BSc in Medical Sciences with NEUROSCIENCE AND MENTAL HEALTH

Introduction:

This course will provide students with a multidisciplinary approach to understanding the aetiology of neurological and mental disorders. During the Science year students will learn about the aetiology of common disorders encountered by neurologists and psychiatrists and how an understanding of the biological, psychological and social factors have also informed the development of interventions aimed at helping people with these conditions.

The course aims to provide an introduction to the molecular basis for key processes in the functioning of the nervous system such as communication between nerve cells, the basis for synaptic plasticity and the control of gene expression. The nervous system develops from its early origins as a small but discrete group of undifferentiated cells into the most complex and fascinating system in the human body. Understanding the processes by which highly complex neurons are formed, move and connect, provides insight into the functioning of the mature nervous system, and problems associated with its repair. Recent discoveries have greatly increased our understanding of the molecular signals involved in the development of the nervous system. The aim of the course is to demonstrate how basic neuroscience research from several disciplines can a) be integrated to provide an account of our major neurological and neuropsychiatric disorders and b) not only explain the clinical features but also direct the search for more effective treatments.

Later in the course students will receive teaching in research methods used in the development and evaluation of interventions for people with mental and neurological disorders. The basis for pharmacological treatments for conditions such as epilepsy, Parkinson's disease and depression will be examined. A comprehensive introduction to a range of imaging technologies and interventions used to diagnose and treat mental disorders will also be considered.

Course structure

The course consists of three modules.

Module 1 (September to December)
Teaching in the Autumn Term of 2020 will be delivered remotely except for one week in Block 2.

This is the taught component. There are three blocks; each block has three weeks of teaching and one 'consolidation' week.

The key topics are:

- Block 1: Cellular and developmental neuroscience: from molecules to circuits
- Block 2: Neurological disorders of the central nervous system
- Block 3: Psychiatry and Mental health

There will be three assignments during this module:

- Data Management
- Written task
- Oral task (presentation)

Module 2 (January)
This is a self-directed learning module where the students work in groups.

Group literature review (2 weeks) – assessed by peers and teaching staff
Clinical case report (2 weeks) – assessed by teaching staff

Module 3: Research Project (February to May)
15 weeks includes 3 weeks to write up.
Types of projects:
- Clinical
- Lab-based

Assessment
Write up and oral presentation

After completing the course students will:

- Know how to understand and critically appraise research papers
- Have experience in presenting a paper to colleagues
- Have laboratory experience e.g. designing and conducting a mini-research project in small groups, neuropathology
- Have experience in writing up laboratory data as a research paper
- Be familiar with interpreting brain scans
- Be able to critically appraise research aimed at examining the efficacy of interventions and treatments such as randomised trials and meta-analyses
- Have the skills required to identify and synthesise findings from previously published studies examining the efficacy of pharmacological and psychological treatments.
- Be aware of ethical dilemmas posed by molecular neuroscience.
- Have a basic understanding of how to formulate psychological problems using cognitive and psychodynamic approaches.
- To assess literature, consider caveats and draw appropriate conclusions
- To be able to participate in the processes of article submission, peer review and rebuttal

The particular skills that will be gained in this module include an appreciation of the importance of critical analysis when reading the research literature and valuable experience of bringing together information from a variety of sources to improve understanding of complex topics. The practical component of the module will also provide useful training in experimental design, group negotiation, the use of observation and reporting skills.

Content Aims and Objectives

Module 1:

- Block 1: The first module will introduce the molecular and cellular basis of nervous system development, regeneration, circuitry and functioning.
- Block2: Neurological and Psychiatric disorders will be reviewed and foreach of the disorders being studied the objectives are to gain an understanding of the clinical presentation, the aetiology and underlying pathology, experimental studies of mechanisms of damage and repair, animal models for neurological diseases, genetic background, new approaches to therapy
- Block 3: students will learn about the theoretical basis of a range of pharmacological, psychological and social interventions

Each block will be followed by one consolidation week.

Block 1: Cellular and developmental neuroscience: from molecules to circuits

Module Leader: Prof Amin Hajitou a.hajitou@imperial.ac.uk

Aims

This module aims to give insight into the molecular and cellular basis of nervous system development, circuitry and functioning, with prominence given to the clinical consequences of dysfunction and potential treatment strategies. The cells of the nervous system and their complex interrelationships is a particular theme, as is the problem of central nervous system regeneration, clues to repair strategies found in development, and the neuronal circuitry controlling systems such as pain, sleep and coordination of movement. A feature of the module is a laboratory project in which students conceive, design and execute their own cellular neurobiology research in small groups within a guiding framework.

