**Table S1** Characteristics of the European consensus panel (n= 129).

| Country | Profession | Grade | Specialty | Educational experience |
|---|---|---|---|---|
| Belgium | Doctor | Professor | Basic Pharmacology | 25 years |
| Belgium* | Doctor | Professor | Basic Pharmacology and General Practice | 20 years |
| Bulgaria | Doctor | Professor | Basic Pharmacology, Clinical Pharmacology and Therapeutics | 15 years |
| Bulgaria* | Doctor | Associate professor | Basic Pharmacology, Clinical Pharmacology and Dermatology | 10 years |
| Bulgaria | Doctor | Associate professor | Clinical Pharmacology and Therapeutics | 16 years |
| Bulgaria | Doctor | Associate professor | Basic Pharmacology, Clinical Pharmacology and Therapeutics | 27 years |
| Bulgaria | Doctor | Associate professor | Basic Pharmacology and Clinical Pharmacology | 18 years |
| Croatia | Doctor | Professor | Clinical Pharmacology and Toxicology | 21 years |
| Croatia | Doctor | Associate professor | Therapeutics and Internal Medicine | 15 years |
| Croatia | Doctor | Associate professor | Clinical Pharmacology and Toxicology | 7 years |
| Cyprus | Doctor | Assistant professor | Clinical Pharmacology and Neuropharmacology | 15 years |
| Cyprus* | Scientist | Senior lecturer/assistant professor | Basic Pharmacology | 7 years |
| Czech Republic | Doctor | Professor | Clinical Pharmacology | 18 years |
| Czech Republic | Doctor | Professor | Human Pharmacology | 14 years |
| Czech Republic | Scientist | Associate professor | Basic Pharmacology | 16 years |
| Czech Republic* | Doctor | Associate professor | Clinical Pharmacology | 15 years |
| Czech Republic | Pharmacist | Senior lecturer | Clinical Pharmacology and Therapeutics | 11 years |
| Denmark* | Doctor | Senior lecturer/consultant | Clinical Pharmacology | 10 years |
| Denmark | Doctor | Professor | Clinical Pharmacology | 20 years |
| Estonia* | Doctor | Senior lecturer/drug agency assessor | Basic Pharmacology and Clinical Pharmacology | 10 years |
| Finland | Doctor | Professor | Clinical Pharmacology and Therapeutics | 30 years |
| Finland | Doctor | Professor | Clinical Pharmacology | 20 years |
| France | Doctor | Professor | Clinical Pharmacology and Cardiology | 28 years |
| France | Doctor | Professor | Pharmacology and Neurology | 17 years |
| France* | Doctor | Professor | Pharmacology and Pulmonology | 22 years |
| France | Doctor | Senior lecturer/consultant | Rheumatology | 6 years |
| France | Doctor | Senior lecturer/consultant | Rheumatology | 5 years |
| France* | Doctor | Professor | Therapeutics and Rheumatology | 22 years |
| France* | Doctor | Professor | Clinical Pharmacology | 9 years |
| France* | Doctor | Professor | Therapeutics and General Medicine | 30 years |
| France | Doctor | Scientist | Human Drug Research | 3 years |
| France | Doctor | Professor | Cardiology | 36 years |
| France | Doctor | Associate professor | Basic Pharmacology | 8 years |
| France | Doctor | Professor | Therapeutics and Intensive Care Medicine | 6 years |
| France | Pharmacist | Associate professor | General Pharmacy | 17 years |
| France | Doctor | Professor | Internal Medicine and Intensive Care Medicine | 18 years |
| France | Doctor | Professor | Basic Pharmacology and Cardiology | 25 years |
| Germany* | Doctor | Senior lecturer/consultant | Clinical Pharmacology | 12 years |
| Germany | Doctor | Professor | Clinical Pharmacology and Pharmacogenetics | 16 years |
| Germany* | Doctor | Professor | Basic Pharmacology and Toxicology | 24 years |
| Germany | Doctor | Professor | Basic Pharmacology, Clinical Pharmacology and Toxicology | 26 years |
| Germany* | Doctor | Senior lecturer/consultant | Clinical Pharmacology | 10 years |
| Germany | Doctor | Professor | Basic Pharmacology, Toxicology and Neurology | 10 years |
| Germany | Doctor | Professor | Basic Pharmacology and Toxicology | 20 years |
| Germany | Doctor | Lecturer/post-doc researcher | Basic Pharmacology and Toxicology | 7 years |

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|---|---|---|---|---|
| Germany | Doctor | Senior lecturer/consultant | Clinical Pharmacology | 25 years |
| Germany | Doctor | Professor | Clinical Pharmacology | 30 years |
| Germany | Doctor | Professor | Clinical Pharmacology | 25 years |
| Greece* | Doctor | PhD student | Clinical Pharmacology | 5 years |
| Greece* | Doctor | Professor | Basic Pharmacology | 35 years |
| Greece | Doctor | Lecturer/resident | General and Family Medicine | 5 years |
| Greece* | Doctor and Pharmacist | Professor | Clinical Pharmacology and General medicine | 25 years |
| Greece | Doctor | Professor | Basic Pharmacology and Gastroenterology | 15 years |
| Hungary | Doctor | Associate professor | Pharmacology and Pharmacotherapy | 26 years |
| Ireland | Doctor | Professor | Clinical Pharmacology and Cardiology | 11 years |
| Ireland | Doctor | Associate professor | Clinical Pharmacology, Geriatrics and Stroke Medicine | 20 years |
| Ireland | Scientist | Senior lecturer | Clinical Pharmacology | 6 years |
| Italy* | Doctor | Professor | Clinical Pharmacology | 25 years |
| Italy | Doctor | Professor | Basic Pharmacology | 35 years |
| Italy | Doctor | Professor | Clinical Pharmacology | 20 years |
| Italy* | Doctor | Senior lecturer/researcher | Clinical Pharmacology | 5 years |
| Italy | Doctor | Professor | Clinical Pharmacology | 25 years |
| Italy | Doctor | Senior lecturer | Pharmacology and Toxicology | 25 years |
| Italy | Doctor | Professor | Basic Pharmacology | 34 years |
| Italy | Doctor | Professor | Basic Pharmacology | 20 years |
| Italy | Scientist | Professor | Clinical Pharmacology and Cardiology | 30 years |
| Italy* | Doctor | Assistant professor | Basic Pharmacology | 9 years |
| Latvia | Doctor | Associate professor | Clinical Pharmacology and Pharmacotherapy | 9 years |
| Lithuania | Doctor | Professor | Basic Pharmacology and Clinical Pharmacology | 16 years |
| Lithuania* | Doctor | Professor | Clinical Pharmacology and Clinical Pharmacy | 25 years |
| Malta | Scientist | Associate professor | Clinical Pharmacology and Therapeutics | 25 years |
| Netherlands* | Doctor | Senior lecturer/consultant | Clinical Pharmacology and Geriatrics | 4 years |
| Netherlands | Pharmacist | Senior lecturer | Clinical Pharmacology and Therapeutics | 9 years |
| Netherlands* | Scientist | Assistant professor | Clinical Pharmacology and Therapeutics | 15 years |
| Netherlands | Scientist | Senior lecturer/consultant | Pharmacology and Therapeutics | 13 years |
| Netherlands | Scientist | Post-doc researcher | Clinical Pharmacy | 3 years |
| Norway | Doctor | Professor | Clinical Pharmacology | 20 years |
| Norway | Doctor | Associate professor | Clinical Pharmacology | 9 years |
| Poland | Doctor | Professor | Basic Pharmacology and Neuroscience | 23 years |
| Poland* | Doctor | Associate professor | Clinical Pharmacology and Neuroscience | 15 years |
| Poland | Doctor | Professor | Clinical Pharmacology and Internal Medicine | 15 years |
| Poland | Doctor | Professor | Clinical Pharmacology | 15 years |
| Portugal | Doctor | Associate professor | Internal Medicine and Intensive Care Medicine | 13 years |
| Portugal | Doctor | Professor | Clinical Pharmacology and Therapeutics | 18 years |
| Portugal | Doctor | Professor | Basic Pharmacology | 16 years |
| Romania* | Doctor | Associate professor | Clinical Pharmacology | 17 years |
| Romania | Doctor | Associate professor | Clinical Pharmacology and Emergency Medicine | 21 years |
| Romania | Pharmacist | Associate professor | Clinical Pharmacy and Pharmacology | 7 years |
| Romania | Doctor | Professor | Clinical Pharmacology and Paediatrics | 25 years |
| Romania | Doctor | Associate professor | Basic Pharmacology | 11 years |
| Slovakia* | Doctor | Assistant professor | Clinical Pharmacology and Hepatology | 13 years |
| Slovakia | Doctor | Post-doc researcher | Basic Pharmacology | 17 years |
| Slovakia* | Doctor | Professor | Clinical and Experimental Pharmacology and Hepatology | 25 years |
| Slovenia | Doctor | Professor | Basic Pharmacology | 30 years |
| Spain* | Doctor | Lecturer/consultant | Clinical Pharmacology | 3 years |
| Spain | Doctor | Professor | Clinical Pharmacology | 15 years |
| Spain | Doctor | Professor | Clinical Pharmacology | 36 years |

