In the context of the wide-reaching impact of sleep and its disorders on biology, health and disease, Professor Richard Horner discusses the need to expand the field, revealing the progress he and his collaborators are making with their new broad-based initiative.

Could you provide a synopsis of your background? How did you become interested in physiology?

As a high school student in Lincoln, UK, I was strongly interested in biology in general and the workings of the body in particular. After reading more about those areas, I decided to pursue a degree in physiology, and did so at the University of Sheffield. Even at that time I was thinking about a university career as a physiologist, although as a high school student I did not really know what that fully entailed. Nevertheless, as I learned more about physiology through classes, reading, experiments and some excellent professors, I realised I had chosen the right path.

I went on to undertake a PhD at the University of London and subsequently, postdoctoral work at the University of Toronto, and then the University of Pennsylvania. I returned to a faculty position at the University of Toronto where I have worked since 1997. My interest and commitment to the field has continually grown.

What inspired you to establish Sleep and Biological Rhythms Toronto?

My commitment to research and educational activities, team building and programme growth inspired me to establish this initiative. I felt that although there is some top class research activity in sleep and biological rhythms at the University of Toronto and its affiliated institutions, there were problems of isolated silos of excellence, stagnated growth and missed opportunities for additional growth. At the same time, a request for applications to grow research teams in Canada in sleep and circadian biology was introduced by the Canadian Institutes of Health Research (CIHR), and this impetus was pivotal.

Is enough research conducted on sleep and circadian rhythm disorders?

There are certain subjects that simply span so many biological disciplines, medical specialties and subspecialties that they have no ‘home’ or champion because they have such a wide reach and constitute a smaller component of many larger subjects. A lack of training and research was recognised by the National Institutes of Health (NIH) some time ago, leading to the establishment of the National Center on Sleep Disorders Research to coordinate federally funded research, training and education in sleep and biological rhythms across the NIH institutes.

More recently, the Institute of Medicine of the National Academies also provided recommendations for building effective programmes in these areas because the causes and consequences of sleep and circadian rhythm disorders are relevant to a variety of disciplines. In Canada, however, it was not until recently that the fields of sleep and biological rhythms were specifically sponsored as a priority, and this was via the Institute of Circulatory and Respiratory Health at CIHR.

How can the situation be improved in Canada?

I think Canada would benefit from the type of structure that exists in the US; an entity to coordinate research, training and education in sleep and biological rhythms across the CIHR institutes. Sleep and its disorders is a subject...
that encompasses the interests and mandates of all CIHR institutes, not just one or two – not many subjects can say the same.

What can be done to attract more researchers to this interdisciplinary field?

This is an excellent and critical question, and a source of one of the major problems in the field, in my opinion. The problem and its resolution boil down to two issues: should we be training and generating more sleep and/or circadian rhythm researchers who can expand the field from within; or should we be encouraging researchers from outside the field to incorporate sleep and/or circadian rhythm research into their disciplines by involving them in collaborative projects and access to trainees who then become engaged in their field?

Common thinking favours the former (likely because it protects the status quo) but our programme focuses on the latter. It is highly unlikely that a world-class endocrine, memory or anaesthesia researcher (to take three examples) will switch and suddenly become a self-identified ‘sleep researcher’. It is both unnecessary and unrealistic. We chose the second approach to expand the field by engaging with other disciplines because of the potential for new innovation, science and collaborations. The only necessary change in thinking is to accept and encourage that new innovation and growth in the field can occur outside the status quo, and this view can apply to any interdisciplinary field. In my opinion, insularity and protecting silos can hinder advances.

Responding to a gap in the basic research and healthcare landscapes, an exciting interdisciplinary initiative at the University of Toronto, Canada, is fostering the emergence of new and growing programmes incorporating sleep and biological rhythms

PRESENT IN MAMMALS, birds, reptiles and other animals, sleep is essential for optimum health and longevity. In short, sleep and circadian rhythms are fundamental components of our biology and their importance to health cannot be underestimated. Sleep and biological rhythms significantly influence cellular as well as physiological and mental processes – disrupted sleep patterns and insufficient sleep are linked to a whole host of prevalent acute and chronic health problems, including breathing difficulties, cardiovascular disease, obesity, diabetes, cancer, and deterioration in mental health.

One in four Canadians complain of significant sleep problems. The harmful consequences of these problems impact on nearly all key indicators of human health, such as mortality, morbidity, performance and productivity, accidents and injuries, daily function and quality of life, safety, family wellbeing and healthcare utilisation. In attempts to counter these problems, Western society consumes both alerting and sleep-promoting drugs in large quantities, with significant cost to the healthcare system.

UNCOVERING MECHANISMS

Despite being recognised as integral to health and wellbeing, the purposes and inner workings of sleep are only partially clear, and remain the subject of ongoing research. Understanding the mechanisms underlying the links between sleep, circadian rhythm disturbances and acute and chronic health problems is a relatively new science. Unravelling these mysteries is central to the aims of a new collaborative research and training programme – ‘Sleep and Biological Rhythms Toronto’ – led by Professor Richard Horner from the University of Toronto, Canada. The programme includes a number of new, emerging and established researchers across a range of biological and medical disciplines, and is supported by the Institute of Circulatory and Respiratory Health of the Canadian Institutes of Health Research (CIHR).

Horner identified that a major obstacle to effective and significant advances in the fields of sleep and biological rhythms is a lack of researchers and trainees across a range of other disciplines who incorporate these fields into their research programmes. This led him to establish the novel interdisciplinary research, training and educational programme, which is also a team-building initiative. ‘Sleep and Biological Rhythms Toronto’ addresses the properties of brain states and biological timing systems, their mechanistic underpinnings, and their role in cellular, organ and organisational function and dysfunction.