Content

The module starts with the cellular organisation and development of the nervous system. Here, after looking at the molecular basis of neural tube development, the development, interrelationships and function of neurons, astrocytes, oligodendrocytes, Schwann cells and microglia in health and disease will be examined, ending with a snapshot of some key laboratory techniques in neurobiology research. There will be a section on nervous system regeneration, the reason why this is problematic in the CNS, and practical strategies for CNS repair such as cell replacement therapies, biomaterial scaffolds, and targeted antibody therapeutics. In the next session students will have an overview on computational neuroscience and finally there will be several lectures on Brain tumours. The final section is a laboratory research project: following lectures and extensive interactive tutorials on experimental design, interpretation and statistical analysis, students will design and execute unique research projects in threes, based around the treatment of brain tumour cultures with chemotherapeutic drugs.

Topics to be covered

- Cellular organisation and development of the nervous system
    - Astrocytes & neurons
- Oligodendrocytes & Schwann cells in health and disease
    - Microglia in health and disease
- Axon growth and guidance
- Experimental techniques: tissue culture and immunohistochemistry
- Nervous system regeneration
    - Axon regeneration, molecules & mechanisms
- Stem cells: therapeutic potential
- Brain Development
- Brain Tumours
- Computational Neuroscience

Laboratory research project

Wet-lab: treatment of brain tumour cultures with chemotherapeutic drugs

Format of teaching and formative assessment Seminars

- Interactive tutorials with group work and presentations
- 3-day laboratory practical
- Format of in-course summative assessment: Data interpretation linked to a cell culture practical (Treatment of brain tumour cultures with chemotherapeutic drugs)

Assessment

- ***Scientific Abstract: 350 words***
- ***Lay Summary: 500 words***

Block 2: Neurological disorders of the central nervous system

Module Leader: Dr Magdalena Sastre m.sastre@imperial.ac.uk

Aims

This aim of this module is to provide a comprehensive review of the aetiology and pathogenesis of cerebral disorders which present clinically with neurological disorders. The clinical features will be reviewed followed by sessions detailing our current understanding of the neural basis of these disorders, which will include findings from genetics, molecular biology, neurochemistry, neuropathology and neuroimaging. In addition, animal models used for research for the majority of these disorders will be reviewed.

The module will draw on the broad knowledge gained in the earlier block of the neuroscience pathway, instil a sound knowledge of the biological basis of CNS diseases and provide an invaluable insight into current research strategies and the rationale for future therapeutic interventions.

Content

In this module the aim will be to take a detailed look at some of the common, and not so common, diseases that affect the central nervous system. Common neurological conditions covered will be Stroke, Multiple Sclerosis, Epilepsy, Alzheimer's disease, Amyotrophic lateral sclerosis and Parkinson's disease.

There will be sessions covering trauma, prion disease, Huntington Disease and frontotemporal dementias.

Topics to be covered

- Stroke, anatomy and risk factors
- Stroke: Clinical features, therapies, Animal models
- CNS trauma: neuropathology
- CNS trauma imaging
- CNS trauma animal models
- Parkinson's disease - clinical & therapeutics
- Parkinson's disease –neuropathology
- Parkinson's disease –Genetics and experimental models
- Parkinson's plus – MSA and related conditions
- Amyotrophic Lateral Sclerosis/ Motor Neurone Disease
- Alzheimer's disease: neuropathology
- Alzheimer's disease: drug treatments for dementia

- Alzheimer's disease: Molecular mechanisms and animal models
- Frontotemporal lobar dementias
- Imaging techniques for the diagnosis of neurodegenerative disorders
- Prion disease - clinical, pathology & experimental
- Multiple Sclerosis – clinical features and treatments
- Pathology of Multiple Sclerosis and animal models
- Multiple Sclerosis immunology
- Huntington Disease
- Epilepsy and its treatment
- Neuropathology practical

Assessment
Written assessment: letter to the editor "Critical Essay on a controversial topic 700-1000 words:"

Block 3: Psychiatry and Mental health

Module Leaders: Dr Dasha Nicholls d.nicholls@imperial.ac.uk and Dr David Erritzoe d.erritzoe@imperial.ac.uk

Aims

This three week module aims to provide students with a basic foundation in the current understanding of the biological underpinnings of normal mental processes, and how they go wrong – in psychosis, affective disorder, personality disorder, eating disorders and addictions. It will cover aetiology, epidemiology, and treatment – both pharmacological and psychological.

Content

This block will describe how techniques used to examine the aetiology of neurological disorders have been applied in the context of mental health.

In week one of the course there will be a general overview of the module including an introduction to how to perform systematic reviews in Mental Health, how to perform TBL and an introduction to drug addictions and self-harm behaviour.

