



# **SYLLABUS**

## **FOR THE BASIC SCIENCES IN INTENSIVE CARE MEDICINE**

SECOND EDITION, 2011 (Reprinted 2014)

## **FOREWORD**

This is the second edition of the Syllabus for the Basic Sciences in Intensive Care Medicine.

This second edition has evolved from the components of the first edition. It incorporates the experience and knowledge gained since publication of the first edition and the development of the College of Intensive Care Medicine First Part Examination. Significantly, this edition has also been more closely integrated with the College of Intensive Care Medicine Fellowship Objectives of Training and the overall Training Program.

There have been important changes made since the first edition. These include a rating system for each topic, the addition of a Pharmacopeia with a rating system of its own, and a broader outline of the required topics. The intention of these changes are to assist trainees by providing improved clarification as to the areas of study, and to encourage them to explore, collate, synthesize, and thus better comprehend the necessary body of knowledge. In addition it provides trainees, tutors and examiners with an improved guide as to the desired breadth and depth of knowledge, particularly if read in conjunction with the First Part Examination reports.

The overall content of the Syllabus has not increased and remains similar to that of the first edition. Topics are still listed under major systems, which include the relevant physiology, pharmacology and anatomy. This is in keeping with the emphasis of an integrated approach to the learning and assessment of the Basic Sciences in Intensive Care Medicine.

The basic sciences, as well as educational principles, are constantly evolving. This document can never be complete. The intention is to review it regularly and so it will continue to evolve. The College of Intensive Care Medicine encourages trainees to update and maintain a long-term pursuit of their basic science knowledge.

Finally, the strengths and value of this document could not have been attained without the contribution of those involved with the first edition, candidates who have sat the CICM First Part Examination, past and current CICM First Part Examiners, and all those listed within this document.

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# LEARNING OBJECTIVES FOR THE BASIC SCIENCES IN INTENSIVE CARE MEDICINE

## INTRODUCTION

The purpose of the learning objectives for the basic sciences in Intensive Care Medicine, are to provide a:

- guide to trainees in their study and preparation for the First Part Examination
- guide to tutors and teachers
- guide to examiners

This will ensure that trainees, tutors and examiners can all work from a common base. These learning objectives set out to outline for trainees, the minimum level of understanding and comprehension that is required for each topic. They are not exclusive, but instead reflect the minimum requirements, and as such, trainees are encouraged to not limit their depth and breadth of knowledge of these topics.

All examination questions will be based around this syllabus. The accompanying texts are recommended on the basis that the material contained within them provides a clear indication of the minimum level of understanding that will be expected. Trainees however would be expected to have read more widely than these texts, and synthesized information from multiple sources. Trainees are strongly encouraged to explore the existing, and evolving, body of knowledge of the basic sciences as they apply to Intensive Care Medicine.

## LEVEL OF UNDERSTANDING

Throughout the document, each topic has been assigned a rating, being the Level of Understanding. This rating is a guide to trainees, tutors, teachers and examiners as to the level of knowledge and assessment that can be expected for that topic.

### **Level of Understanding (L1)**

These topics are core areas of the basic sciences as they apply to Intensive Care Medicine. A detailed knowledge and comprehension of the principles and facts that relate to these areas will be expected. As such, they will be eligible to be assessed on all occasions, in depth and are considered essential knowledge.

### **Level of Understanding (L2)**

These topics are important and relevant to Intensive Care Medicine. A good understanding of the key concepts and facts that relate to these areas is expected. They will be eligible to be assessed on most occasions, in some depth, and are considered important knowledge.

### **Level of Understanding (L3)**

These topics are of relevance to Intensive Care Medicine. A basic level of understanding and comprehension will be expected. They will be eligible for assessment regularly and a broad understanding of the concepts the principles involved will be expected.

## RECOMMENDED TEXTS

Please note that the most recent version of each of the following texts is the recommended text

*Textbook of Medical Physiology* / A C Guyton, J E Hall - 12<sup>th</sup> ed - Philadelphia : W B Saunders, 2010, ISBN 9781416045748

*Ganongs Review of Medical Physiology* / K E Barrett, W F Ganong- 23rd ed : Lange/McGraw-Hill, 2005, ISBN 9780071605670

*Nunn's Applied Respiratory Physiology* / A B Lumb - 7<sup>th</sup> ed - Oxford : Butterworth Heinemann, 2010 ISBN 9780702029967

*Basic Physics and Measurement in Anaesthesia* / P D Davis, G N C Kenny - 5<sup>th</sup> ed - Edinburgh : Butterworth-Heinemann, 2003 ISBN: 9780750648288

*Basic and Clinical Pharmacology* / B G Katzung - 11<sup>th</sup> ed - McGraw-Hill, 2009, ISBN 9780071604055

*Goodman and Gilman's the Pharmacological Basis of Therapeutics* / ed by J G Hardman et al - 12<sup>th</sup> ed - New York : McGraw-Hill, 2005, ISBN 9780071624428

*Statistical methods for anaesthesia and intensive care* / P S Myles, T Gin - 1<sup>st</sup> ed - Oxford : Butterworth-Heinemann, 2001 ISBN: 9780750640657

*Gray's Anatomy for students.* / R L Drake, A. W Vog, A W M Mitchell. Churchill Livingstone ISBN:9780443069529

*Lippincott's Illustrated Reviews: Microbiology* / R A Harvey, P C Champe, Lippincott Williams and Wilkins 5<sup>th</sup> edition ISBN: 9781608317332

*Principles of Physiology for the Anaesthetist* / P. Kam, I. Power – 3<sup>rd</sup> ed – CRC Press, July 2014, ISBN: 9781444135237

Australian Red Cross Blood Service (<http://www.transfusion.com.au/>) and

New Zealand Blood Service (<http://www.nzblood.co.nz/>)

## SECTION A: RESEARCH METHODS AND STATISTICS

### Objectives

An understanding of the scientific method and its application in research, including the appropriate use of statistics.

