

# Table of contents

## Prof Kim:

- Introduction (Integrated system Gut-Brain)
- Stress and the brain
- Fear conditioning and extinction
- Sex hormones and the brain

## Prof Jordan:

### Motor Control

- Introduction to motor control
- Central control of movement
- Brain body interactions failure
- Using knowledge of brain body interactions

### Sleep

- Introduction
- Homeostatic and circadian regulation of sleep
- Sleep Neurobiology
- Disorders of the sleep control system
- Function of sleep
- Function of sleep 2 (Restorative theories)
- Sleep and mental health

### Pain & Others

- Acute pain
- Chronic pain
- Respiratory control and panic disorder
- Sleep Apnea

## Prof Olivia:

### Consciousness

- Grand theories of consciousness
- Levels and dimensions of consciousness
- Altered states of consciousness
- Ethics and enhancement

# L1 Introduction to neuroscience and neuropharmacology (integrated system gut-brain)

## Learning outcomes

- Basic elements of interactions and integration between mind, brain, body and society
- Some examples of enteric nervous system and sickness behaviour

## Neurons and synapses

- Neurons (cells in nervous system) - electrical signals "action potentials" are transmitted along the axons
- Synapses (where neurons meet) - chemical signals "neurotransmitters" transmitted between neurons

## Neurotransmitters/neuromodulators

- All neurons in CNS (central), PNS (peripheral), and ENS (enteric) communicate through chemical signals (neurotransmitters and neuromodulators)
- Without these chemical signals, the action of one neuron would not influence any other neuron in nervous system (no brain integration and no useful brain function)
- These chemicals also modulate neural activity and a range of other functions in the brain such as synaptic plasticity (building new synapses or altering the function of old synapses)

## Neurotransmission

- Either excitatory or inhibitory
- serves rapid (millisecond), precise, point to point communication

## Neuromodulation

- Describes slower (milliseconds to seconds) processes that alter the subsequent responsiveness of neurons

## (1) Central nervous system (CNS)

- Brain and spinal cord
- ~100 billion neurons in CNS

## Neurotransmitters/neuromodulators in CNS

- **Cholinergic (ACh)** system - pontine and basal forebrain groups
- **Norepinephrine (NE)** system - main nucleus is 'locus coeruleus' in the pons
- **Dopamine (DA)** system - ventral tegmental area and substantia nigra area (both in midbrain) - more localized projections
- **Histamine (HA)** system - 'forgotten one', neurons localized to posterior hypothalamus
- **Serotonin (5-HT)** system - several 'raphe' nuclei distributed in brainstem
- These originate in small clusters of neurons (nuclei) deep within the brain, but are released throughout CNS

## Hormones

- Signalling molecules **produced by glands** and transported through **blood** to regulate physiology (muscles, neurons etc) and behaviour
- The effect of a number of specific hormones link to stress, sex and social bonding

	<b>Neurotransmitters</b>	<b>Hormones</b>
System	Nervous system	Endocrine system
Transport	Transmission is between neurons (across a synapse)	Travel by blood
Target cells	Specific neurons or other cells	Some distance from endocrine gland
Speed	Action is generally extremely fast (milliseconds through sustained neurotransmitter release can lead to more sustained changes in brain)	The main effects of hormones are normally much slower ranging from a few seconds to days
		Hormones also directly modulate neurotransmitter levels and function

### **Blood brain barrier**

- Exists within 600 km of blood vessels in CNS
- Prevents many substances from passing between blood and brain
- Many drugs, natural chemicals and foreign infections cannot pass through (but small amounts of many things still get through)
- Multiple other avenues for controlled passage between blood and nervous exist

### **(2) Peripheral nervous system**

- The **nerves and ganglia outside of brain and spinal cord**
- Receives sensory information about body position, temperature etc
- Sends messages from brain to control muscles and movement
- Sensory input ---> integration (brain) ---> motor output

### **(3) Enteric nervous system**

- Part of PNS
- Termed as **second brain**
- Contains 100 million neurons
- Has its own reflexes and senses and can act independently of the brain (**the only part of PNS that can act autonomously**)
- Nearly every **neurotransmitter** found in brain is also found in gut
- 95% of all **serotonin** is found in gut (bacteria in the gut trigger certain cells to synthesise serotonin --- increasing muscle action and gut motility)
- But, the second brain does **not help digestion**
- 90% of connections between brain and gut go **from the gut to the brain**
- Plays a major role in **emotions and stress** (butterflies in our stomachs) and also clinical depression/anxiety
- Informative to consider what it does not do (consciousness, philosophy, decision making) despite being so much like our 'main brain'

### **Brain gut interactions**

#### **The gut-brain axis**