Foreword

Understanding how the brain works is one of the greatest scientific challenges of our time. The health and economic burden of sensory, neurological and psychiatric disorders that affect the central nervous system throughout its lifespan is not only acute and growing, but also has a global impact. Such disorders include, but are not limited to, learning disabilities, dementia, sensory loss, stroke, psychiatric disorders (e.g., anxiety, depression, schizophrenia), and neurodevelopmental and excitability disorders. All of these have considerable individual, family and societal consequences. Our understanding of how neuronal cells and systems function in health and disease, and the influence of the environment on the brain, continues to increase rapidly. Moreover, the development of technology allows far greater interrogation of brain structure and function, presenting numerous opportunities to develop novel approaches in treating disease and in understanding how our behavioural phenotypes evolve.

The overarching mission of UCL Neuroscience is to facilitate innovative and collaborative research, including infrastructural developments. This research aims to determine how the brain develops and functions to sustain our mental and physical health in given social and natural environments; from the level of the molecular protein machinery and components of neurons and glia, through the function of individual cells, to the complex, integrative communications operated by small to large scale neural networks. Ultimately, our purpose is to understand how the brain works, evolves and develops, and dynamically responds to changing circumstances, with the aim of being able to apply this knowledge to explain behaviour, as well acting as a launch platform for the development of new treatments and therapeutics.
‘Purkinje cell dendrites’
Professor Michael Hausser,
Wolfson Institute for Biomedical Research
The breadth and depth of neuroscience research at UCL offers an unrivalled wealth of opportunities to undertake cutting-edge, collaborative and multidisciplinary research. As a multi-faculty university, our neuroscience activity is enriched by the expertise of many other areas, such as computer sciences, engineering, physical sciences, humanities and social sciences. The ability to combine neuroscience with research from other areas offers new ways in which to understand and interrogate how the brain develops and functions. Furthermore, we benefit from strong clinical partnerships with the NHS, its neurologists, psychiatrists and other clinicians through UCL Partners and the NIHR Biomedical Research Centres, enabling the development of new treatments.

For the 2021-2025 strategy the Domain will concentrate its efforts on maximising our impact and outputs in three areas:

1) Interdisciplinary Research Initiatives;
2) Career Development and Training; and,
3) Communication and Engagement.

Professor Trevor Smart
Chair
UCL Neuroscience Domain
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The neuroscience symposium has been running for ten years, and attracts around 800 attendees.

BrainPower, the first major public engagement event led by the Domain attracted 850 members of the public.
The UCL Neuroscience Domain was created in January 2008 with the aim of developing and coordinating research activities across the full spectrum of neuroscience at UCL. Neuroscience is the flagship research area for UCL, with nearly 500 research groups that account for over 30% of UCL’s research income. Through the actions of the Steering Committee, the Domain encourages, facilitates and supports endeavours of strategic importance that supersede departmental, divisional, faculty and discipline boundaries.

The objectives of the UCL Neuroscience Domain are to:

- Facilitate the highest quality neuroscience research across UCL
- Initiate, support and develop collaborations between researchers from different research disciplines
- Maximise our potential for interaction and ability to create new fields of research
- Cultivate and train future generations of neuroscientists
- Promote communication and engagement in neuroscience, both internally and externally

This document outlines our core strategy for the period 2021-2025, and builds on our previous strategic aims and achievements.
Review of progress

The previous UCL Neuroscience Strategy outlined our goals across five main areas. Key amongst these were the focus on interdisciplinary research areas, supporting career development, and internal and external communications.