### Abilities

- |    |  |    |
|----|--|----|
| a. | Describe the features of evidence-based medicine, including levels of evidence (eg. NH&MRC), meta-analysis and systematic review.                              | L1 |
| b. | Describe the stages in the design of a clinical trial.   | L1 |
| c. | Describe the different types of data   | L1 |
| d. | Describe bias, types of error, confounding factors and sample size calculations, and the factors that influence them   | L2 |
| e. | Describe frequency distributions and measures of central tendency and dispersion   | L2 |
| f. | Describe the appropriate selection of non-parametric and parametric tests and tests that examine relationships (e.g. correlation, regression).                 | L1 |
| g. | Understand the terms sensitivity, specificity, positive and negative predictive value and how these are affected by the prevalence of the disease in question  | L2 |
| h. | Understand the concepts of risk and Odds Ratio   | L2 |
| i. | Understand concept of significance and testing of significance   | L1 |
| j. | Describe the processes by which new drugs are approved for research and clinical use in Australia, and to outline the phases of human drug trials (phase I-IV) | L3 |



## SECTION B: PHARMACEUTICS

### Abilities

- a. Outline the importance of packaging, formulation, and compatibilities of drugs. L3
- b. Describe the mechanisms of action and potential adverse effects of buffers, anti-oxidants, anti-microbial and solubilizing agents added to drugs L3
- c. Describe isomerism and provide examples. L3

## SECTION C: PHARMACOKINETICS

### Objective

An understanding of the fate of drugs in the body, including dosage, and how it relates to **normal physiology, extremes of age** (i.e. neonates, paediatrics and the elderly), **obesity, pregnancy** (including foetal) and **disease**.

### Abilities

- a. Explain the concept of pharmacokinetic modeling of single and multiple compartment models. L1
- b. Describe absorption and factors that will influence it. L1
- c. Describe factors influencing the distribution of drugs. L1
- d. Describe the mechanisms of drug clearance and metabolism. L1
- e. Explain the concepts of intravenous bolus and infusion kinetics. To describe the concepts of effect-site and context sensitive half time. L1
- f. Explain clinical drug monitoring with regard to peak and trough concentrations, minimum therapeutic concentration and toxicity L1
- g. Describe the pharmacokinetics of drugs in the epidural and subarachnoid space L2

## SECTION D: PHARMACODYNAMICS

### Objective

A general understanding of how drugs work, how their actions may be modified, including adverse effects and drug interactions, as they apply to **normal physiology, extremes of age** (i.e. neonates, paediatrics and the elderly), **obesity, pregnancy** (including foetal) and **disease**.

### Abilities

- a. To explain the concept of drug action with respect to: L2
- receptor theory
  - enzyme interactions
  - physico-chemical interactions
- b. To explain receptor activity with regard to: L2
- ionic fluxes
  - second messengers and G proteins
  - nucleic acid synthesis
  - evidence for the presence of receptors
  - regulation of receptor number and activity
  - structural relationships
- c. To define and explain dose-effect relationships of drugs, including dose-response curves with reference to: L1
- graded and quantal response
  - therapeutic index
  - potency and efficacy
  - competitive and non-competitive antagonists
  - partial agonists, mixed agonist-antagonists and inverse agonists
- d. To explain the Law of Mass Action and describe affinity and dissociation constants L2

## **SECTION E: VARIABILITY IN DRUG RESPONSE**

### **Abilities**

- |    |   |    |
|----|---|----|
| a. | Classify and describe adverse drug effects  | L1 |
| b. | Classify and describe mechanisms of drug interaction  | L1 |
| c. | Define tachyphylaxis, tolerance, addiction, dependence and idiosyncrasy   | L2 |
| d. | Describe mechanisms of tolerance  | L2 |
| e. | Outline genetic variability   | L2 |
| f. | Explain the mechanisms and significance of pharmacogenetic disorders (eg malignant hyperpyrexia, porphyria, atypical cholinesterase and disturbance of cytochrome function) | L2 |

## **SECTION F: TOXICOLOGY and OVERDOSE**

### **Abilities**

- |    |  |    |
|----|--|----|
| a. | Understanding of the general principles of poisoning and its management. | L1 |
| b. | Understand the pharmacology of alcohol, nicotine and recreational drugs. | L2 |
| c. | Understanding of the mechanisms of actions of specific antidotes         | L3 |

# PHYSIOLOGY

An understanding of normal physiology, and physiology at the **extremes of age** (i.e. neonates, paediatrics and the elderly), **obesity**, **pregnancy** (including foetal) and **disease** is expected. In addition, an understanding of the effects of commonly used drugs on the relevant physiological systems outlined in the following Sections is also expected.

## SECTION G: CELLULAR PHYSIOLOGY

### Abilities

- |    |   |    |
|----|---|----|
| a. | Describe the cell membrane and cellular organelles and their properties   | L2 |
| b. | Explain mechanisms of transport of substances across cell membranes, including an understanding of the Gibbs-Donnan effect                | L2 |
| c. | Outline the role of cellular receptors and the function of secondary messengers.  | L2 |
| d. | To describe the composition and control of intracellular fluid and the mechanisms by which cells maintain their homeostasis and integrity | L2 |

## SECTION H: RESPIRATORY SYSTEM

### H1: ANATOMY OF THE RESPIRATORY SYSTEM

#### Abilities

- |    |   |    |
|----|---|----|
| a. | Describe the function and structure of the upper, lower airway and alveolus.                        | L1 |
| b. | Understand the differences encountered in the upper airway for neonates, children and adults.       | L1 |
| c. | Describe the structure of the chest wall and diaphragm and to relate these to respiratory mechanics | L1 |
| d. | Outline the anatomy of the pulmonary and bronchial circulations.                                    | L1 |

### H2: CONTROL OF VENTILATION

#### Abilities

- |  |                                   |    |
|--|-----------------------------------|----|
|  | Describe the control of breathing | L1 |
|--|-----------------------------------|----|

### **H3: MECHANICS OF BREATHING**

#### **Abilities**

- a. Describe the inspiratory and expiratory process involving the chest wall, diaphragm, pleura and lung parenchyma L1
- b. Define compliance (static, dynamic and specific), its measurement, and relate this to the elastic properties of the respiratory system. L1
- c. Explain the concepts of time constants. L1
- d. Describe the pressure and flow-volume relationships of the lung, chest wall and the total respiratory system. L1
- e. Describe the properties, production and regulation of, surfactant and relate these to its role in influencing respiratory mechanics. L1
- f. Explain the significance of the vertical gradient of pleural pressure and the effect of positioning. L1
- g. Explain the relationship between resistance and respiratory gas flow. L1
- h. Describe the factors affecting airway resistance, and its measurement. L1
- i. Define closing capacity and its clinical significance and measurement L1
- j. Describe the work of breathing and its components L1

