



THE UNIVERSITY OF
BUCKINGHAM

MEDICAL SCHOOL

MB ChB

Unit Summary: Membranes and Receptors

1 *Educational Aims of the Unit*

The unit aims to enable students to make progress towards meeting some of the learning outcomes described in Tomorrow's Doctors (2009) relevant to 'The Doctor as a Scholar and Scientist' and 'the Doctor as a Professional'. The specific aims of this second term unit are that students should understand membrane structure and function and be able to relate this to cell behaviour; understand how the movement of ions and molecules across membranes may contribute to pH and cell volume regulation and electrical excitability and nerve impulse conduction, appreciate how chemical messengers, such as hormones and neurotransmitters, influence the activity of cells and organs by interacting with receptors; understand in principle how drugs might modify the action of such chemical messengers.

2 *Learning Outcomes From Tomorrow's Doctors (2009)*

Outcomes 1: The Doctor as a Scholar and Scientist.

8. The graduate will be able to apply to medical practice biomedical scientific principles.
 - a) Explain normal human structure and functions.
 - b) Explain the scientific bases for common disease presentations.
 - c) Justify the selection of appropriate investigations for common clinical cases.
 - d) Explain the fundamental principles underlying such investigative techniques.
 - g) Make accurate observations of clinical phenomena and appropriate critical analysis of clinical data.
12. Apply scientific method and approaches to medical research.
 - a) Critically appraise the results of relevant diagnostic, prognostic and treatment trials and other qualitative and quantitative studies as reported in the medical and scientific literature.
 - b) Formulate simple relevant research questions in biomedical science, psychosocial science or population science, and design appropriate studies or experiments to address the questions.
 - c) Apply findings from the literature to answer questions raised by specific clinical problems.

Outcomes 3: The Doctor as a Professional

20. The graduate will be able to behave according to ethical and legal principles. The graduate will be able to:
 - e) Recognise the rights and the equal value of all people and how opportunities for some people may be restricted by others' perceptions.
21. Reflect, learn and teach others.
 - b) Establish the foundations for lifelong learning and continuing professional development, including a professional development portfolio containing reflections, achievements and learning needs.
 - c) Continually and systematically reflect on practice and, whenever necessary, translate that reflection into action, using improvement techniques and audit appropriately for example, by critically appraising the prescribing of others.
 - d) Manage time and prioritise tasks, and work autonomously when necessary and appropriate.

- e) Recognise own personal and professional limits and seek help from colleagues and supervisors when necessary.
- f) Function effectively as a mentor and teacher including contributing to the appraisal, assessment and review of colleagues, giving effective feedback, and taking advantage of opportunities to develop these skills.

3 Teaching and Learning Strategies

Principles will be introduced in formal lectures, and learning will be reinforced in practical classes and facilitator led small-group work immediately afterwards. Student will work in the same teams throughout Phase I to encourage team-working.

Some concepts will be discussed in more detail in tutorials, and Moodle- based tests and coursework will allow for formative assessment. Students will be provided with workbooks describing structured tasks to direct independent learning throughout the unit, and ongoing use of an e-portfolio will nurture and encourage reflective practice.