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|---|---|---|---|---|
| Spain | Doctor | Senior lecturer/consultant | Clinical Pharmacology | 3 years |
| Spain* | Doctor | Professor | Clinical Pharmacology | 20 years |
| Spain | Doctor | Professor | Clinical Pharmacology | 30 years |
| Spain | Doctor | Professor | Clinical Pharmacology | 18 years |
| Spain | Doctor | Professor | Clinical Pharmacology and Pharmacogenomics | 38 years |
| Spain* | Doctor | Associate professor | Clinical Pharmacology | 30 years |
| Spain* | Doctor | Professor | Clinical Pharmacology | 35 years |
| Spain | Pharmacist | Professor | Basic Pharmacology | 22 years |
| Spain | Doctor | Senior lecturer/consultant | Clinical Pharmacology | 14 years |
| Spain | Doctor | Senior lecturer/consultant | Clinical Pharmacology | 3 years |
| Spain* | Doctor | Associate professor | Basic Pharmacology and Clinical Pharmacology | 20 years |
| Sweden | Doctor | Professor | Clinical Pharmacology | 17 years |
| Sweden | Doctor | Professor | Clinical Pharmacology | 22 years |
| Sweden | Doctor | Professor | Basic Pharmacology and Neuroscience | 18 years |
| Sweden | Doctor | Senior lecturer/consultant | Internal Medicine and Clinical Pharmacology | 5 years |
| Switzerland | Doctor | Professor | Clinical Pharmacology and Toxicology | 25 years |
| Switzerland | Doctor | Professor | Clinical Pharmacology, Internal Medicine and Hepatology | 30 years |
| UK | Doctor | Senior lecturer/consultant | Clinical Pharmacology, Therapeutics and General Medicine | 11 years |
| UK* | Doctor | Senior lecturer/consultant | Clinical Pharmacology, General Medicine and Medical Education | 11 years |
| UK | Doctor | Senior lecturer/consultant | General Practice | 5 years |
| UK | Doctor | Professor | Clinical Pharmacology and Therapeutics | 22 years |
| UK | Doctor | Senior lecturer/consultant | Clinical Pharmacology and General Medicine | 10 years |
| UK* | Doctor | Senior lecturer/consultant | Clinical Pharmacology and General Medicine | 10 years |
| UK | Doctor | Senior lecturer/consultant | Acute and General Medicine | 3 years |
| UK | Doctor | Senior lecturer/consultant | Clinical Pharmacology and Therapeutics | 15 years |
| UK | Doctor | Senior lecturer/consultant | Clinical Pharmacology and General Medicine | 14 years |
| UK* | Doctor | Professor | Clinical Pharmacology and General Medicine | 25 years |
| UK | Doctor | Professor | Clinical Pharmacology and Therapeutics | 20 years |
| UK | Pharmacist | Senior lecturer | Clinical Pharmacology and Therapeutics | 13 years |
| UK | Doctor | Senior lecturer/consultant | Clinical Pharmacology and General medicine | 30 years |
| UK | Pharmacist | Senior lecturer/consultant | Clinical Pharmacology and Therapeutics | 4 years |
| UK | Doctor | Professor | Internal Medicine and Neonatology | 21 years |

* Panellists (n= 33) who attended the face-to-face panel meeting.

**Table S2** Articles (n= 23) identified in the systematic literature search.

| Author | Date | Country | Aim | Evidence type | Main results |
|---|---|---|---|---|---|
| **Antman *et al.*[1]** | 2016 | USA | To define core competencies for the prevention and management of prescription drug misuse for medical education | Evidence based on the opinion of a working group consisting of four deans and two leaders of medical societies in one country | 10 core competencies for the prevention and management of prescription drug misuse |
| **Banna *et al.*[2]** | 1994 | United Arab Emirates | To present a core curriculum for the teaching of pharmacology and therapeutics for medical students | Evidence based on the opinion of four CPT teachers from one institution | 27 knowledge outcomes and 21 skill outcomes for pharmacology and therapeutics education |
| **Borgeat *et al.*[3]** | 1985 | Canada | To describe specific learning outcomes for the teaching therapeutic skills of a psychological nature to future physicians | Evidence based on the opinion of psychiatry teachers from one institution | 3 cognitive, 14 aptitudinal and 5 attitudinal outcomes for teaching therapeutics skill of a psychological nature |
| **Davenport *et al.*[4]** | 2005 | UK; BSAC | To define learning outcomes for prudent antimicrobial prescribing to undergraduate medical students | Evidence based on the opinion of two working groups consisting of teachers from multiple institutions in one country | 12 learning outcomes domains for undergraduate education of prudent antibiotic prescribing |
| **de Vries[5]** | 1993 | The Netherlands | To define a framework of the whole problem-solving prescribing process and the learning outcomes for medical education which can be derived from it | Evidence based on the opinion of general practitioners and clinical pharmacologists from multiple institutions in one country | 8 cognitive skills, 2 motor skills and 6 communication skills for CPT education |
| **Donnenberg *et al.*[6]** | 2016 | USA; ACCP | To develop a comprehensive set of guidelines in clinical pharmacology for entering residency | Evidence based on the opinion of medical teachers from multiple institutions in one country | 8 topic for clinical pharmacology education |
| **Flockhart *et al.*[7]** | 2002 | USA | To design and evaluate a core curriculum in CPT for 4$^{th}$-year medical students | Evidence based on a literature survey and the opinion of CPT teachers from two institutions in one country | 13 learning outcomes for a core curriculum in CPT |
| **Gitanjali & Shashindran[8]** | 2006 | India; IPS | To develop a curriculum draft for clinical pharmacology for medical undergraduates | Evidence based on a modified Delphi study among pharmacologists of multiple institutions in one country* | 13 knowledge, 3 psychomotor skills, 12 attitudes and communication skills for clinical pharmacology education |

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| **Lum *et al.*[9]** | 2013 | Australia | To develop a set of national competencies for teaching safe and effective prescribing during the medical curriculum | Evidence based on the opinion of three teachers from three institutions in one country | 12 core competencies for safe and effective prescribing education |
| **Mathur[10]** | 2004 | India | To describe a curriculum in pharmacology for medical students | Evidence based on the opinion of one pharmacologist from one institution | 8 learning outcomes for teaching pharmacology |
| **Maxwell & Walley[11]** | 2003 | UK | To define national learning outcomes in CPT and to identify the minimum knowledge for medical graduates to prescribe safely and effectively | Evidence based on the opinion of two CPT teachers from two institutions in one country | 48 core knowledge and understanding, 35 core skill, 19 core attitude learning outcomes for CPT education |
| **Midlöv *et al.*[12]** | 2015 | Sweden | To identify the core competencies in basic and clinical pharmacology for medical students | Evidence based on a modified three-round Delphi study involving 25 physicians of multiple institutions in one country | 40 core competencies for basic and clinical pharmacology education |
| **Murison *et al.*[13]** | 2013 | USA; AAPM | To define learning outcomes for a new curriculum in pain medicine for medical students | Evidence based on a literature survey among 15 pain physicians of multiple institutions in one country | 27 recommended topics for pain medicine |
| **Nierenberg[14]** | 1990 | USA; CMSECPT | To formulate an essential core curriculum for medical students in CPT | Evidence based on consensus among faculty members and council representatives of multiple institutions in one country | 17 core knowledge, 16 core skill and 5 core attitude learning outcomes for CPT education |
| **O'Brien *et al.*[15]** | 2009 | USA | To describe the development and implementation of a pharmacogenomics course for health professional students | Evidence based on the opinion of a group of medical and health science teachers from two institutions in one country | 7 molecular knowledge, 8 pharmacology knowledge and 7 technical skill learning outcomes for pharmacogenomics education |
| **Orme & Sjöqvist[16]** | 2010 | IUPHAR | To present a model core curriculum for CPT and prescribing for medical students | Evidence based on the opinion of clinical pharmacologists from multiple countries | 63 core knowledge and understanding, 39 core skill, 19 core attitude learning outcomes for CPT and prescribing education |
| **Pulcini & Gyssens[17]** | 2013 | France, The Netherlands | To review the education of prescribers of antibiotics, and analyze and discuss all relevant aspects | Evidence based on the opinion of two infectiologists from two countries | 34 learning outcomes for prudent antibiotic prescribing, divided among 10 topics |

