The Group A was mentored by Ms Mansi Rathi, Group B by Mr. Anuj Menon and Dr. Babita Pandey, Group C by Dr. Aakanksha Sharma and Dr. Roshan Fatima Begum, and Group D by Mr. Surajit Dawn and Dr. Shahnaz Rahman Lone.

Theoretical Exercises – Python Session

A session on the basics of Python programming language was led by Anjoom Nikhat and Thanmayee Gore. Strings, mathematical operations, conditional and loop statements using for, while and if/elif/else and writing small functions. The students also coded out a few exercises like printing even/odd number, Fibonacci sequence etc.

The group presentations were on the results of four of the laboratory exercises conducted as part of the school – Analysis of Sleep Data from Ultrahuman rings, Drosophila Eclosion, Blood Pressure Monitoring using ABPM and qPCR of circadian genes from Drosophila heads. While all groups performed all the exercises, based on lottery, each group presented the findings of one of the exercises after collating the data from all.

The Aschoff Group presented the evaluation of relationship between melatonin release and sleep onset. The results of the melatonin assay sampled every 4 hrs from 9 am and the sleep data from the Ultrahuman Ring were correlated for the analysis. The assay was not successful in the identification of the melatonin onset for most of the participants. The early and late types showed no difference. The Pittendrigh Group presented the findings of the eclosion essay on three genotypes that were characterized into Early, Control and Late types based on the onset, offset and peak phases from the obtained data. The analysis of blood pressure data from the ABPM by the Chandrasekhar Group revealed the cyclic rise and fall of the blood pressure over a circadian cycle. Cosinor analysis was used to analyze and quantify cyclical patterns in time series data. The analysis of the qPCR for the quantification of the timelessmRNA levels in *Drosophila melanogaster* for the three genotypes - Early, Control and Late - by the Daan Group showed that the tim mRNA showed varying expression levels in a circadian cycle with all three peaking at ZT15 (few hours after lights off) but with different amplitudes and waveforms. Anotherobservation was that the tim mRNA levels had an early rise in the Early genotype compared to the Control. In addition, the Late genotype had amplitudes lower than the Control.

Dr. Abhilash Lakshman, City University of New York, US, led two online sessions on Time Series Analysis. The first session gave a primer on the terminologies and conventions in the Chronobiology field like

Zeitgeber Time (ZT), Circadian Time (CT), External Time and Internal Time. The Continuous/Parametric and Instantaneous/Non-parametric models for entrainment and zeitgebers by Aschoff and Pittendrigh respectively, were introduced. The applicability and limitations of these models were also discussed. In addition, Phase Response Curves (PRC) and Velocity Response Curves (VRC) were discussed in great detail that are closely related to the above models. The second session dealt with the time series analysis were the various methods currently used in the field, such as ANOVA, Autocorrelation, COSINOR and Wavelet Analysis were introduced along with caveats on the applicability of the different methods on specific data types.

Satellite Meeting summary

A satellite meeting was held in conclusion to the INDIA–EMBO Lecture Course on Understanding Biological Clocks; on 8th and 9th March 2025 at JNCASR, Bengaluru, titled "Ultimate and Proximate Forces Shaping Biological Rhythms: Cell Cycle to Seasonality." It was styled in the form of a conference and organized into eight scientific sessions, during which faculty members who had delivered lectures during the course, along with other chronobiologists from across India and students from various institutions, presented insights into their ongoing and latest research. A total of

The sessions focused on diverse aspects of biological rhythms and clocks, including their adaptive significance, seasonal regulation of biological clocks, the neurobiology of circadian organization and its molecular underpinnings. Additionally, there were sessions dedicated to the role of circadian clocks in physiology, the consequences of circadian misalignment on health, and theoretical frameworks underlying clockwork function.

The Indian Society for Chronobiology (InSC) held their general body meeting during the satellite conference, where they discussed the aims and goals of the society. The President Prof Vinod Kumar, as well as other EC members invited students to enroll as members of InSC and to spread the word regardingthe benefits of associating with the Society.

In addition to the oral sessions, two poster sessions were conducted, providing students from diverse institutions an opportunity to present their research work to all participants and a panel of judges. The panel of judges evaluated the posters based on scientific merit, originality, and clarity of presentation. Dr. Borja Ferrero-Bordera won best oral presentation prize among the student talks and Ms. Kamakshi Tomar bagged first prize for best poster presentation.

The conference concluded with a gala dinner and networking with many eminent scientists and researchers in the field.

InSC in action : Events of the year

Visit by InSC members to the European Biological Rhythms Society meeting, Lubeck, Germany

XVIII EBRS CONGRESS

24TH TO 28TH AUGUST 2025

In print: Articles (Jan-Jun 2025)

JANUARY

FEBRUARY

MARCH

T. Stevenson, A. Liddle, S. Meddle, J. Pérez, S. Peirson, R. Foster, G. Majumdar. Hypotheses in light detection by vertebrate ancient opsin in the bird brain. J Neuroendocrinol. 2025 Mar 16:e70020

APRIL

A.Nikhat, A. Shaikh, S. Chakrabarti. Combining lineage correlations and a small molecule inhibitor to detect circadian control of the cell cycle. iScience 2025 April 28; 4: 112269

L. Mondal, A. Mondal, S. Sahu. Abnormal eating behaviors among female college students (18–23 years): a chrono-nutritional study, Biological Rhythm Research, 2025 April 56 (9).

MAY

JUNE

A. Sharma, S. Rao, R. Manjithaya, S. Vasu. Differential response of neurons to autophagy modulation in Huntington's disease. Autophagy Rep. 2025 Jun 30;4(1):2519102

Grants and Fellowships (Jan-Jun 2025)

JANUARY

FEBRUARY

MARCH

'Clock control of Drosophila egg-laying: revelation of the underlying neural circuit that integrates circadian regulation with sensory plasticity' is a joint research project between Abhishek Chatterjee, Institute of Ecology & Environmental Sciences iEES-Paris, Versailles and Sheeba Vasu, Jawaharlal Nehru Centre for Advanced Scientific Research, (JNCASR), Bangalore. March 1st 2025 - February 27th 2028

APRIL

MAY

DBT-NER Major Project on Seasonality in vertebrate physiology .
P.I: Dr. Amit K Trivedi; Mizoram University and Dr. Gaurav Majumdar; University of Allahabad. Start date: May 2025

JUNE

Dr. Subhashis Sahu was conferred the Fellowship of the Physiological Society of India (FPSI) 2025 for extraordinary contribution in the field of Physiology.

Prof. Vinod Kumar was awarded the Prime Minister's Research Professorship Award for the year 2025

Next in the clock : Upcoming events

EMBO | EMBL SYMPOSIUM, HEIDELBERG

BIOLOGICAL OSCILLATORS: RHYTHMS AND SYNCHRONISATION ACROSS SCALES

https://www.embl.org/about/info/course-and-conference-office/events/ees26-04/

THE SOCIETY FOR RESEARCH ON BIOLOGICAL RHYTHM

2026 BIENNIAL MEETING, OMNI AMELIA ISLAND RESORT & SPA

https://srbr.org/2026-biennial-meeting/

INFORMATION

SHARE YOUR FEEDBACK

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