### **H4: PULMONARY GAS VOLUMES AND VENTILATION**

#### **Abilities**

- a. Explain the measurement of lung volumes and capacities, and factors that influence them. L1
- b. State the normal values of lung volumes and capacities L1
- c. Define dead space and its components, and explain how these may be measured L1

### **H5: DIFFUSIVE TRANSFER OF RESPIRATORY GASES**

#### **Abilities**

- a. Describe and explain the oxygen cascade L1
- b. Describe the movement of carbon dioxide from blood to the atmosphere. L1
- c. Explain perfusion-limited and diffusion-limited transfer of gases L1
- d. Define diffusing capacity and its measurement L1

- e. Describe the physiological factors that alter diffusing capacity L1

## **H6: VENTILATION-PERFUSION RELATIONSHIPS**

### **Abilities**

- a. Describe West's zones of the lung and explain the mechanisms responsible for them. L1
- b. Explain the concept of shunt and its measurement. L1
- c. Explain ventilation-perfusion matching and mismatching. L1
- d. Outline the methods used to measure ventilation-perfusion mismatch. L1
- e. Explain venous admixture and its relationship to shunt and ventilation-perfusion (V/Q) mismatch. L1
- f. Explain the effect of ventilation-perfusion mismatch on oxygen transfer and carbon dioxide elimination L1
- g. Understand the common respiratory equations L1

## **H7: GAS TRANSPORT IN THE BLOOD**

### **Abilities**

- a. Describe the carriage of oxygen in blood L1
- b. Explain the oxyhaemoglobin dissociation curve and factors that may alter it L1
- c. Describe the carbon dioxide carriage in blood including the Haldane effect, and the chloride shift L1
- d. Explain the carbon dioxide dissociation curve. L1
- e. Describe the oxygen and carbon dioxide stores in the body L1

## **H8: PULMONARY CIRCULATION**

### **Abilities**

- a. Describe the physiological features of the pulmonary circulation and its resistance. L1
- b. Understand the differences between the pulmonary and systemic circulation. L1

## **H9: PULMONARY FUNCTION TESTS**

### **Abilities**

- |    |  |    |
|----|--|----|
| a. | Describe the measurement and interpretation of pulmonary function tests, including diffusion capacity.               | L1 |
| b. | Describe the carbon dioxide and oxygen response curves and how these may be used to assess the control of breathing. | L1 |
| c. | Interpret normal and abnormal blood gases.   | L1 |
| d. | Outline the measurement of lung volumes including functional residual capacity and residual volume.                  | L2 |

## **H10: APPLIED RESPIRATORY PHYSIOLOGY**

### **Abilities**

- |    |  |    |
|----|--|----|
| a. | Describe the physiological consequences of intermittent positive pressure ventilation and positive end-expiratory pressure | L1 |
| b. | Explain the physiological effects of hyperoxia, hypoxaemia, hypercapnia, hypocapnia, and carbon monoxide poisoning         | L1 |
| c. | Explain the effect of changes in posture on ventilatory function   | L1 |
| d. | Define humidity and give an outline of the importance of humidification  | L1 |
| e. | Explain the pathways and importance of the cough reflex  | L1 |
| f. | Outline the non-ventilatory functions of the lungs   | L1 |
| g. | Outline the effects of altitude and hyperbaric environments on respiratory function  | L2 |

## **H11: RESPIRATORY PHARMACOLOGY AND THERAPEUTIC GASES**

### **Abilities**

- |    |  |    |
|----|--|----|
| a. | Describe the pharmacology of anti-asthma drugs.                              | L1 |
| b. | Outline the pharmacology of drugs used to treat acute pulmonary hypertension | L1 |
| c. | Outline the drugs used to treat chronic pulmonary hypertension               | L3 |
| d. | Describe the pharmacology of oxygen  | L1 |
| e. | Outline the pharmacology of helium   | L3 |
| f. | Describe the pharmacology of surfactant.                                     | L3 |

## **SECTION I:        CARDIOVASCULAR SYSTEM**

### **I1:     STRUCTURE AND FUNCTION OF THE HEART**

#### **Abilities**

- a.     Describe the structure and functional significance of the excitatory, conductive and contractile elements of the heart L1
- b.     Describe the anatomy of the heart, the pericardium and coronary circulation L1
- c.     Describe the normal pressure and flow patterns (including velocity profiles) of the cardiac cycle L1
- d.     Describe the fetal circulation L2
- e.     Describe the circulatory and respiratory changes that occur at birth L2

### **I2:     ELECTRICAL PROPERTIES OF THE HEART**

#### **Abilities**

- a.     Explain the ionic basis of spontaneous electrical activity of cardiac muscle cells. L1
- b.     Describe the normal and abnormal processes of cardiac excitation and electrical activity L1
- c.     Explain the physiological basis of the electrocardiograph. L1
- d.     Correlate the mechanical events of the cardiac cycle with the physical, electrical and ionic events L1

### **I3:     DETERMINANTS AND CONTROL OF CARDIAC OUTPUT**

#### **Abilities**

- a.     Explain the Frank-Starling mechanism and its relationship to excitation-contraction coupling L1
- b.     Define the components and determinants of cardiac output. L1
- c.     Describe myocardial oxygen demand and supply, and the conditions that may alter each L1
- d.     Describe and explain cardiac output curves, vascular function curves and their correlation L1
- e.     Describe the pressure-volume relationships of the ventricles and their clinical applications L1



- f. Describe the cardiac reflexes L2

#### **I4: THE PERIPHERAL CIRCULATION**

##### **Abilities**

- a. Describe the essential features of the micro-circulation including fluid exchange (Starling forces) and control mechanisms present in the pre- and post-capillary sphincters L1
- b. Describe the distribution of blood volume and flow in the various regional circulations and explain the factors that influence them, including autoregulation. These include, but not limited to, the cerebral and spinal cord, hepatic and splachnic, coronary, renal and utero-placental circulations L1
- c. Outline methods and principles used to measure regional blood flow L2
- d. Explain the factors that determine systemic blood pressures and their regulation L1
- e. Describe the physiological factors that may contribute to pulse variations in blood pressure. L1
- f. Describe total peripheral vascular resistance and the factors that affect it. L1
- g. Describe the factors that affect venous oxygen saturation. L1

