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**College of Intensive Care Medicine
of Australia and New Zealand**

SYLLABUS FOR THE BASIC SCIENCES IN INTENSIVE CARE MEDICINE

FOREWORD

This is the first Syllabus developed for the basic sciences in Intensive Care. It has been developed as a result of the interest expressed to the Joint Faculty of Intensive Care Medicine to develop its own primary examination as an additional path towards advanced training.

A significant component of this Syllabus was adopted (with permission) from the second edition of the Syllabus for the Basic Sciences in Anaesthesia and Intensive Care produced by the Australian and New Zealand College of Anaesthetists. That publication in particular represents an enormous effort on behalf of the Primary Examination Committee of ANZCA (under the leadership of Neville Gibbs and David Cottee).

At the time of publication of this Syllabus, no equivalent document for the basic sciences had been published by the other parent College (Royal Australasian College of Physicians).

Significant additional input was also provided by the Examination Committee and the Education Committee of the Joint Faculty of Intensive Care Medicine, and by a number of Fellows who have already had experience in the Primary Examination process of one of the parent Colleges.

Topics have been listed under major systems (with relevant anatomy, pharmacology and physiology for each) in an attempt to simplify the document for trainees, and to minimise duplication. It is recognised that with constant changes in the field of Intensive Care Medicine this document will need to be regularly reviewed and revised as appropriate. This list is by no means comprehensive but is intended to provide a guide to the trainee and tutors.

TABLE OF CONTENTS

Foreword _____	2
1. Learning Objectives for Basic Sciences in Anaesthesia and Intensive Care Medicine	5
2. Recommended Texts for the Basic Sciences in Anaesthesia and Intensive Care Medicine	6
3. Evidence Based Medicine	10
4. Generic Pharmacology	11
Pharmacodynamics _____	11
Pharmacokinetics _____	11
Variability in Drug Response _____	12
Pharmaceutical Aspects and Drug Development _____	13
Pharmacological Basis of Poisoning _____	13
5. Physiology	14
6. Specific Systems	15
<u>SECTION A - Cellular Physiology</u> _____	15
<u>SECTION B - Respiratory System</u> _____	16
B1: Respiratory Physiology _____	16
B1a - General Respiratory Physiology _____	16
B1b - Anatomy of the Respiratory System _____	16
B1c - Control of Ventilation _____	16
B1d - Mechanics of Breathing _____	17
B1e - Pulmonary Gas Volumes and Ventilation _____	17
B1f - Diffusive Transfer of Respiratory Gases _____	17
B1g - Ventilation-Perfusion Relationships _____	18
B1h - Gas Transport in the Blood _____	18
B1i - Pulmonary Circulation _____	18
B1j - Clinical Pulmonary Function Tests _____	19
B1k - Applied Respiratory Physiology _____	19
B2: Respiratory Pharmacology _____	20
B2a - Respiratory Pharmacology and Therapeutic Gases _____	20
<u>SECTION C - Cardiovascular System</u> _____	21
C1: Cardiovascular Physiology _____	21
C1a - Structure and Function of the Heart _____	21
C1b - Electrical Properties of the Heart _____	21
C1c - Determinants and Control of Cardiac Output _____	21
C1d - The Peripheral Vascular System _____	22
C1e - Control of Circulation _____	22
C1f - Regional Circulation _____	22
C1g - Applied Aspects of CVS Physiology _____	23
C1h - Measurement of CVS Function _____	23
C2: Cardiovascular Pharmacology _____	23
C2a - Adrenoceptor Blocking Agents _____	23
C2b - Anti-Hypertensive Drugs _____	24
C2c - Anti-Arrhythmic Drugs _____	24
C2d - Inotropes and Vasopressors _____	25
<u>SECTION D - Renal System</u> _____	26
D1: Renal Physiology _____	26
D2: Renal Pharmacology _____	26
D2a - Diuretics _____	26
<u>SECTION E - Body Fluids and Electrolytes</u> _____	27
E1: Physiology of Body Fluids and Electrolytes _____	27
E2: Pharmacology Related to Body Fluids and Electrolytes _____	27
E2a - Intravenous Fluids _____	27