The Neuroscience Careers Network (NCN; https://www.ucl.ac.uk/research/domains/neuroscience/neuroscience-careers-network) is a major success of the Domain’s activities and continues to evolve. It has become the driving force and benchmark for institution-wide high standards of care for early (and increasingly all stage) career individuals. The NCN steering committee operates as a sub-committee of the Domain and organises seminars and workshops aimed primarily at supporting the career development of neuroscientists, from postgraduate students through to junior group leaders. The topics covered include:
grant-writing, interview skills, work-life balance and careers outside of academia. Furthermore, the NCN organises numerous events that are relevant for members of the Neuroscience community in more senior positions, such as involvement with Public Policy and engaging with PPI. It has proved enormously popular and successful, and is widely acknowledged as an exemplar across the university for how to structure early career support.

The Domain previously identified three interdisciplinary research areas upon which to focus. In two of these, neurodegeneration and mental health, significant progress was made. The main focus in neurodegeneration was coordinating and supporting UCL’s successful application to become the hub of the UK Dementia Research Institute. This award of over £140million has provided funds to develop a Dementia Research Institute at UCL, recruit new group leaders and support a number of major research programmes. The Domain also supported the HEFCE Research Partnership Investment Fund for the redevelopment of the UCL Queen Square’s Institute of Neurology. Furthermore, 2016 realised the opening of the Alzheimer’s Research UK (ARUK) UCL Drug Discovery Institute.

With respect to Mental Health, the work of the Domain in bringing together researchers from different areas led ultimately to the development of a UCL Mental Health Strategy. Furthermore, the Faculty of Brain Sciences established a new UCL Institute of Mental Health (IoMH), which aims to unite UCL’s researchers behind the goal of improving our understanding of mental health and its disorders.

Both communication and engagement are strong dual foci for the Domain. The Domain newsletter goes out every two weeks to a mailing list of over 2000 people, and the NCN newsletter, which updates on events and seminars, circulates on a weekly basis. The annual UCL neuroscience symposium celebrated its 11th consecutive year in 2020, and regularly attracts over 800 attendees each year with world-leading neuroscientists giving keynote talks. The challenge imposed by the pandemic was met by running the symposium online, with 1000 people registering for the event.

In 2019 the Domain also organised its first major public engagement event, called “BrainPower”. This event, comprising interactive stands and scientific talks, attracted 850 members of the public and received extremely positive feedback from those that attended (https://www.ucl.ac.uk/research/domains/neuroscience/events/brainpower).
'Zebrafish motor control'
Joanna Lau
Bianco Lab
UCL Department of Neuroscience, Physiology, and Pharmacology
The breadth and depth of fundamental, translational, and clinical research at UCL means that we are ideally positioned to be at the forefront of neuroscience research and healthcare. Our aim in supporting specific research initiatives is to ensure that UCL will have significant impact in terms of discovery science and in the development of new treatments. The strategic areas identified for 2021-2025 are all exemplars where inter-disciplinary coordination is likely to lead to the greatest output, the most insight, and particularly represents areas we identify where UCL has the opportunity to increase its achievements.

Given this near-unique combination of expertise that UCL encompasses, we should be able to facilitate deeper and broader interactions between neurology, psychology, psychiatry, social science and fundamental neuroscience. This is especially important for interrogating underlying pathological processes, especially when two or more syndromes are co-morbid and may not have common pathogenic bases. While neurology, psychology and psychiatry have advanced by neuroscientific insights in recent years, our understanding of mechanisms that underlie disorders that impact on healthy ageing, neurodevelopment and cognition is still lacking and will require considerable integration in our approach to provide solutions over the next 10 years. For example, the study of how sensory systems develop and decline during the lifespan may offer valuable insight into sensory dysfunction that underlies and may precede many psychiatric and neurological disorders. Furthermore, the study of brain circuits underpinning stress, fear and anxiety will be informative for dementia and anxiety disorders.
Mental Health
Disorders of mental health are worldwide with 1 in 6 people per week estimated to suffer with a mental health disorder in the UK (https://www.mentalhealth.org.uk/statistics/mental-health-statistics-uk-and-worldwide). Such disorders affect people throughout their lifespan and cost the UK economy ~£35bn per year. Almost half of the adults living in England will experience a diagnosable mental health disorder in their lifetime. Furthermore, although approximately half of all mental health disorders have their onset in childhood and adolescence, we have inadequate understanding of the developmental trajectories. Current treatments based on drugs and/or psychotherapy are effective for many, but not all individuals, and we need a deeper understanding of the varied causal pathways to mental ill health in order to identify new treatments and to target interventions and preventative strategies more precisely.