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|---|---|---|---|---|---|
| **Ross & Loke**[18] | 2010 | UK; BPS | To create consensus on the required competencies for new graduates in the area of prescribing | Evidence based on a systematic review and modified two-round Delphi study involving 28 experts in clinical pharmacology, pharmacy and medical education of multiple institutions in one country | 50 learning outcomes for prescribing education |
| **Ross & Maxwell**[19] | 2012 | UK; BPS | To provide clear statement of the learning outcomes in clinical pharmacology and prescribing, and to describe a curriculum that might enable medical students to achieve these outcomes | Evidence based on a previous Delphi study and opinion of two CPT teachers from two institutions in one country | 226 core knowledge and understanding and 58 core skill learning outcomes for teaching clinical pharmacology and prescribing |
| **Sice**[20] | 1975 | USA | To define the basic outcomes for pharmacological education for pre-clinical students, clerks and residents | Evidence based on the opinion of one pharmacologist from one institution | 6 learning outcomes for pharmacological education for pre-clinical medical students, 7 outcomes for clerks and 5 outcomes for residents |
| **Taylor *et al.***[21] | 2016 | Barbados | To create a summative document containing aims, outcomes and methods that can be used for the training of health care professionals in ward-based inpatient diabetes care | Evidence based on the opinion of 55 final-year medical students of one institution using a four-stage approach | 13 aims, 29 learning outcomes and 21 methods for the inpatient diabetes care |
| **Turner & Weiner**[22] | 2002 | USA | To develop expert-based guidelines for a medical curriculum on chronic pain evaluation and management in older adults | Evidence based on a modified two-round Delphi study involving 12 experts in pain management and medical education of multiple institution in one country | 8 pain assessment knowledge, 7 pain management knowledge, 12 skills/abilities and 12 attitude items for chronic pain curriculum |
| **Walley & Webb**[23] | 1997 | UK; BPS | To develop a national core curriculum in CPT for medical education | Evidence based on a four-round Delphi study involving 8 senior clinical pharmacologists from two countries | 16 core knowledge and understanding, 14 core skill and 4 core attitude learning outcomes for teaching CPT |

BSAC, British Society Antimicrobial Chemotherapy. BPS, British Pharmacological Society. CMSECPT, Council for Medical Students Education in Clinical Pharmacology and Therapeutics. CPT, clinical pharmacology and therapeutics. IPS, Indian Pharmacological Society. IUPHAR, International Union of Basic and Clinical Pharmacology.* No reference or description of the Delhi process was provided.

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**Table S3** Learning outcomes for knowledge in clinical pharmacology and therapeutics (n= 192) that were included (≥80% of the panellists scored 'important' or 'very important').

| Category | Learning outcome<br><br>A European medical graduate should be able to… | % (very) unimportant | % neutral | % (very) important | % pre-clinical | % clinical | % both |
|---|---|---|---|---|---|---|---|
| **1.1 Introduction to CPT**<br>Basic principles | 1.1.1 Explain the terms 'clinical pharmacology' and 'therapeutics' | 5.5 | 11.0 | 83.5 | 36.4 | 19.3 | 44.3 |
| | 1.1.2 Recognize the breadth of topics embraced by clinical pharmacology and therapeutics | 6.7 | 12.0 | 81.3 | 25.3 | 37.9 | 36.8 |
| | 1.1.3 Recognize the importance of clinical pharmacology as the scientific discipline that underpins a rational approach to prescribing medicines | 2.7 | 4.6 | 92.7 | 12.9 | 46.5 | 40.6 |
| **1.2 Introduction to CPT**<br>Drugs in health care and society | 1.2.1 Recognize the impact of prescription drugs in society | 2.8 | 9.3 | 87.9 | 18.0 | 53.0 | 29.0 |
| | 1.2.2 Explain the extent of illicit drug use and its public health consequences | 3.6 | 13.8 | 82.6 | 24.2 | 49.5 | 26.4 |
| **2.1 Pharmacodynamics**<br>Mechanism of action | 2.1.1 Define the term 'pharmacodynamics' | 2.7 | 2.8 | 94.5 | 62.4 | 4.0 | 33.7 |
| | 2.1.2 Identify molecular targets for drug action including receptors, ion channels, enzymes and transporters | 0.9 | 1.8 | 97.3 | 74.8 | 2.9 | 22.3 |
| | 2.1.3 Identify cellular mechanisms of action including excitation, contraction and secretion | 6.4 | 6.4 | 87.2 | 86.0 | 3.2 | 10.8 |
| | 2.1.4 Describe how these actions translate into responses at the tissue and organ level | 1.8 | 3.7 | 94.5 | 67.0 | 6.0 | 27.0 |
| **2.2 Pharmacodynamics**<br>Dose-response relationships | 2.2.1 Explain the relationship between drug dose and response | 0.0 | 0.9 | 99.1 | 52.8 | 7.5 | 39.6 |
| | 2.2.2 Define the terms 'agonist', 'antagonist' and 'partial agonist' | 1.0 | 6.4 | 92.6 | 76.0 | 5.0 | 19.0 |
| | 2.2.3 Explain the effect of antagonists on the dose-response curve of an agonist | 3.7 | 6.4 | 89.9 | 80.2 | 5.2 | 14.6 |
| | 2.2.4 Explain the assessment of receptor selectivity | 6.4 | 9.2 | 84.4 | 78.3 | 7.6 | 14.1 |
| | 2.2.5 Define the terms 'efficacy' and 'potency' and their clinical relevance[#] | 1.1 | 6.7 | 92.2 | 42.9 | 13.0 | 44.1 |
| | 2.2.6 Explain the difference between pharmacological and clinical efficacy[$] | 4.5 | 7.9 | 87.6 | 27.5 | 30.5 | 42.0 |
| | 2.2.7 Define the term 'therapeutic index' | 0.0 | 1.9 | 98.1 | 51.0 | 16.3 | 32.7 |
| | 2.2.8 Describe the phenomena of desensitization and tolerance | 0.9 | 4.7 | 94.4 | 60.6 | 11.1 | 28.3 |
| **3.1 Pharmacokinetics**<br>Drug absorption, distribution, metabolism and excretion | 3.1.1 Explain the term 'pharmacokinetics' | 0.9 | 2.7 | 96.4 | 52.5 | 4.0 | 43.6 |
| | 3.1.2 List the four phases of pharmacokinetics (i.e. absorption, distribution, metabolism, excretion) | 1.8 | 1.9 | 96.3 | 60.4 | 5.0 | 34.7 |
| | 3.1.3 Explain why an understanding of pharmacokinetics is relevant to prescribers | 1.8 | 0.9 | 97.3 | 27.2 | 35.0 | 37.9 |
| | 3.1.4 Explain the mechanisms of drug movement across physiological barriers | 1.8 | 11.9 | 86.3 | 75.6 | 7.8 | 16.7 |
| | 3.1.5 Explain fundamental differences between various routes of drug administration | 0.0 | 2.8 | 97.2 | 43.1 | 17.6 | 39.2 |
| | 3.1.6 Describe first-pass metabolism and its importance | 0.9 | 2.8 | 96.3 | 48.0 | 13.7 | 38.2 |
| | 3.1.7 Describe how one drug can influence the absorption of another | 0.9 | 4.6 | 94.5 | 30.9 | 16.5 | 52.6 |
| | 3.1.8 Explain the distribution of drugs across body compartments | 0.9 | 7.3 | 91.5 | 58.9 | 14.7 | 26.3 |
| | 3.1.9 Define the term 'volume of distribution' and its clinical relevance | 0.9 | 5.6 | 93.5 | 41.4 | 16.2 | 42.4 |