SECTION F - Acid Base Physiology	28
SECTION G - Nervous System (including Pain)	29
G1: Physiology of the nervous system	29
G2: Pharmacology related to the nervous system	29
G2a - Intravenous Anaesthetic Agents	29
G2b - Local Anaesthetic Agents	30
G2c - Pain	30
G2d - Opioid Agonists and Antagonists	31
G2e - Non-Steroidal Anti-Inflammatory Drugs	31
G2f - Neuropharmacology	31
G3: Autonomic Tonomic Nervous System	32
G3a - Physiology and Pharmacology of the Autonomic Nervous System	32
G3b - Anticholinergic Drugs	32
SECTION H - Musculoskeletal System	33
H1: Musculoskeletal System Physiology	33
H2: Musculoskeletal System Pharmacology	33
H2a - Neuromuscular Blocking Agents	33
H2b - Anticholinesterase Drugs	33
SECTION I - Liver Physiology	34
SECTION J - Haematological System	35
J1: Physiology of Haematological system	35
J2: Pharmacology of Haematological system	35
J2a - Drugs and Coagulation	35
SECTION K - Nutrition and Metabolism	36
SECTION L - Thermoregulation	37
SECTION M - Immunology and Host Defence	38
M1: Physiology of Immunology and Host Defence	38
M2: Pharmacology Related to Immunology and Host Defence	38
M2a - Anti-Microbial and Chemotherapeutic Agents	38
M3: Physiology and Pharmacology of Histamine and Serotonin	39
SECTION N - Endocrine System	40
N1: Endocrine Physiology	40
N2: Endocrine Pharmacology	40
SECTION O - Obstetrics	41
O1: Maternal (Obstetric) Physiology	41
O2: Maternal (Obstetric) Pharmacology	41
SECTION P - Foetal and Neonatal Physiology	42
SECTION Q - Gastrointestinal System	43
Q1: Gastrointestinal Physiology	43
Q2: Gastrointestinal Pharmacology	43
Q2a - General Gastrointestinal Pharmacology	43
Q2b - Anti-Emetic Drugs	43
SECTION R - Principles of Measurement	44
SECTION S - Clinical Monitoring	45

1. LEARNING OBJECTIVES FOR BASIC SCIENCES IN ANAESTHESIA AND INTENSIVE CARE MEDICINE

INTRODUCTION

The purpose of these learning objectives is threefold:

- A guide to trainees for learning
- A guide to tutors and teachers
- A guide to examiners

This will ensure that trainees, tutors and examiners can all work from a common base. It is important to recognise that these learning objectives, while attempting to circumscribe the subject matter, are not designed to discourage trainees from pursuing greater depth, breadth or understanding. Throughout the document specific wording has been used under the required abilities to indicate the level of knowledge and understanding expected, and a glossary of these terms is provided.

- **Outline** - Provide a summary of the important points.
- **Define** - Give the precise meaning
- **Describe** - Give a detailed account of
- **Explain** - Make plain, interpret, and account for

Trainees are advised that all examination questions are based around the syllabus. The accompanying texts (books and journal articles) are recommended as references for the subject matter. Trainees may find certain Web based resources also to be of use. A good trainee will have read more widely than these texts, but the material contained in the references provides a clear indication of the level of understanding required and the boundaries of the subject matter.

Trainees and tutors are encouraged to refer to the learning objectives as they form the basis for training and the examination.