#### **I5: CONTROL OF CIRCULATION**

##### **Abilities**

- a. Describe the role of the vasomotor centre and the autonomic nervous system in the regulation of cardiac output and venous return L1
- b. Describe the function of baroreceptors and to relate this knowledge to common clinical situations L1
- c. Explain the role of the autonomic nervous system in controlling systemic vascular resistance and redistribution of blood volume L1
- d. Explain the humoral regulation of blood volume and flow. L1
- e. Explain the response of the circulation to situations such as changes in posture haemorrhage, hypovolaemia, anaemia, intermittent positive pressure ventilation, positive end-expiratory pressure, and the Valsalva manoeuvre L1

## **I6: CARDIOVASCULAR PHARMACOLOGY**

### **Abilities**

- |    |  |    |
|----|--|----|
| a. | Understand the detailed pharmacology of inotropes and vasopressors | L1 |
| b. | Understand the pharmacology of adrenoreceptor blocking drugs.      | L1 |
| c. | Understand the pharmacology of anti-hypertensive drugs.            | L1 |
| d. | Understand the pharmacology of antiarrhythmic drugs                | L1 |
| e. | Understand the pharmacology of anti-anginal drugs                  | L2 |

## **SECTION J: RENAL SYSTEM**

### **J1: RENAL PHYSIOLOGY**

#### **Abilities**

- |    |  |    |
|----|--|----|
| a. | Describe the functional anatomy of the kidneys and renal blood flow                              | L1 |
| b. | Describe glomerular filtration and tubular function  | L1 |
| c. | Explain the counter-current mechanisms in the kidney   | L1 |
| d. | Outline the endocrine functions of the kidney  | L1 |
| e. | Describe the role of the kidneys in the maintenance of acid/base balance                         | L1 |
| f. | Describe the role of the kidneys in the maintenance of fluid, osmolality and electrolyte balance | L1 |
| g. | Describe the role of the kidney in the handling of glucose, nitrogenous products and drugs       | L1 |
| h. | Describe the principles of measurement of glomerular filtration rate and renal blood flow        | L1 |
| i. | Describe the physiological effects and clinical assessment of renal dysfunction                  | L1 |

### **J2: RENAL PHARMACOLOGY**

#### **Abilities**

- |  |  |    |
|--|--|----|
|  | An understanding of the pharmacology of diuretics. | L2 |
|--|--|----|

## **SECTION K: BODY FLUIDS AND ELECTROLYTES**

### **K1: PHYSIOLOGY OF BODY FLUIDS AND ELECTROLYTES**

#### **Abilities**

- a. Explain the distribution and movement of body fluids and their measurement L1
- b. Describe the function, distribution, regulation and physiological importance of sodium, chloride potassium, magnesium, calcium and phosphate ions L1
- c. Outline the composition and functions of lymph L2
- d. Define osmosis, colloid osmotic pressure and reflection coefficients and explain the factors that determine them. L1
- e. Describe the measurement of osmolality and the mechanisms involving the regulation of osmolality L1

### **K2: INTRAVENOUS FLUIDS**

#### **Abilities**

- An understanding of the pharmacology of colloids and crystalloids (including renal replacement therapy fluids) used in Intensive Care Medicine L1

## **SECTION L: ACID BASE PHYSIOLOGY**

### **Abilities**

- |    |  |    |
|----|--|----|
| a. | Explain the principles underlying acid-base chemistry.   | L1 |
| b. | Explain the Henderson-Hasselbach (traditional) and the Stewart (physico-chemical) approach to acid-base. | L2 |
| c. | Describe the chemistry of buffer mechanisms and explain their relevant roles in the body                 | L1 |
| d. | Explain the physiological basis to clinical acid – base disturbance                                      | L1 |

## **SECTION M: NERVOUS SYSTEM (including PAIN)**

### **M1: PHYSIOLOGY OF THE NERVOUS SYSTEM**

#### **Abilities**

- |    |   |    |
|----|---|----|
| a. | Explain the basic electro-physiology of neural tissue, including conduction of nerve impulses and synaptic function   | L2 |
| b. | Describe the major sensory and motor pathways (including anatomy)   | L2 |
| c. | Describe the physiology of cerebrospinal fluid  | L1 |
| d. | Describe the major neurotransmitters and their physiological role, with particular reference to GABA, excitatory and inhibitory amino acids, acetylcholine, noradrenaline, dopamine and serotonin and NMDA receptor | L2 |
| e. | Explain the control of intra-cranial pressure   | L1 |
| f. | Describe the physiology of sleep  | L2 |
| g. | Outline the basis of the electroencephalogram (EEG), evoked potentials, electromyography (EMG) and nerve conduction studies   | L3 |

### **M2: PHARMACOLOGY RELATED TO THE NERVOUS SYSTEM**

#### **Abilities**

- |    |   |    |
|----|---|----|
| a. | Understanding of the pharmacology of sedating drugs.                                    | L1 |
| b. | Understanding of the pharmacology of local anaesthetic drugs, including their toxicity. | L1 |

### **M3: PAIN**

#### **Abilities**

- |    |  |    |
|----|--|----|
| a. | Describe the physiology of pain, including the pathways and mediators.                                     | L1 |
| b. | To describe peripheral and central sensitization, gate control theory, preemptive and preventive analgesia | L2 |
| c. | Describe the eicosanoid pathway and the physiological role of prostaglandins                               | L2 |
| d. | Describe the classes of drugs used to treat pain.  | L1 |

## **M4: NEUROPHARMACOLOGY**

### **Abilities**

- a. An understanding of the pharmacology of anti-depressant anti-psychotic, anti-convulsant, and anti-Parkinsonian medication.