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| | 3.1.10 Explain how the distribution of a drug influences its pharmacokinetics | 0.9 | 11.0 | 88.1 | 57.6 | 17.4 | 25.0 |
| | 3.1.11 Define phase I and II metabolism | 3.7 | 14.7 | 81.6 | 67.8 | 12.2 | 20.0 |
| | 3.1.12 Explain the important role of the liver in drug metabolism | 0.9 | 1.8 | 97.3 | 45.1 | 11.8 | 43.1 |
| | 3.1.13 Explain the important routes of drug excretion from the body | 0.0 | 1.8 | 98.2 | 47.1 | 10.6 | 42.3 |
| **3.2 Pharmacokinetics** Concentration-time relationships | 3.2.1 Describe the typical concentration-time curve for a drug with first-order kinetics | 0.9 | 10.1 | 89.0 | 66.0 | 13.8 | 20.2 |
| | 3.2.2 Explain the importance of zero order (saturation) kinetics | 3.7 | 14.7 | 81.6 | 68.9 | 13.3 | 17.8 |
| | 3.2.3 Define the terms 'clearance' and 'half-life' and their clinical relevance | 0.0 | 0.0 | 100.0 | 33.0 | 19.8 | 47.2 |
| | 3.2.4 Define the term 'bioavailability' and its clinical relevance | 0.0 | 1.8 | 98.2 | 36.2 | 22.9 | 41.0 |
| **3.3 Pharmacokinetics** Repeated drug dosing | 3.3.1 Explain the pharmacokinetic factors that determine choice of dose, route, frequency and duration of drug administration | 1.9 | 2.8 | 95.3 | 33.0 | 28.2 | 38.8 |
| | 3.3.2 Explain the pharmacokinetics of repeated dosing including time to 'steady-state' | 0.9 | 2.8 | 96.3 | 38.8 | 26.2 | 35.0 |
| | 3.3.3 Explain fundamental differences between drugs with long and short half-lives | 1.8 | 2.8 | 95.4 | 34.7 | 22.8 | 42.6 |
| | 3.3.4 Explain the rationale for loading doses | 0.9 | 1.8 | 97.3 | 28.4 | 31.4 | 40.2 |
| **4.1 Individual variability in the response to drugs** Basic principles | 4.1.1 Identify the main factors influencing variability in response to drugs | 3.7 | 15.7 | 80.6 | 42.7 | 33.7 | 23.6 |
| | 4.1.2 Explain how different pharmaceutical factors produce variation in response to drugs | 2.7 | 13.8 | 83.5 | 38.5 | 31.9 | 29.7 |
| | 4.1.3 Explain how altered pharmacokinetic handling of drugs produces variation in response to drugs | 3.7 | 11.0 | 85.3 | 38.0 | 33.7 | 28.3 |
| | 4.1.4 Explain how pharmacogenetic variation can influence the response to drugs | 0.9 | 5.5 | 93.6 | 29.0 | 39.0 | 32.0 |
| | 4.1.5 Explain how pharmacodynamic factors can affect drug response (e.g. receptor sensitivity, tolerance) | 1.8 | 10.1 | 88.1 | 40.9 | 28.0 | 31.2 |
| **4.2 Individual variability in the response to drugs** Pharmacokinetic variability | 4.2.1 Identify important groups of patients where pharmacokinetic handling of drugs is altered | 0.9 | 2.8 | 96.4 | 14.6 | 50.5 | 35.0 |
| | 4.2.2 Explain in each of the cases above why handling is altered | 0.9 | 11.0 | 88.2 | 17.5 | 62.9 | 19.6 |
| | 4.2.3 Explain in each of the cases above how this might have been predicted and the adjustments that might have to be made by prescribers | 0.9 | 12.0 | 87.1 | 8.4 | 71.6 | 20.0 |
| **4.3 Individual variability in the response to drugs** Pharmacogenetic variability | 4.3.1 Identify common ways in which genetic variation influences the handling and response to drugs | 2.7 | 11.0 | 86.2 | 31.6 | 37.9 | 30.5 |
| | 4.3.2 Provide common examples where pharmacogenetic variation influences prescribing | 0.9 | 7.3 | 91.7 | 23.5 | 54.1 | 22.4 |
| | 4.3.3 Explain how increasing knowledge of pharmacogenetic variation will influence future prescribing practice* | 3.3 | 12.0 | 84.7 | 12.9 | 63.5 | 23.5 |
| **5.1 Adherence, compliance and concordance** Adherence and compliance | 5.1.1 Define the terms 'adherence' and 'compliance', separating them from 'concordance' | 5.5 | 14.3 | 80.2 | 16.7 | 64.4 | 18.9 |
| | 5.1.2 Explain the scale of non-adherence and its consequences | 6.4 | 11.0 | 82.6 | 10.0 | 77.8 | 12.2 |
| | 5.1.3 Explain the importance of patient consent in the adherence to therapy | 2.7 | 12.8 | 84.5 | 6.5 | 78.5 | 15.1 |
| | 5.1.4 Identify measures to improve poor adherence whether intentional or unintentional | 4.6 | 8.3 | 87.1 | 6.4 | 81.9 | 11.7 |
| **5.2 Adherence, compliance and concordance** Concordance | 5.2.1 Describe the influence of patients' beliefs on adherence* | 3.3 | 13.0 | 83.7 | 9.8 | 80.5 | 9.8 |
| | 5.2.2 Explain ways in which concordance can be improved (e.g. presenting accessible information) | 2.7 | 16.5 | 80.8 | 3.4 | 89.7 | 6.9 |

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| | 5.2.3 Describe how to discuss the benefits and risks of drug therapy with patients | 1.8 | 11.9 | 86.3 | 2.1 | 87.6 | 10.3 |
| | 5.2.4 Describe how to explore patients' views and wishes in relation to drug treatment** | 7.0 | 7.0 | 86.0 | 2.3 | 88.5 | 9.2 |
| **6.1 Therapeutic Drug Monitoring** Basic principles | 6.1.1 Explain the importance of monitoring the impact of drug therapy | 0.0 | 6.4 | 93.6 | 9.1 | 61.6 | 29.3 |
| | 6.1.2 Describe the ways in which therapy can be monitored including clinical outcomes, biological markers, pharmacodynamics responses and plasma drug concentrations[#] | 1.1 | 5.4 | 93.5 | 9.6 | 63.5 | 26.9 |
| | 6.1.3 Identify common examples of where monitoring drug concentrations are important | 0.9 | 1.8 | 97.3 | 10.9 | 65.3 | 23.8 |
| **6.2 Therapeutic Drug Monitoring** Using drug effect and concentration | 6.2.1 Identify ways in which drug effects can be measured | 3.7 | 11.1 | 85.2 | 19.1 | 47.2 | 33.7 |
| | 6.2.2 Explain why the impact of drugs on clinical outcomes is difficult to measure* | 1.1 | 14.1 | 84.8 | 17.6 | 67.1 | 15.3 |
| | 6.2.3 Identify the difference between a surrogate and hard outcome | 0.0 | 11.0 | 89.0 | 16.7 | 66.7 | 16.7 |
| | 6.2.4 Explain what makes a good surrogate outcome | 0.0 | 16.7 | 83.3 | 15.6 | 71.1 | 13.3 |
| | 6.2.5 Explain the variable relation between dose and plasma drug concentration, and between drug concentration and clinical effect | 0.0 | 6.5 | 93.5 | 25.0 | 48.0 | 27.0 |
| | 6.2.6 Describe the characteristics that make a drug suitable for monitoring by measurement of concentration* | 3.3 | 10.9 | 85.8 | 23.5 | 59.3 | 17.3 |
| | 6.2.7 List common medicines whose use is facilitated by measurement of drug concentration | 3.7 | 11.9 | 84.4 | 16.5 | 71.4 | 12.1 |
| **7.1 Adverse drug reactions** Basic principles | 7.1.1 Define an adverse drug reaction and other adverse outcomes of drug therapy | 0.9 | 2.8 | 96.3 | 23.3 | 33.0 | 43.7 |
| | 7.1.2 Explain the frequency of adverse drug reactions in primary and secondary care and their impact on public health | 2.7 | 7.4 | 89.9 | 17.7 | 61.5 | 20.8 |
| | 7.1.3 Explain why all drugs have both beneficial and adverse effects | 2.7 | 5.5 | 91.8 | 30.5 | 30.5 | 38.9 |
| | 7.1.4 Describe the common classification of adverse drug reactions (e.g. ABCDE)** | 7.0 | 3.0 | 90.0 | 27.4 | 45.2 | 27.4 |
| **7.2 Adverse drug reactions** Drug allergy | 7.2.1 Discuss risk factors for allergy/anaphylaxis | 2.7 | 12.8 | 84.5 | 23.9 | 48.9 | 27.3 |
| | 7.2.2 Explain how to identify and characterize an allergic drug reaction | 0.9 | 8.3 | 90.8 | 12.9 | 68.8 | 18.3 |
| | 7.2.3 Explain the importance of accurate diagnosis and recording of allergic reactions to drugs | 2.7 | 9.2 | 88.1 | 9.6 | 74.5 | 16.0 |
| | 7.2.4 List medicines that are commonly implicated in allergic reactions | 2.7 | 11.9 | 85.4 | 14.1 | 56.5 | 29.4 |
| | 7.2.5 Explain the precautions that should be taken to prevent allergic reactions | 1.8 | 5.5 | 92.7 | 12.4 | 69.1 | 18.6 |
| **7.3 Adverse drug reactions** Diagnosis, management and prevention | 7.3.1 Describe the principles of assessing drugs as a possible cause of new symptoms and signs | 1.8 | 5.5 | 92.7 | 13.5 | 67.7 | 18.8 |
| | 7.3.2 Describe important risk factors that predict susceptibility to adverse drug reactions | 0.9 | 6.4 | 92.7 | 12.4 | 68.0 | 19.6 |
| | 7.3.3 Describe how identification of those risk factors can influence prescribing decisions | 2.7 | 11.0 | 86.3 | 9.9 | 76.9 | 13.2 |
| | 7.3.4 Identify sources of information about adverse drug reactions | 2.7 | 6.4 | 90.9 | 6.1 | 70.7 | 23.2 |
| | 7.3.5 Explain the importance of warnings and monitoring in preventing adverse drug reactions | 3.7 | 9.2 | 87.1 | 9.6 | 72.3 | 18.1 |
| **7.4 Adverse drug reactions** Pharmacovigilance | 7.4.1 Explain the ways in which adverse drug reactions can be identified (e.g. drug development, voluntary reporting) | 5.5 | 8.3 | 86.2 | 16.1 | 58.1 | 25.8 |