2. RECOMMENDED TEXTS FOR THE BASIC SCIENCES IN ANAESTHESIA AND INTENSIVE CARE

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

General Texts

Foundations of Anesthesia Basic and Clinical Science, 2nd Edition, Hugh C. Hemmings, Mosby, 2005 ISBN 0323037070

General Physiology

Textbook of Medical Physiology / A C Guyton & J E Hall - 11th ed - Philadelphia : W B Saunders, 2005, ISBN 0721602401

Review of Medical Physiology / W F Ganong- 22st ed : Lange/McGraw-Hill, 2005, ISBN 0071440402

Lecture Notes on Human Physiology / ed J J Bray et al - 4th ed - Oxford : Blackwell Science, 1999, ISBN 0865427755

Principles of Physiology for the Anaesthetist / I Power & P Kam - 1st ed - London : Arnold, 2001, ISBN 0340742135

Comprehensive Human Physiology: From Cellular Mechanisms to Integration/ ed R. Greger, U. Windhorst, Springer-Verlag Berlin and Heidelberg 1996, ISBN 354058109

Physiology / Robert M. Berne, Matthew N. Levy, Bruce M. Koeppen, Bruce A. Stanton Mosby, 2003, ISBN: 0323022251

Respiratory

Respiratory Physiology : the essentials / J B West - 7th ed - Baltimore : Williams & Wilkins, 2004, ISBN 0781751527

Nunn's Applied Respiratory Physiology / A B Lumb - 6th ed - Oxford : Butterworth Heinemann, 2005 ISBN 0407003428

Cardiovascular

Cardiovascular Physiology / R M Berne and M N Levy - 8th ed - St Louis : Mosby, 2001, ISBN: 0323011276

Clinical Measurement

Basic Physics and Measurement in Anaesthesia / P D Davis and G N C Kenny - 5th ed - Edinburgh : Butterworth-Heinemann, 2003 ISBN: 0750648287

Clinical Monitoring : Practical Applications for Anesthesia and Critical Care / ed by C L Lake, R L Hines & C D Blitt - 1st ed - Philadelphia : WB Saunders, 2001, ISBN 0721686982

Diagnostic Ultrasound: Physics and Equipment / Peter Hoskins, Kevin Martin, Tony Whittingham, Abigail Thrush. Greenwich Medical Media, 2002, ISBN: 1841100420

Mathematics and Statistics in Anaesthesia / Steven Cruickshank, Oxford University Press, ISBN: 9780192623126

General Pharmacology

Pharmacology / H P Rang, J M Ritter and M M Dale - 5th ed - Edinburgh : Churchill-Livingstone, 2003, ISBN 0443071454

Goodman and Gilman's the Pharmacological Basis of Therapeutics / ed by J G Hardman et al - 11th ed - New York : McGraw-Hill, 2005, ISBN 0071422803

Basic and Clinical Pharmacology / B G Katzung - 9th ed - McGraw-Hill, 2004, ISBN 0071410929

Pharmacology for Anaesthesia and Intensive Care / Tom Peck, Sue Hill, Mark Williams, Greenwich Medical Media 2003 ISBN: 1841101664

Anaesthetic Pharmacology

Pharmacology and Physiology in Anesthetic Practice / R K Stoelting - 3rd ed - Philadelphia: Lippincott-Raven, 1999, ISBN 0781716217

Neural blockade: in clinical anaesthesia and management of pain / M J Cousins and P O Bridenbaugh - 3rd ed - Philadelphia: Lippincott, 1998, ISBN 0-397-51159-0

Anesthetic Pharmacology, Physiological Principles and Clinical Practice / A S Evers and M Maze - 1st ed – New York: Churchill-Livingstone, 2004, ISBN 0443065799

Statistics

Basic and Clinical Biostatistics / B Dawson-Saunders and R G Trapp - 3rd ed - California: Lange, 2001, ISBN 0838505104

Statistical methods for anaesthesia and intensive care / P S Myles and T Gin - 1st ed - Oxford: Butterworth-Heinemann, 2001 ISBN 0750640650

Other

Neuromuscular Block / Stanley Feldman, Butterworth-Heinemann 1996, ISBN: 0750617640

Renal Physiology / Bruce M. Koeppen, Bruce A. Stanton Mosby's Physiology Monograph Series 2000, ISBN: 03230124

Anatomy at a Glance / Omar Faiz , David Moffat, Blackwell,2002, ISBN:0632059346

Anatomy for Anaesthetists, / Harold Ellis, Stanley Feldman, A W Harrop-Griffiths, Blackwell 2004, ISBN:1405106638