L2

## **SECTION N: AUTONOMIC NERVOUS SYSTEM**

### **N1: PHYSIOLOGY OF THE AUTONOMIC NERVOUS SYSTEM**

#### **Abilities**

- a. Describe the autonomic nervous system, including anatomy, receptors, subtypes and transmitters (including their synthesis, release and fate) L1

### **N2: PHARMACOLOGY OF THE AUTONOMIC NERVOUS SYSTEM**

#### **Abilities**

- a. Understanding of the pharmacology of drugs acting upon the autonomic nervous system. L1
- b. Describe the structure activity relationships of adrenergic and cholinergic drugs L1
- c. Outline the mechanisms by which drugs may affect neurotransmission and noradrenaline effect at the sympathetic nerve terminal L3



## **SECTION O: MUSCULOSKELETAL SYSTEM**

### **O1: MUSCULOSKELETAL SYSTEM PHYSIOLOGY**

#### **Abilities**

- |    |   |    |
|----|---|----|
| a. | Describe the anatomy and physiology of skeletal, smooth, and cardiac muscle             | L1 |
| b. | Describe the physiology of the neuromuscular junction and its receptors                 | L1 |
| c. | Describe the mechanism of excitation-contraction coupling                               | L1 |
| d. | Explain the concept of motor units  | L2 |
| e. | Describe the monosynaptic stretch reflex, single twitch, tetanus and the Treppe effect. | L2 |
| f. | Describe the relationship between muscle length and tension                             | L1 |
| g. | Understand the concept of muscle fatigue  | L1 |

### **O2: MUSCULOSKELETAL SYSTEM PHARMACOLOGY**

#### **Abilities**

- |    |  |    |
|----|--|----|
| a. | Understanding of the pharmacology of neuromuscular blocking drugs. | L1 |
| b. | Understanding of the antagonism of neuromuscular blocking drugs    | L2 |
| c. | Understanding of the pharmacology of anticholinesterase drugs.     | L2 |

## **SECTION P: LIVER PHYSIOLOGY**

### **Abilities**

- |    |   |    |
|----|---|----|
| a. | Describe the storage, synthetic, metabolic and excretory functions of the liver                 | L1 |
| b. | Outline the physiological consequences of hepatic disease                                       | L3 |
| c. | Describe the laboratory assessment of liver function  | L2 |
| d. | Describe the physiology of bile and its metabolism  | L2 |
| e. | Describe the physiology and anatomy of the hepatic and portal blood flow and the biliary tract. | L2 |
| f. | Outline the immunological functions of the liver  | L3 |

## **SECTION Q: HAEMATOLOGICAL SYSTEM**

### **Q1: PHYSIOLOGY OF HAEMATOLOGICAL SYSTEM**

#### **Abilities**

- a. Outline the physiological production of blood and its constituents. L2
- b. Explain the major blood groups and process of cross matching L1
- c. Outline the constituents and functions of plasma L1
- d. Describe the process and regulation of haemostasis, coagulation and fibrinolysis L1
- e. Describe the mechanisms of preventing thrombosis including endothelial factors and natural anticoagulants L2
- f. Outline the methods for assessing coagulation, platelet function and fibrinolysis L2
- g. Explain the physiological consequences of acute and chronic anaemia L2
- h. Describe physiology and consequences of abnormal haemoglobin L3

### **Q2: PHARMACOLOGY OF HAEMATOLOGICAL SYSTEM**

#### **Abilities**

- a. Understanding of the pharmacology of anti-coagulants, anti-platelet drugs, thrombolytic drugs and anti-fibrinolytic drugs. L1
- b. Outline the pharmacology of chemotherapeutic drugs. L3

### **Q3: BLOOD AND BLOOD PRODUCTS**

#### **Abilities**

- a. Understanding of the pharmacology of blood and its components, including individual factor replacement. L1
- b. Understanding the adverse consequences of blood transfusion, including that of massive blood transfusion L1
- c. Understand the process of collection and production of blood and its components L3

## **SECTION R: NUTRITION & METABOLISM**

### **Abilities**

- |    |   |    |
|----|---|----|
| a. | Describe basal metabolic rate and its measurement                                     | L3 |
| b. | Outline the factors that influence metabolic rate.                                    | L2 |
| c. | Describe the physiology and biochemistry of fat, carbohydrate and protein metabolism. | L1 |
| d. | Describe the normal nutritional requirements.   | L1 |
| e. | Outline the role of vitamins and trace elements.                                      | L3 |
| f. | Describe the consequences of anaerobic metabolism and ketone production               | L1 |

## **SECTION S: THERMOREGULATION**

### **Abilities**

- |    |  |    |
|----|--|----|
| a. | Describe the mechanisms by which heat is produced by the body  | L1 |
| b. | Outline the mechanisms for heat transfer between the body and its environment                          | L1 |
| c. | Define thermoneutral zone, and describe the mechanisms by which normal body temperature is maintained. | L2 |
| d. | Understand the physiological response to hypo- and hyper-thermia                                       | L2 |
| e. | Explain temperature regulation specific to the neonate   | L2 |

## **SECTION T: IMMUNOLOGY & HOST DEFENCE**

### **T1: PHYSIOLOGY OF IMMUNOLOGY & HOST DEFENCE**

#### **Abilities**

- a. Describe the factors involved in the process of inflammation and the immune response, including innate and acquired immunity L2
- b. Outline the non-immune host defenses used to defend against infection L3
- c. Outline the principles of wound healing and tissue repair (including bone) L3
- d. Outline the process of apoptosis L3
- e. Explain the immunological basis and pathophysiological effects of hypersensitivity, including anaphylaxis L1

### **T2: PHARMACOLOGICAL TREATMENT OF ANAPHYLAXIS**

#### **Abilities**

- a. Understand the pharmacology of the drugs used in the treatment of anaphylaxis L1

## **SECTION U: MICROBIOLOGY**

### **U1: GENERAL MICROBIOLOGY**

#### **Abilities**

- a. Describe the classification of micro-organisms, including viruses, bacteria, protozoa and fungi. L1
- b. Describe the principles of anti-microbial resistance. L1

### **U2: ANTI-MICROBIAL DRUGS**

#### **Abilities**

- a. Understanding the classification and pharmacology of antimicrobials. L1
- b. Outline the pharmacology of antiseptics and disinfectants L3

## **SECTION V: ENDOCRINE SYSTEM**

### **V1: ENDOCRINE PHYSIOLOGY**

#### **Abilities**

- |    |  |    |
|----|--|----|
| a. | Describe the exocrine and endocrine functions of the pancreas                        | L2 |
| b. | Describe the physiology of insulin, glucagon and somatostatin                        | L1 |
| c. | Explain the control of blood glucose   | L1 |
| d. | Describe the control, secretions and functions of the pituitary and the hypothalamus | L2 |
| e. | Describe the control, secretions and functions of the thyroid.                       | L2 |
| f. | Describe the control, secretions and functions of renal and adrenal hormones         | L1 |
| g. | Describe the control of plasma calcium.  | L2 |
| h. | Describe the control, secretions and functions of natriuretic peptides               | L3 |
| i. | Describe the physiology of histamine and serotonin                                   | L2 |
| j. | Outline the physiology of vasoactive peptides  | L3 |