Week two will focus on neuroimaging and psychopharmacology and how to apply them for psychiatric disorders including depression and drug addiction.

In week three we will describe eating disorders, anxiety disorder, adolescent mental health, the aetiology of additive behaviour (drug and alcohol misuse, policies and also gambling), and find out how our understanding of the biological basis of addition and the psychological and social factors which lead to misuse of alcohol and drugs is shaping the development of treatments for these problems. There will also be a discussion of how research into psychedelic drugs may help us to understand the nature of consciousness.

After taking the module the student will

- Have an understanding of the aetiology and epidemiology of different psychiatric disorders and substance misuse problems.
- Have developed an understanding of how biological, psychological and social factors interact to increase the likelihood of mental disorders

- Understand how neurochemical, functional and structural imaging have led to advances in understanding the aetiology of psychoses and drug addiction
- Have an understanding of the main interventions and treatment options for people with anxiety, eating disorders, personality disorder and drug addiction
- Be able to critically appraise studies which examine the effectives of treatments for mental disorders including clinical trials and systematic reviews

Specific skills

- Be able to critically appraise research aimed at examining the efficacy of interventions and treatments such as randomised trials and systematic reviews.
- Have the skills required to identify and synthesis findings from previously published studies examining the efficacy of pharmacological and psychological treatments.
- Be aware of ethical dilemmas associated with clinical research.
- Have a basic understanding of how to formulate psychological problems using cognitive and systems approaches.

Assessment:
Oral presentation
Powerpoint presentation on planning a project based on a paper.

Module 2: Self-direct learning, involving a Literature Review and a clinical case study (Science in Context)

Module Leaders: Prof. Simone Di Giovanni and Dr Nabil Hajji

The literature review will consist of **3500 words** (abstract 350 words) on a neurological or psychiatric disease and will be done in groups. ***Assessed***

Students will review another group's review and provide a peer review report.

The clinical case study will consist of a virtual clinical or psychiatric case and students will need to provide answers for some of the questions raised in the case. ***Assessed***

Module 3: Research project

Module Leaders: Dr Samuel Barnes and Dr Magdalena Sastre

The projects can be either lab-based, clinical or systematic review projects.

Past BSc Project Titles in Neuroscience and Mental Health

- The Impact on staff working in forensic settings upon staff mental health & their impact on staff of working with people with personality disorder: Literature reviews
- Does the efficiency of exon-skipping vary between muscles?
- Investigation of GABAergic interneuron diversity in the early postnatal cortex.
- Study into specific cortical thickness changes in the frontal, temporal and occipital lobes in schizophrenia and depression.
- Network breakdown following traumatic brain injury – investigating changes infunctional connectivity.
- Molecular pathogenic pathways in Parkinson's disease.

- The genetics of carotid atheroma
- Photogenetic neural control
- An audit study of the clinical features of orthostatic tremor
- Examining the fate of transplanted mesenchymal stem cells in a rat model of Multiple Sclerosis.
- Elucidation of the pathway of cortisol synthesis and interaction with glycolysis inglioblastoma multiforme.
- The effects of buffeting in a vehicle on respiration in neurological patients with respiratory dysrrhythmia
- Cognitive factors underlying motor stroke recovery.
- Does the efficiency of exon-skipping vary between muscles?
- Brain monoamine systems in Multiple System Atrophy: A PET study.
- Examination of glial changes in the nucleus basalis of schizophrenia anddepression.
- Testing for the association of polyglutamine expansions in atrophin-1 in schizophrenia.
- Measuring the volume of the fetoplacental unit using MRI.
- Investigation into whether activated microglia, associated with the innate inflammatory response in Parkinson's disease; release factors e.g. cytokines that trigger the alterations in iron metabolism.
- Investigating pathogenic mechanisms mediating the effects of novel mutations in familial motor neurone disease/ amyotrophic lateral sclerosis.
- Modulating visual perception from the contents of working memory: a psychophysical study
- Does striatal D2 receptor availability predict personality traits in healthy volunteers?
- Is MAdCAM-1 involved in inflammatory leukocyte trafficking and ectopic lymphoid tissue formation in multiple sclerosis?
- Progression of monoaminergic dysfunction in Parkinson's disease. An in vivo 18F-dopa PET study
- Evaluation of mevalonate kinase in human gliomastoma
- Annexin A1-formyl peptide receptor interaction in microglia cell line: effect on beta-amyloid processing
- Striatal pathology in Parkinson's disease: a substrate for dementia?
- The effects of buffeting in a vehicle on respiration in neurological patients with respiratory dysrrhythmia
- The role of astrocytes in grey matter demyelination in multiple sclerosis.
- Audit of comorbidity and pharmacological treatment in high security hospital personality disorder services.
- The effects of chronic subthalamic nucleus deep brain stimulation on postural stability in patients with Parkinson's disease
- Role of opioid or GABA-ergic system in addiction
- Neuroinflammation and alcohol misuse.
- Imaging neuroinflammation with Positron Emission Tomography (PET): a critical review of the current literature
- Molecular targets of anti-inflammatory drugs in chronic pain
- Is the nausea which accompanies vestibular disease Motion Sickness?
- Learning without seeing
- Is the nausea which accompanies vestibular disease Motion Sickness?
- TRAIL-mediated apoptosis in response to Hypoxic-Ischaemic challenge in immature neurons