Metabolism at a Glance/ J G Salway, Blackwell 2003 ISBN :1405107162

Medical Biochemistry at a Glance / Salway, Blackwell 2005, ISBN: 140511322726

Medical Microbiology and Infection at a Glance, S H Gillespie, K B Bamford, Blackwell 2003, ISBN 0632050268

Vander's Renal Physiology 6/E / Eaton, Douglas; Pooler, John, Mcgraw Hill, 2004, ISBN: 0071357289

Pocket Guide to Spirometry / David, Pierce Mcgraw Hill, 2003 ISBN: 0074713310

Acute Pain Management, A Practical Guide 2nd ed/ P Macintyre, B Ready, Saunders 2005, ISBN 070202581

Transfusion Medicine. Manual 2003. Australian Red Cross Blood Service, Victoria

ARTICLES

These articles are not listed in any particular order and do not encompass the entire syllabus. They are intended to complement the texts. Not all trainees may find them useful and trainees may find other articles of greater use.

Adrogue, H J.; Madias, N E. Medical Progress: Management of Life-Threatening Acid-Base Disorders: First of Two Parts. NEJM 1998;338:26-34

Adrogue, H J.; Madias, N E. Medical Progress: Management of Life-Threatening Acid-Base Disorders: Second of Two Parts. NEJM 1998;338:107-111

Boyer EW, et al. The serotonin syndrome. NEJM 2005;352:1112-20

Corey, HE. Bench to bedside: Fundamental principles of acid-base physiology. Critical Care. 2004. <http://ccforum.com/inpress/cc2985>

Di Nisio M, et al. Direct Thrombin Inhibitors. NEJM 2005;353:1028-40

Esmon CT. The interactions between inflammation and coagulation. Brit J haematology. 2005;131:417-30

Galley HF, et al. Physiology of the endothelium. Brit J Anaesthesia. 2004;93:105-13

Hirsch IB. Insulin analogues. NEJM 2005;352:174-83

Hsia C. Respiratory function of hemoglobin. NEJM. 1998;338:239-47

Jones D, et al. Serotonin Syndrome and the anaesthetist. Anaesth Intens Care. 2005;33:181-7

Kales SN, et al. Acute Chemical Emergencies. NEJM 2004;350:800-8

Kellum JA. Reunification of acid base physiology. Critical Care 2005;9:500-507

Lamberts SWJ, et al. Octreotide. NEJM 1996;334:246-54

Malik A, et al. Nerve conduction studies essentials and pitfalls in practice. J Neurol Neurosurg Psychiatry. 2005;76(suppl):ii23-ii31

Moxham J. Respiratory muscle fatigue: mechanisms, evaluation and therapy. Br J Anaesthesia 1990;65:43-53

NHLBI Workshop summary. Respiratory muscle fatigue: report of the respiratory muscle fatigue workshop group. Am Rev Respir Dis 1990;142:474-80

Palmer SN, Glesecke M, et al. Pharmacogenetics of anaesthetic and analgesics agents. Anaesthesiology. 2005;102:663-71

Roberts HR, Monroe DM, et al. Current concepts of hemostasis, implications for therapy. Anesthesiology. 2004;100:722-30

Roussos C, et al. The respiratory muscles. NEJM 1982;307:786-97

Rosenberg R. Mechanisms of Disease: Vascular-Bed-Specific Hemostasis and Hypercoagulable States. NEJM. 1999;340:1555-64

Snead OC, et al. Gamma-Hydroxybutyric Acid. NEJM 2005;352:2721-32

Weir EK, et al. Acute oxygen sensing mechanism. NEJM 2005;353:2042-55

Welsby IJ, et al. Recombinant activated factor VII and the anaesthetist. Anaesthesia. 2005;60:1203-12

3. EVIDENCE BASED MEDICINE

3.1 General Instructional Objectives

An understanding of scientific method and its application in research, including the appropriate use of statistical methods. The demonstration of the capacity to critically evaluate published research.