### **V2: ENDOCRINE PHARMACOLOGY**

#### **Abilities**

- |    |  |    |
|----|--|----|
| a. | Understand the pharmacology of hypoglycaemic drugs and insulin preparations  | L2 |
| b. | Understand the pharmacology of thyroid hormones and anti-thyroid drugs       | L2 |
| c. | Understand the pharmacology of ACTH, glucocorticoids and mineralocorticoids. | L2 |
| d. | Outline the pharmacology of glucagon   | L3 |
| e. | Describe the pharmacology of vasopressin and its analogues                   | L2 |



## **SECTION W: OBSTETRICS**

### **W1: OBSTETRIC PHYSIOLOGY**

#### **Abilities**

- a. Explain the physiological changes during pregnancy, and parturition. L1
- b. Outline the functions of the placenta, and determinants of placental blood flow L2
- c. Describe the transfer of nutrients, drugs and gases between mother and fetus including the double Bohr and Haldane effects L2
- d. Physiological consequences of changes in posture during pregnancy L2

### **W2: OBSTETRIC PHARMACOLOGY**

#### **Abilities**

- a. Understand the changes in pharmacokinetics and pharmacodynamics during pregnancy L1
- b. Describe the pharmacology of oxytocic drugs L2
- c. Describe the pharmacology tocolytic drugs L2
- d. Outline the potential effects on the fetus and neonate of drugs administered during pregnancy L3
- e. Outline the potential effects on the neonate of drug administration in association with lactation L3

## **SECTION X: GASTROINTESTINAL SYSTEM**

### **X1: GASTROINTESTINAL PHYSIOLOGY**

#### **Abilities**

- a. Describe the composition, volumes and regulation of gastrointestinal secretions. L2
- b. Describe the control of gastrointestinal motility, including sphincter function. L2
- c. Outline the digestion and absorption of fat, protein, carbohydrates and the absorption of water, electrolytes and vitamins L2
- d. Outline the gastrointestinal blood supply. L2
- e. Describe the physiological consequences of intra abdominal hypertension. L3

### **X2: GASTROINTESTINAL PHARMACOLOGY**

#### **Abilities**

- a. Describe the pharmacology of drugs that affect gastrointestinal motility. L2
- b. Describe the pharmacology of drugs that influence gastric fluid pH and volume. L2
- c. Describe the specific mechanisms of action of drugs with anti-emetic activity. L2
- d. Describe the pharmacology of the octreotide. L2
- e. Outline the pharmacology of laxatives. L3

## SECTION Y: PRINCIPLES OF MEASUREMENT AND MONITORING

### Abilities

- |    |   |    |
|----|---|----|
| a. | Explain the mathematical concepts of exponential functions, integration and differentiation   | L2 |
| b. | Explain the electrical concepts of current, potential difference, resistance, impedance, inductance, capacitance, frequency and amplitude as they relate to biological signals and biomedical apparatus | L2 |
| c. | Understand the concepts of patient safety as it applies to monitoring involving electrical devices  | L3 |
| d. | Describe the laws governing the behavior of gases and liquids   | L1 |
| e. | Describe the principles of measurement, limitations, and potential sources of error for pressure transducers, and their calibration   | L1 |
| f. | Describe the invasive and non-invasive measurement of blood pressure and cardiac output including calibration, sources of errors and limitations  | L1 |
| g. | Explain the derived values from common methods of measurement of cardiac output (i.e. measures of vascular resistance)  | L2 |
| h. | Describe the principles of pulse and tissue oximetry, co-oximetry and capnography, including calibration, sources of errors and limitations   | L1 |
| i. | Describe the methods of measurement of oxygen and carbon dioxide tension in blood and blood pH  | L2 |
| j. | Describe the principles of measuring oxygen concentration   | L2 |
| k. | Describe the measurement of flow, pressure and volume of gases  | L2 |
| l. | Describe the physical principles of ultrasound and the Doppler Effect   | L3 |
| m. | Describe the measurement of temperature and humidity  | L3 |
| n. | Describe the measurement of intracranial pressure   | L3 |
| o. | Describe the principles behind the  |    |
|    | • electrocardiogram (ECG)   | L2 |
|    | • electroencephalogram (EEG), the electromyography (EMG), nerve conduction studies, evoked potentials and BIS   | L3 |
|    | • monitoring of neuromuscular blockade  | L3 |

## **SECTION Z: PROCEDURAL ANATOMY**

- a. Describe the anatomy relevant to central venous access (including femoral, internal jugular, external jugular, subclavian and peripheral veins). L1
- b. Describe the anatomy relevant to the insertion of an arterial line into a brachial, axillary, posterior tibial, dorsalis pedis, radial or femoral artery. L1
- c. Describe the anatomy relevant to the insertion of an intercostal catheter. L1
- d. Describe the anatomy relevant to the performance of a naso, or endo, tracheal intubation, a cricothyroidotomy or tracheostomy. L1
- e. Describe the anatomy relevant to the performance of a lumbar puncture and the insertion of an epidural catheter L2

# PHARMACOPEIA

The following is intended to provide trainees, tutors and examiners a guide as to the minimum breadth and depth of knowledge required for certain Classes of drugs, and certain individual drugs, that are considered likely to be encountered within the practice of Intensive Care Medicine. For each drug there is a level of the minimum required Detail of Understanding. Trainees are advised to study the listed example of drugs from a particular Class, and when an example is not given, to study a prototypical drug from each Class, as well as the relevant variations within each class. Trainees are also expected to understand a drug's pharmacology in the context of **normal physiology, extremes of age** (i.e. neonates, paediatrics and the elderly), **obesity, pregnancy** (including foetal) and **disease**. When there is overlap of a drug across the various sections, a drug may be listed in more than one section. In this instance a single Detail of Understanding will be allocated to cover the greatest depth expected.

