LF260-15 Neuropharmacology with lab

26/27

Department
Life Sciences
Level
Undergraduate Level 2
Module leader
Bruno Frenguelli
Credit value
15
Module duration
5 weeks
Assessment
Multiple
Study location
University of Warwick main campus, Coventry

Description

Introductory description

Pharmacology is the study of how chemical agents influence bodily functions in both health and disease, and indeed how the body deals with these chemicals. Chemical agents include a wide range of sources, from hormones and neurotransmitters that occur naturally in the body, to foreign agents taken voluntarily, such as medicines or recreational drugs, to agents acquired when bitten or stung by an animal, or mistakenly eaten, for example via the ingestion of poisonous mushrooms or berries. As such, pharmacology underpins much of modern medicine and is an indispensable subject for the understanding and treatment of disease.

This biomedically-orientated module will provide an overview of the basic principles of pharmacology, as well as the mechanism of action of the major classes of drugs that are currently used in clinical practice, with an emphasis on the peripheral and central nervous systems - neuropharmacology. The module will concentrate on the use of drug-based therapeutics in a range of human conditions and will bridge the gap between basic cell signalling and the complex patho-physiology and treatment of the diseases. The module builds on first year physiology and neurobiology lectures and will be useful in biomedical modules such as Integrative Neuroscience and Modern Approaches to Human Disease.

Module aims

Describe the major neurotransmitter systems for noradrenaline, acetylcholine, GABA, glutamate, purines, opioids, with reference to their receptors and role in physiological and pathological conditions

Understand drug metabolism, pharmacodynamics and pharmacokinetics

Understand the control of pain and induction of anaesthesia

Describe the general structure of the peripheral nervous system, the nature of the primary neurotransmitters and the type and location of their receptors
Understand how psychostimulants (eg amphetamine), antidepressants and antipsychotics act to influence brain and behaviour
Understand the mechanism of action of cannabinoids and psychedelic compounds, and their potential uses
Understand the mechanisms of drug addiction and therapies designed to alleviate them

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

Lecture Topics

Principles of Pharmacokinetics 1
This lecture covers the pharmacokinetics of orally administered drugs and includes therapeutic index, bioavailability, absorption, distribution, metabolism and elimination (ADME). It also introduces different modes of drug delivery. Specific drug examples are used to illustrate points.

Principles of Pharmacokinetics 2
This lecture covers simple pharmacokinetic models and principles including zero and first order elimination, volume of distribution and area under the curve. It also introduces some dosing principles including intravenous (IV) bolus, continuous IV infusion and discusses dosage schedules depending on drug half life. Therapeutic drug monitoring is discussed along with urinary analysis. Specific drug examples are used to illustrate points.

Receptor Pharmacology
This lecture introduces the concepts of receptor theory including efficacy, affinity and potency. Using concentration-response curves the properties of agonists, partial agonists, competitive antagonists and non-competitive antagonists are discussed. The clinical uses of such drugs are described. The difference between Kd and EC50 is explained along with the concept of spare receptors.

Mechanism of Action of General Anaesthetics
Outline of major types of general anaesthetics (including IV and inhalation), pharmacokinetics, mode of action and uses.

Pain and its Control by Opioid Analgesics
Pain can be defined as an unpleasant sensory and emotional experience associated with real or potential tissue damage. This lecture will give an overview of how pain is perceived and outline the major drug classes used to treat pain concentrating on the opioid analgesics.

Pharmacology of the Peripheral Nervous System
Introduction to the peripheral nervous system (PNS): somatic and autonomic nervous systems, including the sympathetic and parasympathetic branches. Neurotransmitters, hormones and receptors of the PNS will be described, as well as the functional consequences of their activation.

Nicotinic Receptors of the Neuromuscular Junction & Ganglia
The neuromuscular junction (NMJ) of the somatic nervous system will be described. The structure, transmitters and receptors, natural and synthetic drugs affecting the NMJ, including toxins, and their consequences and medical uses will be covered.

Pharmacology of Acetylcholine Muscarinic Receptors & AChE
This lecture will describe muscarinic acetylcholine receptors in the nervous system, their natural and synthetic ligands, and their use in the clinic. We will also cover acetylcholinesterases, their inhibitors as medicines and nerve gases – consequences and antidotes.

Noradrenergic Transmission and the Monoamines
This lecture will deal with monoamines in the nervous system including the synthesis, release and metabolism of the neurotransmitters noradrenaline (norepinephrine), dopamine and serotonin (5-HT) and the hormone adrenaline (epinephrine). The site of action of clinically-relevant therapeutic agents will also be discussed.