4 Unit Outline/Syllabus

Session 1: The Membrane Bilayer

Lecture: Introduction and The Membrane Bilayer

Lecture: Membrane Proteins, Membrane Asymmetry and the cytoskeleton

Group Work: The asymmetric structure and dynamic nature of membrane bilayers

Group Work: Oral presentation skills

Session 2: Membrane Permeability / Cell Volume and pH Regulation

Lecture: The Role of Membranes as Permeability Barriers

Lecture: ATP-dependent Ion Pumps and Ion Exchangers

Group Work: Body fluids: regulation of composition and volume

Session 3: The Resting Cell Membrane

Lecture: The resting cell membrane/ Changing membrane potentials

Group Work: Equilibrium potentials

Session 4: Electrical Excitability

Lecture: The action potential and its properties

Group Work: The action potential

Lecture: Conduction of the nervous impulse

Session 5: Effects of Electrical Signals - Ligand-Gated Channels

Lecture: The cellular response to action potentials

Group Work: Recap of group work and self-directed learning from sessions 3+4

Lecture: Control of Intracellular calcium homeostasis

Session 6: Receptors and Membrane Turnover

Lecture: Structure of Receptors - Common Structural Motifs

Lecture: Receptor-mediated Endocytosis

Group Work: Presentations 1

Session 7: Signal Transduction in Biological Membranes

Lecture: Receptor-Effector Signalling via G-proteins

Lecture: Effector Mechanisms in Intracellular Signalling

Group Work: Presentations 2

Session 8: Drugs and Receptors/ Pharmacokinetics

Lecture: Receptors theory/Drug-receptor interactions

Lecture: Receptors theory/Drug-receptor interactions

Group Work: Data handling exercise to illustrate principles of drug-receptor interactions

Session 9: Formative Assessment

Lecture: Formative Assessment

Group Work: Formative Assessment Feedback

Lecture: Pharmacokinetics of drug administration

Session 10: The Autonomic Nervous System/ Pharmacokinetics

Lecture: The Autonomic Nervous System - 1

Lecture: The Autonomic Nervous System - 2

Group Work: Data handling exercise on pharmacokinetics + private study questions for tutorial in session 11

Session 11: Drugs and the Autonomic Nervous System

Lecture: The Autonomic Nervous System - 1

Lecture: The Autonomic Nervous System - 2

Group Work: Data handling exercise on pharmacokinetics + private study questions for tutorial in session 11

5 Secondary Learning Outcomes

In addition to meeting the outcomes described in Tomorrow's Doctors, at the completion of the unit students will be able to:

- Describe the main features of the fluid mosaic model of biological membrane structure and discuss the features of membrane asymmetry and cytoskeletal interactions.
- Describe how membrane transporter mechanisms and ion channels contribute to the maintenance of ionic gradients across membranes, the transport of solutes through membranes and the regulation of intracellular pH and cell volume.
- Describe the ionic basis of the membrane potential.
- Describe the properties of voltage-gated ion channels, the general features of electrical excitability of membranes, and the permeability changes associated with the action potential.
- Discuss factors affecting impulse conduction velocity in nerves.
- Describe and compare biological communication processes involving hormones, local mediators and neurotransmitters.
- Outline the variety of receptor mechanisms which influence the behaviour of cells.

- Outline the variety of effector mechanisms involved in cellular signalling pathways, including the concepts of transducing proteins, second messengers and signal pathway cascades.
- Define the concept of receptor specificity, and define the terms agonist and antagonist.
- Distinguish competitive and non-competitive antagonism.
- Describe the anatomical and pharmacological divisions of the autonomic nervous system.
- Outline the steps of neurotransmission at cholinergic and adrenergic synapses in the autonomic nervous system and the mammalian neuromuscular junction.
- Summarise whole-body considerations of drugs reaching their sites of therapeutic action, including principles of drug bioavailability, inactivation and elimination and describe the adaptive changes which can occur in receptor populations when exposed to agonists and antagonists.
- Describe the principles of drug action using the autonomic nervous system as an example drug target.

6 Key Texts and/or Other Learning Materials

- Golan, D.E., Tashjian, Jr. A.H., Armstrong, E.J. & Armstrong, A.W. *Principles of Pharmacology: The Pharmacologic Basis of Drug Therapy*. 3rd Edition, Wolters Kluwer/Lippincott, Williams & Williams, 2012, ISBN 9781451118056
- Rang, H.P., Dale, M.M., Ritter, J.M. & Flower, R. *Rang & Dale's Pharmacology: With Student Consult Online Access*, 7th Edition, Churchill Livingstone, 2011, ISBN 9780702034718,
- Boron, W.F. & Boulpaep, E.L. *Medical Physiology* (with student consult online), 2nd Edition, Saunders, 2008, ISBN 9781437717532
- Barrett, Brooks, Biotano & Barman, *Ganong's Review of Medical Physiology*, 23rd Rev Edition, McGraw Hill, 2009, ISBN 9780071605670,
- Preston, R.R. & Wilson, T.E. *Lippincott's Illustrated Reviews: Physiology*. Wolters Kluwer, Lippincott Williams & Wilkins, 2013, ISBN 9781451175677
- Also available in the Moodle Learning Environment is a series of self-marking multiple-choice formative assessments to allow you to assess your learning in the Unit.

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