The evolution of new drugs, and new indications for old drugs, is rapid and no list can be all encompassing. As with all aspects of learning of the basic sciences outlined within this syllabus, trainees are strongly encouraged to remain current with the evolving trends and levels of knowledge. Doing so not only fosters an ethos of future learning and exploration, but also better prepares trainees for the desired academic and clinical attributes of future Fellows of the College of Intensive Care Medicine.

## DETAIL OF UNDERSTANDING

The following list of Classes of drugs, and drugs, have been assigned a rating termed the Detail of Understanding. This rating is a guide as to the minimum level of knowledge and assessment that can be expected for that drug.

### Level A (A)

For these drugs, a detailed knowledge and comprehension of their Class, pharmaceuticals, pharmacodynamics, pharmacokinetics and adverse effects (including relevant withdrawal syndromes) will be required. As such, they will be eligible to be assessed on all occasions, in depth and are considered essential knowledge.

### Level B (B)

For these drugs, a general understanding of the Class, pharmacodynamics, pharmacokinetics and adverse effects (including relevant withdrawal syndromes) will be required. They will be eligible to be assessed on most occasions, in some depth, and are considered important knowledge.

### Level C (C)

For these drugs a working knowledge of the important points relating to Class, pharmacodynamics, pharmacokinetics and adverse effects, as they relate to the practice of Intensive Care Medicine will be required. They will be eligible for assessment regularly and a broad understanding of the concepts the principles involved will be expected.

## **TOXICOLOGY**

Alcohols (A)

Nicotine (C)

### Recreational Drugs

Cocaine (C)

Amphetamines (C)

Gammahydroxybutyrate (C)

Cannabinoids (C)

Hallucinogens (C)

Carbon Monoxide (C)

Heavy metals (C)

### Antidotes

Naloxone (B)

Naltrexone (C)

Pralidoxamine (C)

Flumazenil (B)

N-acetylcystine (B)

Sodium bicarbonate (B)

Calcium chloride (B)

Methylene Blue (C)

Glucagon (C)

Chelating drugs (C)

Pralidoxime (C)

Digoxin Antibodies (C)

Intralipid (C)

## **RESPIRATORY PHARMACOLOGY**

Oxygen (A)

Helium (C)

### Bronchodilators

Beta agonists

Salbutamol (A)

Salmeterol (C)

Antimuscarinic drugs

Ipratropium (A)

Tiotropium (C)

Theophylline (B)

Leukotriene antagonist (C)

### Corticosteroids

Oral / intravenous (A)

Inhaled (C)

Pulmonary vasodilators  
Nitric oxide (A)  
Prostacyclin (A)  
Sildenafil (B)  
Endothelin antagonist (C)

Surfactant (C)

## CARDIOVASCULAR PHARMACOLOGY

Adrenergic drugs:

Adrenaline (A)  
Noradrenaline (A)  
Dopamine (A)  
Dobutamine (A)  
Isoproterenol (A)  
Metaraminol (B)  
Ephedrine (C)  
Phenylephrine (C)

Non-adrenergic drugs

Vasopressin (A) and vasopressin analogues (B)  
Phosphodiesterase III inhibitors (A)  
Calcium Sensitisers (A)

Antihypertensive drugs

Centrally acting drugs

Clonidine (A)  
Alpha methyl dopa (C)

Adrenoreceptor antagonist

Alpha blockers  
Prazosin (B)  
Phenoxybenzamine (C)  
Phentolamine (C)

Beta blockers (A)

Mixed Antagonist

Labetalol (A)  
Carvedilol (B)

Direct vasodilators

Calcium channel antagonist  
Non-dihydropyridines (A)  
Dihydropyridines including Nimodipine (A)

Glyceryl Trinitrate (A)  
Sodium Nitroprusside (A)  
Hydralazine (B)

- ACE inhibitors (A)
- Angiotensin receptor blockers (B)
- Potassium channel activators
  - Nicorandil, Minoxidil (C)

#### Antiarrhythmics

- Sodium channel blocking drugs
  - Procainamide (B)
  - Lignocaine (A)
  - Flecainide (B)
- Beta blockers (A)
- Amiodarone, Sotalol (A)
- Calcium channel blockers (A)
- Digoxin (A)
- Adenosine (A)
- Magnesium (A)
- Atropine (A)

## **RENAL PHARMACOLOGY**

#### Diuretics

- Osmotic drugs
  - Mannitol (A)
- Drugs acting on the proximal tubule
  - Carbonic anhydrase inhibitors (A)
- Drugs acting on the Loop of Henle
  - Loop acting diuretics (A)
- Drugs acting on the distal tubule or collecting duct
  - Thiazides (B)
  - Aldosterone antagonist (B)
- Other potassium sparing drugs
  - Amiloride (C)

## **INTRAVENOUS FLUID PHARMACOLOGY**

#### Crystalloids

- 0.9% saline (A)
- Hypertonic saline solutions (A)
- Renal replacement therapy fluids (A)
- Hartmann's / Plasmalyte (A)
- Glucose containing solutions (A)

#### Colloids (A)

- Starches (A)
- Gelatins (A)
- Albumin (A)

#### Electrolytes



Potassium (A)  
Calcium chloride and gluconate (A)  
Magnesium (A)  
Sodium Bicarbonate (B)  
Phosphate (A)

#### Nutritional supplements

Vitamins (C)  
Trace Elements (C)  
Amino acids (C)

## NEUROPHARMACOLOGY

#### Sedative / Hypnotic drugs

Propofol (A)  
Barbiturates  
    Thiopentone (A)  
    Chloral Hydrate (C)  
    Phenobarbitone (B)  
Ketamine (A)  
Dexmedetomidine (A)  
Etomidate (C)  
Inhalational drugs (C)

#### Local Anaesthetics

Esters  
    Cocaine (C)  
Amides  
    Lignocaine (A)  
    Bupivacaine (B)  
    Levobupivacaine (B)  
    Ropivacaine (B)

#### Benzodiazepines

Midazolam (A)  
Diazepam (B)  
Alprazolam (C)  
Clonazepam (B)  
Flunitrazepam (C)  
Lorazepam (C)  
Nitrazepam (C)  
Oxazepam (C)  
Temazepam (C)

#### Antidepressants

Tricyclics  
    Amitriptyline (B)  
Selective serotonin reuptake inhibitors  
    Paroxetine (C)  
Serotonin-Noradrenalin reuptake inhibitors