FILLING AN IMPORTANT GAP

Horner is keen to establish sleep and biological rhythms into the mainstream of other scientific and clinical disciplines within the University of Toronto, and believes that these fields should be a component of high-impact research, generating new knowledge across disciplines to impact science and healthcare. Through the programme, Horner aims to increase capacity for research, education and knowledge transfer in fields encompassing sleep, sedation and biological rhythms. “Ultimately, the aim is to generate new fundamental knowledge that can also be put to use and impact health,” he explains. The programme is rooted in team building, peer review for collaborative projects, and developing new partnerships for further programme growth.

FOSTERING GROWTH AND DEVELOPMENT

Initially, the programme was structured to encompass broad themes such as sleep-wake states and behaviour, learning and memory, brain plasticity, mechanisms of sedation and respiratory depression, the causes and consequences of sleep apnoea, endocrinology, energy balance, cell function and metabolism, and biological rhythms. Equally expansive was the initiative’s range of model systems – spanning cell and molecular biology, cell cultures, fruit fly and rodent models, as well as human subjects; from babies to ageing adults.

Importantly, the programme was also open to trainees and researchers at any level of training or academic standing, the only requirement being: keen, willing and able to perform new science by incorporating sleep and biological rhythms into their projects, irrespective of their discipline. This accessibility, along with the intentionally broad-based theme, afforded the programme scope to grow organically; evolving in those areas demonstrating high levels of energy and activity.
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In combination with peer review-judged levels of excellence, several focused teams came into the spotlight in the early years of the initiative. Additional competitions were then introduced, with a view to further developing emerging programmes and uncovering new growth opportunities, with the hope that these new programmes could also generate support and become self-sustaining.

**NEW EMERGING PROGRAMMES**

’Sleep, Sedation and Anaesthetic Sciences’ is one such programme to emerge from the parent initiative. The growth and establishment of this particular programme is supported by both the Department of Medicine and Faculty of Medicine at the University of Toronto, with additional support from other cognate departments. This team of researchers is working to identify how sleep, anaesthetics and sedating drugs critically depress brain function and breathing, and how this can be exacerbated by the inflammation that often accompanies illness. The group is also exploring why some children and adults with common sleep-related breathing problems are at particular risk for depression of breathing with opioid drugs, development of cardiovascular disease and persistent changes in cognition following a general anaesthetic.

A second new emerging programme is ‘An Initiative for Studying Sleep Biology using Optogenetic and Pharmacogenetic Toolkits’, led by John Peever, PhD from the Department of Cell and Systems Biology, and Director of the Centre for Biological Timing and Cognition at the University of Toronto. Using leading techniques in neuroscience, the team is interrogating the brain circuits responsible for sleep, looking to decipher how they impact the neural systems that underlie memory, mood, motor control and breathing.

**IMPORTANT INTERACTIONS**

Through his role as lead and Director of Sleep and Biological Rhythms Toronto, Horner also interacts with three other teams funded by CIHR: ‘Better Nights, Better Days’ led by Penny Corkum, PhD, at Dalhousie University; ‘Sleep Disordered Breathing’ led by Najib Ayas, MD, at the University of British Columbia; and ‘Effects of Age and Apnea on Cognitive and Sensorimotor Processes During Sleep and Wakefulness’ led by Peter Soja, PhD. Dr Julie Carrier from the Université du Montréal is also working to build a pan-Canadian sleep network encompassing teams and individual researchers from across the country.

Team building, commitment, active engagement and, perhaps most importantly, new collaborations have been key ingredients to the growth of ‘Sleep and Biological Rhythms Toronto’ and its offshoot programmes. Horner and collaborators have been successful in growing this and the new emerging programmes to engage other disciplines, with collaborations intersecting university and hospital departments, faculties and institutions: “This CIHR programme has facilitated levels of new collaboration and partnerships between trainees, investigators and departments in these disciplines that had not existed before at our institution,” he states.

The initiative is the first truly multidisciplinary programme in Toronto to empower new collaborative initiatives in sleep and biological rhythms research, having seeded 28 new research projects and collaborations, and funded 21 trainees since its establishment in 2011. Horner is pleased with its development to date: “From where we started, I feel that the growth has been significant in the first three years of operation”.

**SLEEP AND BIOLOGICAL RHYTHMS TORONTO**

**OBJECTIVES**

To increase capacity for research, education and knowledge transfer in sleep and biological rhythms at the University of Toronto, its affiliated institutions and other collaborating Universities.

**KEY COLLABORATORS**

Please visit [http://sleepandrhythms.utoronto.ca](http://sleepandrhythms.utoronto.ca) for a list of active participants and partners.

**FUNDING**

Canadian Institutes of Health Research (CIHR) - Institute of Circulatory and Respiratory Health

**KEY PARTNERS AND STAKEHOLDERS**

Sleep, Sedation and Anesthetic Sciences: Department of Medicine; Faculty of Medicine, University of Toronto • Department of Physiology; Department of Anesthesia; Department of Pediatrics; Division of Respiratory Medicine; Faculty of Medicine, Institute for Safe Medication Practices, Canada • Drs Richard L Horner, PhD and Beverley Orser, MD, PhD are further growing this programme as a cross-departmental initiative.

[www.news.utoronto.ca/safer-anesthesia-and-sounder-sleep](http://www.news.utoronto.ca/safer-anesthesia-and-sounder-sleep)

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**PROFESSOR RICHARD HORNER** received his undergraduate degree with honours in Physiology from the University of Sheffield. He then completed his PhD at the University of London, UK. Horner’s subsequent postdoctoral work investigated the control of breathing and sleep in the Department of Medicine, University of Toronto, with further research training at the Centre for Sleep and Respiratory Neurobiology, University of Pennsylvania.