- Therapeutic potential of anti-inflammatory drugs in stroke
- Therapeutic potential of anti-inflammatory drugs in stroke
- Fatigue in child survivors of critical illness
- MR quantification of brain development in fetuses with enlarged ventricles.
- Cerebellar pathology in Parkinson's Disease
- Epigenetic silencing of ASS1 and ASL in Gliomas: Low grade to High Grade
- The role of glucose and BP in acute stroke thrombolysis
- Neural mechanisms of human visual memory and selective attention: TMS and tDCS studies
- Effect of cognitive task on anticipatory responses to rapid movement while seated on a gym ball
- Damage to the brain-CSF barrier in multiple sclerosis
- Diagnostic Accuracy of CSF and Plasma Ab in people with dementia. A Cochrane DTA Review.
- Neural mechanisms of human visual memory and selective attention: TMS and tDCS studies
- Linking clinical status and outcome to new computational representations of brain anatomy
- Fibrinolytic cascade and neurodegeneration in MS
- MRI quantification of the cerebellar vermis and relationship to 2 year outcome in ex-preterm infants
- Social anxiety in children with sickle cell disease
- Sleep disorders in Parkinson's disease
- A combined post mortem MR imaging and immunohistochemistry study to investigate the cellular processes associated with injury to the developing brain
- Who buys cheap booze?
- Music effects on memory function in health and disease
- Music effects on memory function in health and disease
- Changes in fatty acid metabolism in human glioblastoma multiforme
- Characterising factors that regulate disease progression in Motor Neurone Disease/ Amyotrophic lateral sclerosis
- fMRI scans of hippocampal regions during memory recollection
- Imidazoline binding sites / receptors: a critical review of the current literature
- Self-expression among people with psychosis

<u>Comments from previous students about the BSc in Neuroscience and Mental Health course</u>

'After the toils of first and second year lectures, Neuroscience becomes a bit like Marmite. You either love it or you hate it. If you're one of those people who enjoyed it, then you should definitely consider the Neuroscience and Mental Health (NSMH) BSc. If you hated it, then perhaps it's wise to steer clear as it's not really for the faint hearted.'

'The 4th year is your chance to live like a proper student; lectures, instead of 8am surgical ward rounds, long lunch breaks and the occasional day off. For NSMH there are usually 2 lectures per day. Time off is seen a little less frequently than in some other courses, but lectures are based at Charing Cross which, for most people, means it gets brownie points for location when compared to some of the hospitals that other BSc courses have to trek to for their lectures.'

'As with all BSc's, coursework makes up a proportion of your overall mark. The coursework for NSMH takes a variety of different forms; essays, lab work, pathology practical, a timed written assessment and group work, so there's bound to be some pieces that suit your strengths.'

'Overall, the NSMH BSc offers a great course to those who think they might have an interest in the field. A bit of motivation is probably quite an important requirement, but the topics covered and the lecturers who teach should make definitely make you consider it as one of your choices.'

'Most importantly, the Neuroscience and Mental Health course is interesting, and fantastically rewarding. All of the material is cutting edge, and the lecturers are world-renowned in their own fields. Having said that, it is not a course for the work-shy. The lecture load is high, and the work expected from you outside of the classroom is certainly no small amount.

'Perhaps the strongest part of the Neuroscience and Mental health course is the projects on offer. These give you the opportunity to work with world-class researchers who are pushing back boundaries in the understanding and treatment of some of the most serious illnesses affecting man. All of the projects are based around vital work that needs doing, as opposed to the repeat of a tired old project as is seen in other courses. Here, you have the chance to carry out vital work on drug development for diseases that were previously thought incurable. There is no greater opportunity available to you within the study of medicine than to be involved in the potential cure for a disease.'

'The Neuroscience and Mental health course is rewarding, stimulating and cutting edge. There is no more fascinating area of medicine to be working or studying in at the moment and the course is one that I would recommend highly to anyone.'

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