Mental health research is an area in which UCL is yet to exploit its full potential. There are over 140 research groups working on topics related to mental health, from fundamental discovery science, through translational research, to clinical science. A recent audit by the IoMH revealed that approximately 800 people, affiliated with UCL, published research on mental health from 2016 to 2020. There are opportunities to link this biomedical research to other disciplines including: population health and epidemiology, engineering, informatics, computer science and social science research at UCL. A main goal of the Domain is to ensure that psychology and psychiatry-based neuroscience can easily open dialog and interact with fundamental neuroscience studies of mental health.

We have an opportunity to create a sustainable, multi-disciplinary approach that brings groups together to understand the causes of poor mental health, prevent mental health problems from developing, and to respond to established illness by developing new treatments, and new services.

The launch of UCL’s Institute of Mental Health (IoMH) and associated development of a UCL’s Mental Health Strategy, have given much needed impetus to this area. The first conference organised by the IoMH featured research from discovery neuroscience to human neuroimaging, including young people’s mental health and post-traumatic stress disorder.

A central focus of the UCL Mental Health Strategy involves capacity building. Our new 4-year Wellcome Trust PhD programmes specifically in Mental Health Science, and in a broader sense, Optical Biology, which will develop new tools to facilitate better understanding of cellular dysfunction in neurons, will be crucial for leading the implementation of this goal. The strategy has also focused on Children and Young People’s Mental Health (CYPMH). This is a key aim for research council and charity-based funding initiatives. The Neuroscience Domain will work closely with the CYPMH strategy implementation working group, to enable UCL to become a world leader in innovative interdisciplinary mental health research across the life-course, with an emphasis on advancing our understanding of the mechanisms underlying the development of mental illness and resilience. Central to our aims is to ensure that we have effective interdisciplinary collaboration between fundamental discovery neuroscience and translational/clinical studies of mental
health. The new Catalyst Seminar Series in Children and Young People’s Mental Health is financially and administratively supported by the Neuroscience Domain and will facilitate this aim.

Goals:

- Drive research into the mechanistic understanding of the basis for mental health dysfunction
- Promote and Support collaborations between fundamental and clinical neuroscience in mental health
- Promote and support the involvement of the wider research community with mental health research through seminars and workshops
- Support, with the IoMH, a Child and Mental Health seminar series
- Promote and support the new 4-year Wellcome Trust PhD programmes
- Facilitate the development of the Institute of Mental Health

Neuro-Artificial Intelligence (Neuro-AI)
The last decade has seen phenomenal advances in the field of machine learning. Such is the pace of change that no area of science can afford to not engage, least of all neuroscience. AI is rapidly gaining ground as an invaluable tool in neuroscience research in two ways. The first is its ability to analyse enormous volumes of data and find hidden associations and patterns in such data that otherwise might prove impenetrable. AI tools provide a means to discover, segment, and track distinct neural and behavioural states, enabling the design of new, more incisive experiments thereby accelerating the pace of discovery.

Secondly, and of equal importance, is that AI shares a common lineage with neuroscience, and provides a means to emulate neural functions and circuit activity. AI models have the potential to act as ‘virtual brains’ to guide the development of hypotheses and experiments, thus eventually improving our understanding of brain function and cognition. These models, and the information they provide, can be fed back into the design of more effective AI architectures and more sophisticated models. Essentially, AI problems posed in neuroscience both require and inspire further advances in AI.