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| | 7.4.2 Explain why the adverse drug reaction profile of individual drugs is unclear at launch | 3.7 | 12.8 | 83.5 | 24.4 | 54.4 | 21.1 |
| | 7.4.3 Discuss the importance of and the prescriber's responsibility in pharmacovigilance | 3.7 | 6.5 | 89.8 | 8.3 | 67.7 | 24.0 |
| **8.1 Drug interactions and contraindications** Interactions | 8.1.1 Explain the potential for interacting drugs to cause beneficial and harmful effects | 1.8 | 4.6 | 93.6 | 28.6 | 40.8 | 30.6 |
| | 8.1.2 Recognize the main ways in which interactions occur (e.g. pharmacokinetic, pharmacodynamic) | 1.8 | 1.8 | 96.4 | 35.6 | 28.7 | 35.6 |
| | 8.1.3 Explain why the potential for drug interactions is increasing* | 4.4 | 7.6 | 88.0 | 21.2 | 54.1 | 24.7 |
| | 8.1.4 Identify sources of information about drug interactions to inform prescribing | 0.9 | 4.6 | 94.5 | 10.0 | 64.0 | 26.0 |
| | 8.1.5 Explain how to adjust drug dosage in anticipation of a drug interaction that cannot be avoided | 1.8 | 9.2 | 89.0 | 6.3 | 73.7 | 20.0 |
| | 8.1.6 Identify the importance of liver metabolism as a point of interaction between drugs | 0.9 | 4.6 | 94.5 | 26.3 | 30.3 | 43.4 |
| | 8.1.7 Explain how liver enzyme metabolism can be inhibited and the impact this has on drug handling | 2.8 | 4.6 | 92.6 | 27.6 | 33.7 | 38.8 |
| | 8.1.8 Explain how liver enzyme metabolism can be induced and the impact this has on drug handling | 4.4 | 6.6 | 89.0 | 26.3 | 33.2 | 40.5 |
| **8.2 Drug interactions and contraindications** Contraindications | 8.2.1 Explain the potential for drug contraindications to cause harmful effects | 2.7 | 8.4 | 88.9 | 12.2 | 53.3 | 34.4 |
| | 8.2.2 Identify sources of information about drug contraindications to inform prescribing | 2.7 | 6.4 | 90.9 | 6.6 | 68.1 | 25.3 |
| | 8.2.3 Identify how to avoid drug contraindications | 6.4 | 6.4 | 87.2 | 6.7 | 73.0 | 20.3 |
| **9. Medication errors** | 9.1 Define the term 'medication error'† | 3.9 | 13.7 | 82.4 | 9.6 | 69.0 | 21.4 |
| | 9.2 Explain the different ways in which errors can occur in the prescription, supply and administration of medicines† | 3.9 | 14.7 | 81.4 | 7.2 | 77.1 | 15.7 |
| | 9.3 Explain how prescribers can reduce medication errors | 3.7 | 6.4 | 89.9 | 0.0 | 82.5 | 17.5 |
| | 9.4 Explain how to identify and correct medication errors | 4.6 | 15.0 | 80.4 | 2.3 | 84.1 | 13.6 |
| **10.1 Drug discovery, development and regulation** Drug discovery and development | 10.1.1 Explain in simple terms how drugs are discovered** | 8.0 | 7.0 | 85.0 | 51.2 | 18.3 | 30.5 |
| | 10.1.2 Explain the various stages of development (preclinical, phase I to phase IV) | 5.5 | 4.6 | 89.9 | 37.5 | 25.0 | 37.5 |
| | 10.1.3 Explain the risks and costs involved in developing drugs* | 3.6 | 14.5 | 81.9 | 39.0 | 32.5 | 28.6 |
| | 10.1.4 Classify the different forms of clinical trial and explain their advantages and disadvantages | 3.7 | 12.8 | 83.5 | 18.7 | 49.5 | 31.9 |
| | 10.1.5 Describe the requirements of a good clinical trial including consent, ethics, bias, statistics and dissemination of information | 4.6 | 9.2 | 86.2 | 19.4 | 53.8 | 26.9 |
| **10.2 Drug discovery, development and regulation** Drug regulation | 10.2.1 Explain why drugs need to be regulated | 4.6 | 11.0 | 84.4 | 27.0 | 48.3 | 24.7 |
| | 10.2.2 Identify the major regulatory authorities in the relevant European country and Europe (i.e. European Medicines Agency (EMA)) | 6.4 | 12.8 | 80.8 | 30.2 | 50.0 | 19.8 |
| **11.1 Medicines management** National and local processes | 11.1.1 Describe how new medicines are assessed on the basis of safety, efficacy and cost-effectiveness | 6.5 | 12.8 | 80.7 | 22.9 | 53.0 | 24.1 |
| | 11.1.2 Explain the role of local formularies and guidelines in the choice and use of medicines* | 2.2 | 14.1 | 83.7 | 7.2 | 75.9 | 16.9 |
| | 11.1.3 Identify the factors that influence individual prescribing choices and why these have to be limited (e.g. cost, antibiotic resistance) | 3.7 | 14.7 | 81.6 | 8.8 | 78.0 | 13.2 |

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| | 11.1.4 Explain the responsibility of prescribers to avoid wasteful prescribing and consumption of limited resources | 4.6 | 11.9 | 83.5 | 5.4 | 79.3 | 15.2 |
| **11.2 Medicines management** Formularies and guidelines | 11.2.1 Explain the reasons for creating limited lists of medicines** | 7.0 | 4.0 | 89.0 | 9.1 | 75.3 | 15.6 |
| | 11.2.2 Describe the definition and purpose of a clinical guideline | 4.6 | 14.7 | 80.7 | 8.2 | 81.2 | 10.6 |
| | 11.2.3 Explain some of the potential limitations and harms of clinical guidelines | 5.5 | 13.8 | 80.7 | 2.4 | 83.5 | 14.1 |
| **12.1 Evidence based prescribing** Basic principles | 12.1.1 Explain the extent of the evidence base | 4.6 | 9.2 | 86.2 | 10.0 | 56.7 | 33.3 |
| | 12.1.2 Explain the terms 'randomized controlled trial', 'cohort study', 'case control study', 'systematic review' and 'meta-analysis' | 2.8 | 2.8 | 94.5 | 12.9 | 51.5 | 35.6 |
| | 12.1.3 Identify different kinds of evidence and their hierarchy in terms of validity | 4.6 | 11.9 | 83.5 | 16.7 | 55.6 | 27.8 |
| | 12.1.4 Explain the limitations of applying clinical trial data to individual patients | 2.8 | 7.3 | 89.9 | 7.4 | 75.8 | 16.8 |
| | 12.1.5 Explain the importance of keeping one's prescribing practice up to date with advances in medical knowledge | 3.7 | 12.8 | 83.5 | 5.1 | 80.6 | 14.3 |
| **12.2 Evidence based prescribing** Critical appraisal of clinical studies | 12.2.1 Describe the process of critical appraisal of clinical studies | 5.5 | 13.8 | 80.7 | 5.8 | 70.9 | 23.3 |
| | 12.2.2 Explain the approach to identifying methodological flaws, including sources of bias* | 3.3 | 13.0 | 83.7 | 5.7 | 72.4 | 21.8 |
| | 12.2.3 Differentiate between true and surrogate endpoints | 6.4 | 12.8 | 80.8 | 9.7 | 69.9 | 19.4 |
| | 12.2.4 Explain the concept of external validity and problems with extrapolating clinical trial results | 8.3 | 8.3 | 83.5 | 6.7 | 77.5 | 15.7 |
| **12.3 Evidence based prescribing** Find reliable information about drugs | 12.3.1 Identify important information resources that might inform prescribing decisions | 2.8 | 5.6 | 91.6 | 6.3 | 74.0 | 19.8 |
| | 12.3.2 Explain how prescribers can keep up to date with change | 0.9 | 9.2 | 89.9 | 7.5 | 80.6 | 11.8 |
| | 12.3.3 Identify potential sources of unreliable information | 3.7 | 13.8 | 82.6 | 6.7 | 78.9 | 14.4 |
| **13.1 Legal and ethical aspects of prescribing** Legal aspects | 13.1.1 Explain the legal categorisation of drugs into general sales list, pharmacy medicines, prescription only medicines and controlled drugs* | 3.3 | 9.8 | 87.0 | 22.4 | 61.2 | 16.5 |
| | 13.1.2 Explain who is entitled to prescribe medicines and the legal requirements involved* | 2.2 | 7.8 | 90.0 | 18.8 | 68.2 | 12.9 |
| | 13.1.3 Describe the legal requirements associated with prescribing controlled drugs (e.g. opioids) | 3.7 | 8.3 | 88.1 | 14.0 | 69.9 | 16.1 |
| | 13.1.4 Recognize the circumstances in which drugs are prescribed 'off-label' | 0.9 | 9.2 | 89.9 | 10.8 | 74.2 | 15.1 |
| | 13.1.5 Explain the additional responsibilities associated with prescribing 'unlicensed' or 'off-label' medicines | 2.8 | 12.8 | 84.4 | 12.2 | 77.8 | 10.0 |
| | 13.1.6 Describe what information should be given to patients to allow them to make informed decisions about 'off-label' treatment* | 6.5 | 6.5 | 87.0 | 8.4 | 81.9 | 9.6 |
| **13.2 Legal and ethical aspects of prescribing** Ethical aspects | 13.2.1 Explain the responsibilities of prescribing in a resource limited healthcare system** | 7.0 | 8.0 | 85.0 | 12.5 | 73.8 | 13.7 |
| | 13.2.2 Explain the reasons for adhering to therapeutic guidelines and drug formularies, as appropriate* | 2.2 | 9.8 | 88.0 | 7.0 | 80.2 | 12.8 |
| | 13.2.3 Explain why it is important to recognize limits of competence and to ask for help when needed* | 3.3 | 9.8 | 86.9 | 7.1 | 77.6 | 15.3 |
| | 13.2.4 Explain the responsibility of all prescribers to update their knowledge | 4.6 | 12.8 | 82.5 | 5.4 | 72.8 | 21.7 |
| **14.1 Prescribing for patient with special requirements** Elderly patients | 14.1.1 Describe how altered physiology, pharmacokinetic handling and pharmacodynamic response occur in elderly patients, and influence their drug adherence | 0.0 | 1.8 | 98.2 | 7.7 | 63.5 | 28.8 |