Venlafaxine (C)  
Monoamine oxidase inhibitors  
Phenelzine (C)

#### Antipsychotics

First generation antipsychotics  
Haloperidol (B)  
Chlorpromazine (B)  
Second generation antipsychotics  
Olanzapine (B)  
Risperidone (C)  
Clozapine (C)  
Quetiapine (C)  
Lithium (B)

#### Anticonvulsants

Phenytoin (B)  
Sodium valproate (B)  
Carbamazepine (B)  
Clonazepam (B)  
Phenobarbitone (C)  
Lamotrigine (C)  
Gabapentin (C)  
Levetiracetam (C)

#### Anti-Parkinsonian drugs

Levodopa (C)  
Carbidopa (C)  
Bromocriptine (C)

Nimodipine (A)

## **ANALGESICS**

#### Opiates

Morphine (A)  
Fentanyl (A)  
Alfentanil (A)  
Remifentanyl (A)  
Oxycodone (A)  
Methadone (B)  
Codeine (B)  
Pethidine (C)  
Buprenorphine (C)  
Heroin (C)

#### Cyclooxygenase inhibitors

Non-steroidal drugs  
Ibuprofen (B)  
Indocid (B)

Other Non-steroidal drugs (C)  
COX 2 drugs  
Parecoxib (B)

Tramadol (A)

Paracetamol (A)

Ketamine (A)

Allopurinol (C)

Colchicine (C)

## **AUTONOMIC PHARMACOLOGY**

Direct Nicotinic stimulants

Nicotine (C) (see toxicology)

Indirect Muscarinic stimulants

Neostigmine (B)

Physostigmine (C)

Pyridostigmine (C)

Edrophonium (C)

Organophosphates (C)

Antimuscarinic drugs

Atropine (A)

Glycopyrrolate (B)

Hyoscine (C)

Benztropine (C)

Scopolamine (C)

Antinicotinic drugs

See neuromuscular pharmacology

## **NEUROMUSCULAR PHARMACOLOGY**

Neuromuscular blockers

Depolarising

Suxamethonium (A)

Non-depolarising

Aminosteroids

Vecuronium (A)

Rocuronium (A)

Pancuronium (B)

Isoquinolines

Atracurium (A)  
Cisatracurium (C)

Anti cholinesterase drugs  
Neostigmine (B)

Dantrolene (C)

Sugammadex (C)

Baclofen (C)

## **HAEMATOLOGICAL PHARMACOLOGY**

Anticoagulants

Heparin (A)  
Low molecular weight heparin (A)  
Warfarin (A)  
Direct thrombin inhibitors (C)  
Antithrombin activity promoters (C)  
Citrate (C)

Anti-platelet drugs

Asprin (A)  
Clopidogrel (A)  
Dipyridamole (C)  
Tirofiban (C)  
Abciximab (C)

Fibrinolytics

Tenecteplase (B)  
rTPA (B)

Antifibrinolytics

Aminocaproic acid (C)  
Tranaxemic acid (B)  
Aprotonin (C)

Blood Products

Red Blood cells (A)  
Fresh Frozen Plasma (A)  
Platelets (A)

Factor Replacement

Prothrombinex (B)  
Factor VIIa (B)  
Factor VIII (C)

Factor IX (C)  
Cryoprecipitate (B)  
Antithrombin III (C)

Immunoglobulin (C)  
Intragram (C)  
Rh(D) Immunoglobulin (C)  
Immunoglobulins for acute post viral exposure prophylaxis (C)

Blood Cell growth stimulants  
Erythropoietin (C)  
Granulocyte colony-stimulating factor (C)  
Granulocyte-macrophage colony-stimulating factor (C)

Vitamin K (B)

Chemotherapeutics (C)

Immunosuppressives (C)

## **ANTIMICROBIALS**

### Antibiotics

Penicillins (A)  
Cephalosporins (A)  
Carbapenems (A)  
Glycopeptides (A)  
Aminoglycosides (A)  
Quinolones (A)  
Macrolides (B)  
Lincosamides (B)  
Tetracyclines (B)  
Trimethoprim / Sulphamethoxazole [Bactrim] (B)  
Metronidazole (B)  
Beta-lactamase inhibitors (B)  
Polymyxins (C)  
Oxazolidinones (C)  
Anti-mycobacterial drugs (C)  
Chloramphenicol (C)

### Antivirals

Acyclovir (B)  
Gancyclovir (C)  
Neuraminidase inhibitors (B)  
Anti-retroviral drugs (C)

### Antifungals

Azoles (B)  
Echinocandins (B)

Amphotericin (B)

Antiprotozals (C)

Anti-malarials (C)

Antiseptics and disinfectants

Isopropyl alcohol (C)

Chlorhexidine gluconate (C)

Sodium hypochlorite (C)

Povidone-iodine (C)

## **ENDOCRINE PHARMACOLOGY**

Hypoglycemic drugs

Insulin (A)

Sulphonylureas (B)

Biguanides (B)

Glitazones (B)

Glucocorticoids (A)

Mineralocorticoids (B)

ACTH (C)

Thyroxine (B)

Antithyroid drugs

Propylthiouracil (C)

Carbimazole (C)

Anti-hypercalcaemic drugs (C)

Glucagon (C)

Vasopressin analogues (B)

Antihistamines (C)

## **OBSTETRIC PHARMACOLOGY**

Oxytocics

Oxytocin (C)

Ergot derivatives (C)

Prostaglandin F<sub>2</sub> alpha (C)

Tocolytics

B<sub>2</sub> agonist (A)

Calcium channel antagonist (A)

Magnesium (A)

Nitrates (A)

## **GASTROINTESTINAL PHARMACOLOGY**

Acid suppression

H<sub>2</sub>-receptor blockers (B)

Proton pump inhibitors (B)

Sucralfate (C)

Lipid lowering drugs (C)

Prokinetics

Metoclopramide (B)

Erythromycin (B)

Antiemetics

Serotonin antagonist

Ondansetron(B)

Tropisetron (C)

Granisetron (C)

Dopamine antagonist

Metoclopramide (B)

Droperidol (B)

Prochlorperazine (C)

Anticholinergics (C)

Antihistamines (C)

Steroids (C)

Octreotide (C)

Laxatives (C)

## **PHARMACOLOGY OF OTHER DRUGS**

Radiology contrast media (C)

## CONTRIBUTORS

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