Goals:

- Engage with Department of Computer Science, the Gatsby Computational Unit, and neuroscience fields to bring the research community together and provide opportunities for collaboration through seminars and workshops
- Work within existing strengths in AI to grow and enhance current programmes
- Establish a regular seminar series and an annual UCL Neuro-AI meeting
- Identify gaps in training from neuroscience and AI perspectives and lead developments in innovative training
- Develop links with the Turing Institute for data handling
Developmental Neuroscience
Developmental neuroscience is an interdisciplinary scientific field with a long exemplary history at UCL. It encompasses basic research addressing the earliest steps in the specification of neuronal identity, through the genetic and cellular mechanisms that establish functional circuits, the development of the human brain, to cognitive neuroscience. The area holds the potential to increase our understanding on many important issues, including:

• How the nervous system develops, takes physical shape, and matures functionally throughout childhood, adolescence and during the ageing process

• How genetics and the environment drives changes to cells and neural networks in the developing brain to impact upon synaptic plasticity and cognitive development

• The biological basis of disorders with neurodevelopmental origins, including autism and schizophrenia, and improving diagnosis and potential treatment of such conditions

• How specific neuronal subtypes (such as photoreceptors) and structures (such as optic vesicles/retinae) can be generated ex vivo for cell replacement therapies and tissue engineering.

Developmental neuroscience encompasses a range of different approaches, including genetic and cellular investigations, particularly in model organisms, stem cell biology, imaging at many levels of resolution, behavioural analyses, the physiology of neural circuits, computational modelling and psychology. It is a vast field, especially here at UCL.

There is recognition that coordination of effort is required to overcome historic fragmentation, to enable the growth of new disciplines and expertise to address broad questions, enabling UCL to be a world leader in this field.

Goals:
• Facilitate links between neurodevelopmental centres of excellence, including Institute of Child Health, Division of Biosciences, the UCL Institute of Ophthalmology, the Toddlerlab at Birkbeck and neurobiologists located at the Francis Crick Institute.

• Use the wealth of knowledge being gained from developmental studies of invertebrate and vertebrate nervous systems to inform and direct new work on human nervous system development, stem cells and in vitro organogenesis

• Organise workshops to support the interaction of groups working on different areas of developmental neurobiology, and link the work of basic scientists and clinicians working on disorders of brain development

• Work with other faculties to (i) develop computational methods and frameworks to provide improved mechanistic accounts of developmental and disease trajectories, (ii) exploit innovations in human brain imaging technologies particularly wearable systems optimised for studies in the first days, weeks and months of postnatal life and (iii) understand how developmental mechanisms impact on all stages of the lifespan, including brain ageing.
**Sensory Systems**

Sensory systems are fundamental to our experiences and interactions with the world. With an ageing population, sensory impairments are becoming ever more prevalent leading to a significant impact on physical and mental health of individuals and to a substantial societal and economic burden.

It is becoming increasingly apparent that sensory systems use similar underlying biological processes for signalling, adaptation and modulation, and for protection from injury and degeneration. UCL has internationally-leading research institutes in hearing, vestibular processing (UCL Ear Institute) and vision (UCL Institute of Ophthalmology), and undertakes world-class research in somato-sensation and pain across several centres (e.g., Department of Neuroscience, Physiology & Pharmacology, and the Wolfson Institute for Biomedical Research).

By bringing together researchers from these different areas we have the potential to advance our understanding of the fundamental neurophysiology of sensory mechanisms and to explore new therapeutic approaches. Combining our expertise in behavioural methods, genetics, electrophysiology, cell biology and animal models in multi-disciplinary endeavours will be necessary to tackle basic and applied problems in sensory function and dysfunction.