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| | 14.1.2 List common medicines to which elderly patients are especially likely to respond differently | 0.0 | 5.5 | 94.5 | 3.0 | 84.0 | 13.0 |
| | 14.1.3 Explain the term 'potentially inappropriate medication' in elderly patients[§] | 5.4 | 5.4 | 89.2 | 3.8 | 81.0 | 15.2 |
| | 14.1.4 Explain where to find relevant information about potentially inappropriate medication in elderly patients (e.g. STOPP/START criteria, Beers criteria)[§] | 2.2 | 11.1 | 86.7 | 2.7 | 82.4 | 14.9 |
| | 14.1.5 Explain where to find relevant information about choosing and adjusting drug dosage in elderly patients | 4.6 | 14.7 | 80.7 | 6.1 | 84.8 | 9.1 |
| | 14.1.6 Explain the principles that underlie prescribing in the elderly, including influences of aging and polypharmacy | 5.5 | 13.8 | 80.7 | 3.9 | 78.4 | 17.6 |
| **14.2 Prescribing for patient with special requirements** Impaired liver function | 14.2.1 Describe how altered physiology, pharmacokinetic handling and pharmacodynamic response occur in patients with impaired liver function | 0.0 | 5.5 | 94.5 | 9.9 | 55.4 | 34.7 |
| | 14.2.2 List common medicines that are especially likely to cause harm to patients with impaired liver function | 1.8 | 8.2 | 90.0 | 9.5 | 74.7 | 15.8 |
| | 14.2.3 Discuss the principals involved in selecting medicines and designing dosage regimens for patients with impaired liver function | 1.8 | 11.1 | 87.1 | 6.4 | 83.0 | 10.6 |
| | 14.2.4 Explain where to find relevant information about choosing and adjusting drug dosage in patients with impaired liver function | 0.9 | 3.7 | 95.4 | 4.0 | 86.9 | 9.1 |
| **14.3 Prescribing for patient with special requirements** Impaired renal function | 14.3.1 Describe how altered physiology, pharmacokinetic handling and pharmacodynamic response occur in patients with impaired renal function | 0.0 | 0.0 | 100.0 | 9.7 | 49.5 | 40.8 |
| | 14.3.2 List common medicines that are especially likely to cause harm to patients with impaired renal function | 1.8 | 3.7 | 94.5 | 7.0 | 76.0 | 17.0 |
| | 14.3.3 Discuss the principals involved in selecting medicines and designing dosage regimens for patients with impaired renal function | 1.8 | 3.7 | 94.5 | 8.1 | 78.8 | 13.1 |
| | 14.3.4 Explain where to find relevant information about choosing and adjusting drug dosage in patients with impaired renal function | 0.9 | 3.7 | 95.4 | 5.1 | 84.8 | 10.1 |
| **14.4 Prescribing for patient with special requirements** Pregnant women and women of childbearing potential | 14.4.1 Explain the reasons for caution when prescribing for pregnant women and women of child-bearing potential | 0.0 | 1.8 | 98.2 | 7.7 | 57.7 | 34.6 |
| | 14.4.2 Describe how altered physiology, pharmacokinetic handling and pharmacodynamic response occur in pregnancy | 0.9 | 5.5 | 93.6 | 16.5 | 58.8 | 24.7 |
| | 14.4.3 List common medicines to which pregnant women are especially likely to respond differently | 1.8 | 10.1 | 88.1 | 8.4 | 76.8 | 14.7 |
| | 14.4.4 Describe the possible effects of drugs on the developing foetus, in relation to the stage of gestation | 0.9 | 3.7 | 95.4 | 12.0 | 66.0 | 22.0 |
| | 14.4.5 Explain the principles involved in selecting medicines and designing dosage regimens for pregnant women and women of child-bearing potential | 0.9 | 8.3 | 90.8 | 5.2 | 84.4 | 10.4 |
| | 14.4.6 Explain where to find relevant information about choosing and adjusting drug dosage in pregnant women and women of child-bearing potential | 0.9 | 0.9 | 98.2 | 2.9 | 85.4 | 11.7 |
| **14.5 Prescribing for patient with special requirements** Lactation | 14.5.1 Explain the reasons for caution when prescribing for women who are breast feeding | 0.9 | 3.7 | 95.4 | 11.9 | 58.4 | 29.7 |
| | 14.5.2 List common medicines that are especially likely to cause harm to the newborn as a result of transmission via breast milk | 2.7 | 10.1 | 87.2 | 6.4 | 79.8 | 13.8 |
| | 14.5.3 Discuss the principals involved in selecting medicines and designing dosage regimens for women who are breast feeding | 0.9 | 15.6 | 83.5 | 5.5 | 86.8 | 7.7 |
| | 14.5.4 Explain where to find relevant information about choosing and adjusting drug dosage in women who are breast feeding | 0.9 | 6.4 | 92.7 | 5.2 | 86.6 | 8.2 |
| **14.6 Prescribing for patient with** | 14.6.1 Describe how altered physiology, pharmacokinetic handling and | 0.0 | 0.9 | 99.1 | 12.4 | 51.4 | 36.2 |