Psychostimulants: use and abuse
A number of drugs of abuse such as cocaine and amphetamine target the monoamine system. This lecture will address some of those compounds, and also stimulants drugs that are used to treat psychiatric disorders.

Purinergic transmission
The suggestion that ATP could serve as a neurotransmitter, as well as the cellular energy source, was fiercely resisted. The overwhelming evidence, not to mention the many receptors with which ATP interacts, supports the elevation of ATP to a bona fide neurotransmitter. This lecture will focus on ATP and its metabolites, ADP and adenosine, and their roles in the nervous system.

Glutamatergic Synaptic Transmission and the Trafficking of Transmembrane Receptors
Receptors are not static objects in the plasma membrane but move to and from the membrane in response to stimulation. This lecture will introduce glutamate receptors and describe the molecular mechanisms underlying their insertion/internalization to/from the plasma membrane and the physiological implications of this activity.

Cannabinoids
The cannabis plant, Cannabis sativa, produces a number of psychoactive compounds. Whilst the effects of cannabis has been known for centuries, only recently has there been an appreciation of the two receptors found in mammals, including humans through which cannabis acts, and that mammals produce endogenous compounds – the endocannabinoids that activate these receptors. This lecture will focus on cannabinoids, endocannabinoids, and drugs of abuse based around these compounds.

Addiction
Many chemical agents have abuse potential in that they induce a desire to continue taking the drug for its physiological effect on the nervous system. This can cause significant harm to the individual, their families and society as a whole. As such, addiction is a major judicial and public

health issue across large parts of the world. This lecture will describe basic mechanisms of addiction and the therapies designed to lessen the dependence upon the abused drug.

Psychedelics
Albert Hofmann was responsible for both the synthesis of LSD (in 1938) and its first consumption (in 1943). LSD is now legend in the Pantheon of illegal drugs. However, it, and other psychedelics are now attracting considerable attention for the treatment of conditions such as depression. This lecture will focus on the pharmacology pf psychedelics and their potential clinical uses.

Learning outcomes

By the end of the module, students should be able to:

- Introduce the basic principles and practise of pharmacology
- Provide knowledge of drug dynamics and metabolism, receptor theory and modern approaches to the study of receptors
- Develop an appreciation for targets for the pharmacological action of drugs based upon an understanding of normal physiology and the pathophysiology process of disease
- Outline the mechanism of action of drugs and their use in a variety of common diseases.

Indicative reading list

Reading lists can be found in Talis

Subject specific skills

Describe the major neurotransmitter systems for noradrenaline, acetylcholine, GABA, glutamate, purines, opioids, with reference to their receptors and role in physiological and pathological conditions

Understand drug metabolism, pharmacodynamics and pharmacokinetics

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Describe the general structure of the peripheral nervous system, the nature of the primary neurotransmitters and the type and location of their receptors
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Transferable skills

Self directed learning
Adult learning

Study

Study time

Type	Required
Lectures	15 sessions of 1 hour (10%)
Tutorials	2 sessions of 1 hour (1%)
Practical classes	1 session of 5 hours (3%)
Private study	120 hours 30 minutes (80%)
Assessment	7 hours 30 minutes (5%)
Total	150 hours

Private study description

Self-directed learning and revision for the end-of-year exam

Costs

Category	Description	Funded by	Cost to student
Equipment and project costs	Students will require a lab coat for lab sessions but these are provided by the department.	Department	£0.00

Assessment

You do not need to pass all assessment components to pass the module.

Assessment group D2

	Weighting	Study time	Eligible for self-certification
In-class assignment	30%	6 hours	Yes (extension)
Wet-lab assessment 1 x 1 hr workshop plus 1 x 5hr lab work			
Closed-book end-of-year examination	70%	1 hour 30 minutes	No
In-person locally-timetabled closed-book end-of-year examination			

Assessment group R2

	Weighting	Study time	Eligible for self-certification
Closed-book examination	100%		No

In-person locally-timetabled closed-book end-of-year examination

Feedback on assessment

Students receive general feedback on the exam essays.

Past exam papers for LF260

Availability

Courses

This module is Core for:

- Year 2 of ULFA-B140 Undergraduate Neuroscience (BSc)
- Year 2 of ULFA-B142 Undergraduate Neuroscience (MBio)
- Year 2 of ULFA-B143 Undergraduate Neuroscience (with Industrial Placement) (MBio)
- Year 2 of ULFA-B141 Undergraduate Neuroscience (with Placement Year) (BSc)