**Goals:**

- *Bridge the research community by providing opportunities for collaboration through seminars and workshops*

- *Support the establishment of a PhD training programme in Sensory Systems (centred on the Ear Institute and Institute of Ophthalmology, and building on the existing SenSyT framework)*

- *Develop a public engagement programme in sensory systems*
'Retinal kaleidoscope'
Anai Gonzalez Cordero
UCL Institute of Ophthalmology
UCL provides an outstanding environment for training future generations of researchers in fundamental and clinical neuroscience. However, we face competition for recruiting and retaining the best neuroscientists. The career pathway for early career researchers is also uncertain and lacks a formal training structure. It is therefore imperative that we provide a supportive environment to enable us to retain outstandingly productive researchers and to recruit junior and senior investigators.
The UCL Neuroscience Careers Network (NCN) seeks to promote the professional development of UCL Neuroscientists. The network provides a platform for careers advice and the dissemination of information regarding training, funding and job opportunities. The Network also encourages interaction and mentoring by organising career-advice seminars as well as grant writing and interview workshops. The NCN work is specifically aligned to the Neuroscience Domain’s key strategic goal to educate, develop, recruit and retain outstanding neuroscientists trained in multiple disciplines.

The NCN is organised by a sub-committee composed of representatives from a variety of Departments under the UCL Neuroscience Domain, including PhD students, post-doctoral researchers and PIs, as well as the Strategic Coordinator and the Communications and Events Officer for the neuroscience domain.

The work of the NCN includes, but is not limited to organizing workshops, including Grant Writing Workshop; Interview Workshop and organising seminars such as “Alternative careers for scientists”, “Media Engagement”, “Open Science”, Mentoring”, “How to be a PI”.

Goals:

- Provide support and advice to the Neuroscience Careers Network to enable it to develop and continue its highly successful work recognised as a benchmark for others at UCL.

- Run the annual UCL Early Career Neuroscientist Prizes and Jon Driver Prize

- Support approaches to develop researchers who can undertake cross-disciplinary research
Communication and engagement are vital, both internally to connect researchers and externally with the public, PPI groups, industry, grant-funding bodies and policy makers to maintain support for the important work that we do at UCL.

In 2019 the UCL Neuroscience Domain organised its first major public engagement event, ‘BrainPower’. This open day attracted over 800 people, providing them with the opportunity to experience a range of interactive activities and to listen to talks from neuroscience researchers. The feedback was incredibly positive, and reinforced both the public’s appetite for learning about research and the need for us to engage with them. Public engagement remains an important requirement of many funding agencies and the Government. Many organisations, most notably the Royal Society, are leading the way in public engagement, and we should look to increase these types of events that the Domain runs, in addition to further major open day-style events.

The annual UCL Neuroscience symposium is now firmly established as a major event in the calendar. The symposium provides an excellent means of bringing together neuroscientists from across UCL to learn about the research underway across UCL through presentation and research posters. We will encourage further integrative events, such as colloquia and workshops, which focus on the Domain’s interdisciplinary research priority areas, and explore hosting events that enable early career researchers to present their work.
Goals

- Organise the BrainPower event every two years

- Increase engagement with non-specialist researchers and the public through different mechanisms, including;
  1) an online presentation and interview series on different areas of neuroscience, and
  2) a series of ‘UCL Brain Lates’; evening events focussing on specific areas of neuroscience.

- Bring public engagement to the fore on the UCL Neuroscience website, with public access to UCL Neuroscience podcast / blog on topical articles and opinion pieces

- Organise the annual UCL Neuroscience Symposium

- Working with the Sainsbury Wellcome Centre, organise a prestigious, named prize annual lecture in Neuroscience, with recipients chosen from around the world by the UCL neuroscience constituency

- Seek funding support to enable sponsorship of British Science Association Media Fellowships to provide opportunities for researchers to work directly with media outlets and develop skills to engage with the media:
  https://www.britishscienceassociation.org/media-fellows-applications

- Encourage applications to Royal Society Parliamentary Pairing Scheme to enable researchers to gain an insight into how research findings can help inform policy making:
  https://royalsociety.org/grants-schemes-awards/pairing-scheme/

#BrainPower - a one-day public festival to showcase the best of neuroscience research at UCL