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| **special requirements**<br>Children | pharmacodynamic response occur in children | | | | | | |
| | 14.6.2 List common medicines to which children are especially likely to respond differently | 2.7 | 12.8 | 84.5 | 6.7 | 82.2 | 11.1 |
| | 14.6.3 Explain where to find relevant information about choosing and adjusting drug dosage in children | 0.9 | 3.7 | 95.4 | 3.0 | 86.9 | 10.1 |
| | 14.6.4 Explain the principles that underlie prescribing in children | 2.7 | 3.7 | 93.6 | 5.2 | 82.3 | 11.5 |
| **15.1 Rational prescribing**<br>Rational approach to prescribing | 15.1.1 Explain the importance of individualizing the prescription | 1.8 | 3.7 | 94.5 | 4.1 | 71.4 | 24.5 |
| | 15.1.2 Describe the selection of an appropriate medicine based on its comparative efficacy, safety, convenience and cost | 4.6 | 8.3 | 87.1 | 5.3 | 79.8 | 14.9 |
| | 15.1.3 Explain the importance of identifying diagnosis (if possible) and therapeutic objectives | 2.7 | 7.4 | 89.9 | 3.2 | 83.2 | 13.7 |
| | 15.1.4 Describe the factors that influence the choice of formulation, dose, route, frequency and duration of treatment | 1.8 | 3.7 | 94.5 | 5.1 | 70.7 | 24.2 |
| **15.2 Rational prescribing**<br>Dose selection | 15.2.1 Explain the importance of accurate calculation of drug dosage, especially for intravenous infusions | 0.0 | 5.5 | 94.5 | 10.1 | 61.6 | 28.3 |
| | 15.2.2 Identify factors that may necessitate amendments of standard doses | 2.7 | 11.9 | 85.4 | 6.7 | 79.8 | 13.5 |
| **16. Clinical toxicology** | 16.1 Describe the principles of assessment of a poisoned patient | 2.7 | 11.9 | 85.4 | 4.5 | 79.8 | 15.7 |
| | 16.2 Describe the clinical features of overdose with commonly used medicines (e.g. paracetamol/acetaminophen, antidepressants, benzodiazepines), including poisoning syndromes | 1.8 | 8.3 | 89.9 | 3.1 | 75.0 | 21.9 |
| | 16.3 Describe the principles involved in treating a poisoned patient | 1.8 | 12.8 | 85.4 | 2.2 | 82.4 | 15.4 |
| | 16.4 Explain how to access and obtain information from the national poison service | 2.7 | 15.6 | 81.7 | 1.1 | 83.1 | 15.7 |
| | 16.5 List drugs and toxins to which effective antidotes are available | 2.7 | 16.5 | 80.8 | 3.4 | 73.6 | 23.0 |
| | 16.6 Explain the means by which the elimination of drugs or toxins can be hastened, including decontamination | 3.7 | 16.1 | 80.2 | 3.5 | 76.7 | 19.8 |
| **17. Misuse of drugs** | 17.1 List drugs that are commonly misused (e.g. alcohol, opiates, cocaine) and some of their important pharmacodynamics effects | 0.0 | 11.0 | 89.0 | 14.7 | 51.6 | 33.7 |
| | 17.2 Define 'tolerance', 'physical dependence' and 'psychological dependence' | 3.7 | 9.2 | 87.1 | 23.3 | 40.0 | 36.7 |
| **18. Complementary and alternative medicine** | 18.1 Explain the potential of complementary and alternative medicines to cause adverse effects | 0.9 | 11.0 | 88.1 | 14.1 | 68.5 | 17.4 |
| | 18.2 Describe common complementary and alternative medicines which interact with prescription drugs (e.g. St. John's wort) | 0.9 | 11.0 | 88.1 | 10.8 | 69.9 | 19.4 |
| **19. Use of antibiotics and antibiotic resistance** | 19.1 Understand the development of antibiotic resistance | 0.0 | 2.8 | 97.2 | 19.2 | 37.5 | 43.3 |
| | 19.2 Understand the principles of rational empiric antibiotic therapy | 0.0 | 0.9 | 99.1 | 8.8 | 59.8 | 31.4 |
| | 19.3 Understand the reasons for inefficacy of antibiotic therapy | 0.9 | 2.8 | 96.3 | 14.0 | 57.0 | 29.0 |
| | 19.4 Explain how to interpret sensitive, low-grade resistance, high-grade resistance, outpatient strains vs. inpatient strains and trends over time | 3.7 | 9.2 | 87.1 | 9.6 | 76.6 | 13.8 |
| **20. Commonly used drugs and high risk medicines** | 20.1 Explain the main mechanism of action of commonly used drugs (e.g. analgesics, anticoagulants)[§‡] | 1.1 | 1.1 | 97.8 | 42.5 | 16.1 | 41.4 |
| | 20.2 Explain the main mechanism of action of high risk medicines (e.g. opioids, insulin)[§‡] | 2.2 | 2.2 | 95.7 | 39.5 | 17.4 | 43.0 |
| | 20.3 Describe the appropriate indications for commonly used drugs[§‡] | 1.1 | 3.3 | 95.6 | 9.5 | 50.0 | 40.5 |
| | 20.4 Describe the appropriate indications for high risk medicines[§‡] | 2.2 | 5.4 | 92.4 | 9.9 | 53.1 | 37.0 |

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| | 20.5 Describe common and severe or potentially lethal side effects of commonly used drugs[$‡] | 0.0 | 2.2 | 97.8 | 10.6 | 47.1 | 42.4 |
| | 20.6 Describe common and severe or potentially lethal side effects of high risk medicines[$‡] | 1.1 | 2.2 | 96.7 | 10.6 | 57.6 | 42.4 |
| | 20.7 Describe the appropriate routes of administration of commonly used drugs[$‡] | 2.2 | 10.9 | 87.0 | 15.4 | 50.0 | 34.6 |
| | 20.8 Describe the appropriate routes of administration of high risk medicines[$‡] | 3.3 | 10.9 | 85.9 | 17.9 | 48.7 | 33.3 |

CPT, clinical pharmacology and therapeutics. * Outcome included after Round 2. ** Outcome included after panel meeting. [$] New outcome suggested by panellists in Round 1. [#] Outcome adapted by panellists in Round 1. [†] Outcome adapted during the panel meeting and included after Round 3. [‡] Outcome should be considered in association with a local list of commonly used and high risk medicines.

**Table S4** Learning outcomes for skills in clinical pharmacology and therapeutics (n= 47) that were included (≥80% of the panellists scored 'important' or 'very important').

| Category | Learning outcome<br><br>A European medical graduate should be able to… | % (very) unimportant | % neutral | % (very) important | % pre-clinical | % clinical | % both |
|---|---|---|---|---|---|---|---|
| **1. Medication history taking** | 1.1 Elicit and record an accurate medication history, including current and recent medicines, over the counter, complementary medicines and the contraceptive pill, to support effective medicines reconciliation | 2.8 | 3.8 | 93.4 | 2.1 | 86.3 | 11.6 |
| | 1.2 Identify, where possible, for each drug the original indication, formulation, dose, route, duration and effect | 1.8 | 7.5 | 90.7 | 3.2 | 81.9 | 14.9 |
| | 1.3 Make an assessment of adherence to a medication regimen | 2.8 | 5.7 | 91.5 | 1.1 | 91.6 | 7.4 |
| | 1.4 Obtain a history of misuse of drugs and recognize which patient may have such problem | 1.9 | 14.1 | 84.0 | 2.3 | 90.8 | 6.9 |
| | 1.5 Identify alternative sources of information about current treatment, understand the limits of information sources and compensating for them* | 3.3 | 13.0 | 83.7 | 2.5 | 88.6 | 8.9 |
| | 1.6 Interpret the medication history so that allergies and adverse drug reactions can be identified (distinguish between a history of drug allergy and intolerance) | 1.8 | 6.6 | 91.6 | 3.2 | 84.9 | 11.8 |
| | 1.7 Identify common potentially important drug contraindications and interactions | 1.8 | 4.7 | 93.5 | 2.1 | 83.3 | 14.6 |
| **2. Rational prescribing** | 2.1 Define patient's problem(s) to be treated | 0.0 | 7.5 | 92.5 | 5.4 | 81.7 | 12.9 |
| | 2.2 Define the therapeutic objective(s) for new therapy | 0.0 | 5.7 | 94.3 | 2.1 | 84.0 | 13.8 |
| | 2.3 Develop a list of possible treatments (i.e. standard treatment or P-drugs) for a diagnosis | 0.9 | 13.2 | 85.9 | 4.7 | 83.7 | 11.6 |
| | 2.4 Consider risks and benefits of specific drug therapies | 0.9 | 2.8 | 96.3 | 4.1 | 84.7 | 11.2 |
| | 2.5 Follow clinical guidelines, protocols and formularies where appropriate | 1.8 | 5.7 | 92.5 | 5.4 | 84.9 | 9.7 |
| | 2.6 Check the drug suitability for a patient by considering possible contraindications, interactions, previous adverse drug reactions, any special circumstances, age and gender, and diseases | 0.9 | 4.7 | 94.4 | 2.1 | 85.4 | 12.5 |
| | 2.7 Prescribe drugs with a narrow therapeutic index or high potential for serious adverse effects/interactions, and take appropriate precautions when prescribing them | 0.0 | 1.9 | 98.1 | 4.1 | 78.6 | 17.3 |
| | 2.8 Prescribe drugs for patients with special requirements (i.e. elderly, children, pregnancy and breast-feeding, renal and liver failure) | 0.9 | 3.8 | 95.3 | 2.1 | 86.5 | 11.5 |
| | 2.9 Choose the appropriate formulation, dose, route, frequency and duration of a drug | 0.9 | 5.7 | 93.4 | 2.1 | 83.0 | 14.9 |
| | 2.10 Interpret data that is relevant to prescribing decisions (e.g. renal function, drug concentrations) | 0.0 | 4.7 | 95.3 | 3.1 | 87.6 | 9.3 |
| | 2.11 Find the most commonly described clinically important pharmacogenetics syndromes that produce atypical patient responses to medication* | 3.3 | 15.2 | 81.5 | 7.5 | 80.0 | 12.5 |
| **3. Drug dose calculation** | 3.1 Calculate appropriate doses for individual patients by weight and body surface area, and based on a normogram | 1.8 | 8.5 | 89.7 | 14.9 | 62.8 | 22.3 |
| | 3.2 Calculate the strength of an infusion based on the required rate of drug administration | 4.7 | 13.2 | 82.1 | 15.5 | 66.7 | 17.9 |
| | 3.3 Convert doses between common units and convert between concentrations expressed as percentage and mass* | 2.2 | 8.7 | 89.1 | 20.5 | 59.0 | 20.5 |
| **4. Prescription writing** | 4.1 Write an unambiguous, legible, complete and legal prescription, including approved drug name, form, route, dose, instructions, patient details, date, prescriber's name and signature | 1.8 | 2.8 | 95.4 | 11.3 | 70.1 | 18.6 |
| | 4.2 Avoid abbreviations and other ambiguities when writing/typing a prescription | 5.7 | 14.1 | 80.2 | 10.5 | 80.2 | 9.3 |
| | 4.3 Keep accurate records of prescribing decisions and responses in patient notes* | 2.2 | 10.9 | 86.9 | 7.3 | 86.6 | 6.1 |
| | 4.4 Cancel prescriptions appropriately* | 4.3 | 14.1 | 81.6 | 4.9 | 90.1 | 4.9 |
| **5. Non-drug therapy** | 5.1 Use non-drug therapy where appropriate (e.g. advice on physical exercise, good nutrition | 5.6 | 10.4 | 84.0 | 2.2 | 74.2 | 23.6 |

