The University of Queensland
AUSTRALIA
CREATE CHANGE

Biomedical Sciences

Timing matters: Chronomedicine to restore circadian and sleep health

The team's research vision is to understand the physiology and functions of sleep and biological timing/timekeeping (Chronobiology), with three main areas of focus. 1) fundamental understanding of the role of light and other time cues (e.g. nutrients) in maintaining a network-wide stability of our biological timing system and in sleep homeostasis. 2) preclinical research aimed to normalise sleep and circadian dysfunctions, the two highly debilitating and main prodromal symptoms common to all major neurodegenerative diseases (e.g., Alzheimer's, Parkinson's and Huntington's disease). 3) translational research in which our lab's acquired fundamental and preclinical knowledge is applied to human sleep and circadian function in health and disease (e.g., the normalization of sleep and circadian disruption in hospitalized patients).

Services

Profiling Sleep Architecture and Epilepsy using Biotelemetry (EEG, EMG and ECG and Video)

We have a behavioural suite for high throughput in vivo assessment of sleep architecture and seizures using our state-of-the-art Biotelemetry System (Data Science International, USA) for small preclinical animal (rodent) models. For data analysis, we offer the use of the latest gold standard NeuroScoreTM CNS Software (DSI, USA) for sleep scoring, seizure detection, video synchronisation and batch processing. We can efficiently characterise quantitative and qualitative parameters of sleep architecture in health and disease, screen, identify and validate candidate drugs for normalising sleep dysfunctions, and treat seizures.

In vivo profiling of the Biological Timing and Time-Keeping System

As part of our behavioural set up, we have a specialised high throughput in vivo circadian biology monitoring system, the Circadian Cabinets from Actimetrics (USA), that allows researchers to track/monitor rodent behaviour continuously (e.g., sleep/wake patterns) around the clock. Furthermore, we use the system to simulate endless combinations of lighting conditions, including simulations of jetlag, shift work, customisable sunrise and sunsets, T-cycles and light pulses of different light intensities and wavelengths. The system is programmable via the ClockLab Chamber Control software (Actimetrics, USA) and complemented with a one-of-its-kind circadian rhythms analysis software, ClockLab Analysis 6 (Actimetrics, USA).

Mouse Models to study Biological Timing and Timekeeping

We have both clock mutant and transgenic clock reporter mouse lines to assess clock regulated physiological processes, screen for drugs targeting the clock, or assess drug-timing on the biological clock.

Mouse Models of Parkinson's disease (seeding and transgenics)

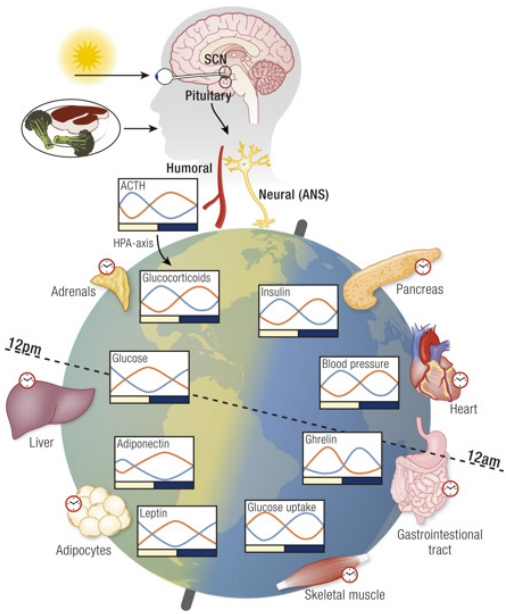
We have multiple murine models to study both the prodromal (non-motor symptoms; sleep and circadian dysfunctions) and advanced stages of Parkinson's disease, which encompasses both non-motor and motor symptoms. Among the models, we use to study Parkinson's at different stages of disease progression are (i) the alpha-synuclein seeding model, (ii) the dopaminergic neurotoxin model, and (iii) the transgenic alpha-synuclein murine models of Parkinson's disease.

Surgical procedures

We also specialise in unique surgical procedures. These include the surgical implantation of biotelemetry devices, epidural placement of electrodes for measuring electroencephalography (EEG), intracerebral placement of deep brain electrodes for characterising neuronal activity, electrode placement in muscle tissue to measure electrical activity in response to nerve stimulation (electromyography, EMG). Additionally, we perform both stereotactic-assisted electrolytic and neurotoxic lesions of surface and deep brain centres, organ transplantation and removal surgeries (e.g., adrenal and pineal glands). For in vivo drug screening, we perform survival surgeries involving the implantation of programmable micro infusion pumps for the timed intraventricular and intracerebral delivery of drugs.

Bioinformatic tools to analyse Sleep Architecture and Biological Timing parameters

We own commercially available specialised software packages for neuroscience research, including sleep, neuronal activity, seizures, and the know-how to use it. We also develop our customised software packages (e.g., CircaCompare) for more in-depth and field-specific analysis into sleep architecture and circadian biology, which are also applicable for analysing human data.



Central-to-peripheral circadian clock coupling. Cycles of day and night resulting from the earth's rotation.

UQ's School of Biomedical Sciences – mission statement:

By harnessing our diversity across the breadth of biomedical science, we will generate, disseminate and apply foundational biology underpinning health and disease to inspire and empower the next generation of leading researchers, educators, and healthcare professionals to innovate together for better health outcomes globally. Our innovative research encompasses basic discovery through translational pathways to medical solutions:

Cell architecture: We use sophisticated molecular and imaging techniques to explain how various cellular components and pathways contribute to building healthy bodies.

Receptors and signalling: We decipher the passage of external messages from the cell surface, through cytoplasmic signalling pathways, and ultimately to genetic regulatory circuits in the nucleus.

Chronic disease: We characterise the genetic, molecular and cellular microenvironments associated with diseases, such as Alzheimer's disease, cancer, MND and others.

Drug design and development: We identify critical biological targets and design drugs based on structural analyses to develop novel therapies.

Functional and comparative anatomy: Our interdisciplinary studies of structure and function across phylogenetically disparate species advance our understanding of the human body in healthy, aging and diseased states.

Injury and repair: We study fundamental mechanisms of cells in response to stress, consequences of repair processes and how these may be influenced for optimal outcomes.

Musculoskeletal and motor control: We develop and apply novel tools, to investigate muscle function and neural control of muscles in humans.

Neurobiology and brain function: We search for and discover genetic and environmental factors that lead to and maintain healthy nervous systems.

Reproduction: We investigate the genetic and molecular environment during early fetal development to advance reproductive technologies and facilitate healthy pregnancies.

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