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|---|---|---|---|---|---|---|---|
| | and self-regulation techniques) | | | | | | |
| **6. Communication** | 6.1 Communicate treatment plan and instructions (e.g. when to take, how to take, what duration) to a patient, at a suitable level of information | 4.7 | 5.7 | 89.6 | 2.2 | 82.8 | 15.1 |
| | 6.2 Engage in shared decision making where appropriate, including obtaining informed consent | 3.8 | 5.7 | 90.5 | 2.2 | 85.9 | 12.0 |
| | 6.3 Assess and improve drug adherence, compliance and concordance | 3.8 | 9.4 | 86.8 | 1.1 | 86.4 | 12.5 |
| | 6.4 Communicate treatment plans and monitoring arrangements clearly with other members of staff and hospital pharmacist, in both verbal and written/electronic form | 6.6 | 9.4 | 84.0 | 1.1 | 89.8 | 9.1 |
| | 6.5 Write accurate discharge prescriptions and letter to general practitioner and follow-up institutions (e.g. nursing home, rehabilitation centre) | 0.9 | 13.2 | 85.9 | 2.3 | 90.9 | 6.8 |
| **7. Reviewing prescriptions** | 7.1 Review current lists of prescribed medicines on indication, contraindications, interactions, suitability and costs | 1.0 | 7.6 | 91.4 | 3.3 | 87.9 | 8.8 |
| | 7.2 Identify and manage inappropriate prescribing | 2.8 | 7.5 | 89.7 | 3.2 | 88.2 | 8.6 |
| | 7.3 Recognize the potential for medication errors and take steps to reduce the risks | 2.8 | 11.3 | 85.9 | 2.3 | 90.9 | 6.8 |
| **8. Adverse drug reactions** | 8.1 Assess and manage common adverse drug reactions and interactions in the context of current clinical situation | 0.9 | 2.8 | 96.3 | 1.0 | 90.8 | 8.2 |
| | 8.2 Report a suspected adverse drug reactions using the national pharmacovigilance service | 2.8 | 5.7 | 91.5 | 2.1 | 86.3 | 11.6 |
| | 8.3 Find information about adverse drug reactions | 2.8 | 5.7 | 91.5 | 3.2 | 76.6 | 20.2 |
| | 8.4 Recognize and treat presentations of drug allergies and acute anaphylaxis | 0.9 | 4.7 | 94.4 | 3.1 | 82.5 | 14.4 |
| **9. Clinical toxicology** | 9.1 Manage overdose with commonly used medicines (e.g. paracetamol/acetaminophen, antidepressants, benzodiazepines) | 0.0 | 7.5 | 92.5 | 4.2 | 83.2 | 12.6 |
| | 9.2 Find information from the national poison service | 0.9 | 13.2 | 85.9 | 8.0 | 78.4 | 13.6 |
| **10. Obtaining information from guidelines and protocols to support prescribing** | 10.1 Find and interpret information from the Summary of Product Characteristics (SmPC) or United States Prescribing Information (USPI) | 2.8 | 11.3 | 85.9 | 4.4 | 62.6 | 33.0 |
| | 10.2 Find and interpret relevant drug information from the paper and online national formularies and protocols | 2.9 | 9.5 | 87.6 | 2.2 | 75.3 | 22.5 |
| | 10.3 Access and interpret reliable drug information from medical journals and databases | 4.8 | 11.4 | 83.8 | 5.7 | 69.3 | 25.0 |
| **11. Monitoring medication** | 11.1 Identify which therapeutic effect to observe | 0.9 | 7.5 | 91.6 | 5.5 | 84.6 | 9.9 |
| | 11.2 Establish parameters with which to monitor therapeutic effect (e.g. clinical outcomes, laboratory tests) | 0.9 | 7.5 | 91.6 | 5.4 | 88.2 | 6.5 |
| | 11.3 Request measurements of drug concentrations at optimal times for appropriate indications | 1.8 | 7.5 | 90.7 | 2.2 | 90.0 | 7.8 |
| | 11.4 Interpret the therapeutic effect based on clinical assessment and investigations (e.g. laboratory tests) and adjust the drug regimen if necessary[†] | 3.9 | 7.8 | 88.3 | 3.3 | 81.1 | 15.6 |

* Outcome included after Round 2. [§] New outcome suggested by panellists in Round 1. [†] Outcome adapted during the panel meeting and included after Round 3.

**Table S5** Learning outcomes for attitudes to clinical pharmacology and therapeutics (n= 13) that were included (≥80% of the panellists scored 'important' or 'very important').

| Category | Learning outcome<br><br>A European medical graduate should be able to… | % (very) unimportant | % neutral | % (very) important | % pre-clinical | % clinical | % both |
|---|---|---|---|---|---|---|---|
| **1. Risk-benefit analysis** | 1.1 Recognize that there are risks and benefits associated with all drug treatments | 0.9 | 3.8 | 95.3 | 8.2 | 54.6 | 37.1 |
| | 1.2 Recognize that risks and benefits may differ between patients, depending on a variety of factors | 1.8 | 3.8 | 94.4 | 8.5 | 63.8 | 27.7 |
| | 1.3 Recognize that doctors should monitor the impact of the drugs they prescribe | 1.8 | 2.8 | 95.4 | 5.2 | 71.9 | 22.9 |
| | 1.4 Recognize the importance of quantifying risks and benefits of drug treatments[$] | 2.2 | 8.7 | 89.2 | 6.2 | 58.8 | 35.0 |
| | 1.5 Describe the tools or strategies to make a risk-benefit analysis[$] | 4.3 | 15.2 | 80.4 | 6.7 | 77.3 | 16.0 |
| | 1.6 Recognize that patient's values and preferences are important in order to make a risk-benefit analysis at an individual level[$] | 2.2 | 14.1 | 83.7 | 1.3 | 81.8 | 16.9 |
| | 1.7 Re-evaluate the benefit and risks of drug treatment during follow-up consultations[$] | 4.3 | 13.0 | 86.9 | 0.0 | 87.2 | 12.8 |
| **2. Recognizing personal limitations in knowledge** | 2.1 Recognize the need to seek further information about drugs when faced with unfamiliar prescribing problems | 0.9 | 6.6 | 92.5 | 3.2 | 66.7 | 30.1 |
| **3. Recognition of balanced approach to the introduction of new drugs** | 3.1 Recognize the need to update prescribing practices | 0.0 | 7.5 | 92.5 | 1.1 | 80.6 | 18.3 |
| | 3.2 Recognize the need to assess the benefits and hazards of new therapies | 0.9 | 6.6 | 92.5 | 1.1 | 81.7 | 17.2 |
| | 3.3 Ensure that patients benefit when possible from advances in medical knowledge | 1.8 | 10.5 | 87.7 | 1.2 | 87.1 | 11.8 |
| | 3.4 Know the limitations of applying clinical trial data to individual patients and compensate for them | 1.8 | 10.4 | 87.8 | 2.2 | 79.8 | 18.0 |
| | 3.5 Develop the attitude that every prescription is really a carefully designed experiment that can produce a useful clinical effect, toxicity, or both | 1.8 | 13.3 | 84.9 | 1.2 | 83.5 | 15.3 |

[$] New outcome suggested by the panellists in Round 1.