3.2 Required Abilities

- a. To describe the features of evidence-based medicine, including levels of evidence (e.g. NH&MRC), meta-analysis and systematic review.
- b. To describe the stages in the design of a clinical trial, taking into account the:
 - research question and hypothesis
 - literature review
 - statistical advice
 - ideal study protocol to minimise the risk of bias and to achieve optimum power of the study
 - ethical issues and informed consent
 - data collection and processing
- c. To explain the concepts in statistics such as distribution of data and frequency distributions, measures of central tendency and dispersion of data, and the appropriate selection and application of non-parametric and parametric tests in statistical inference and tests that examine relationships (e.g. correlation, regression).
- d. To categorise the principles of errors of statistical inference (e.g. Type I & II) and describe techniques to minimise such errors
- e. Have an understanding of sources of bias and confounding in medical research and methods available that may reduce such bias
- f. To describe the concepts of sensitivity, specificity, positive and negative predictive value and how these are affected by the prevalence of the disease in question
- g. To describe the various statistical methods used to estimate risk
- h. To understand the concept of significance and testing of significance

4. GENERIC PHARMACOLOGY

An understanding of the pharmacology of a drug implies an understanding of the relevant pharmaceutics, pharmacokinetics (including dosage), and pharmacodynamics (including adverse effects and drug interactions). In all areas of pharmacology, in addition to an understanding of the specific pharmacological details as listed below, an understanding of the relevant basic physiology is expected.

PHARMACODYNAMICS

4.1 General Instructional Objective

A general understanding of how drugs work and how their actions may be modified. An understanding of the clinical application of this knowledge

4.2 Required Abilities

- a. To explain the concept of drug action with respect to:
 - receptor theory
 - enzyme interactions
 - physico-chemical interactions
- b. To explain receptor activity with regard to:
 - 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 with reference to:
 - graded and quantal response
 - therapeutic index
 - potency and efficacy
 - competitive and non-competitive antagonists
 - partial agonists, mixed agonist-antagonists and inverse agonists
- d. To describe efficacy and potency with reference to dose-response curves
- e. To explain the Law of Mass Action and describe affinity and dissociation constants
- f. To describe the mechanisms of adverse drug effects
- g. To describe the physiological effects and principles of management of drug overdose

PHARMACOKINETICS

4.3 General Instructional Objective

An understanding of the fate of drugs in the body and how this may be affected by physiological and pathological disturbance. An understanding of the clinical application of this knowledge.

4.4 Required Abilities

- a. To explain the concept of pharmacokinetic modelling of single and multiple compartment models and define:

- half-life
 - clearance
 - zero and first order kinetics
 - volume of distribution
 - bio-availability
 - area under the plasma concentration time curve
 - extraction ratio
- b. To describe absorption and factors that will influence it with reference to clinically utilised sites of administration
 - c. To describe factors influencing the distribution of drugs (e.g. protein binding, lipid solubility, pH, pKa) and their alteration in physiological and pathological disturbance
 - d. To describe the mechanisms of drug clearance and how physiological and pathological disturbance may affect these
 - e. To describe the mechanisms of drug metabolism. To describe Phase 1 and Phase 2 reactions, hepatic extraction ratio and its significance, first pass effect, enzyme induction and inhibition
 - f. To explain and apply concepts related to intravenous bolus and infusion kinetics. To describe the concepts of effect-site and effect-site equilibration time and their clinical applications. To describe the concept of context sensitive half time and its clinical applications
 - g. To calculate loading and maintenance dosage regimens
 - h. To describe the pharmacokinetics of drugs administered in the epidural and subarachnoid space
 - i. To explain clinical drug monitoring with regard to peak and trough concentrations, minimum therapeutic concentration and toxicity

VARIABILITY IN DRUG RESPONSE

4.5 General Instructional Objectives

An understanding of the factors that may alter inter- and intra-individual drug responses

4.6 Required Abilities

- a. To define tachyphylaxis, tolerance, addiction, dependence and idiosyncrasy
- b. To describe mechanisms of tolerance
- c. To understand genetic variability
- d. To describe alterations to drug response due to physiological change with special reference to neonates, the elderly and pregnancy
- e. To describe alterations to drug response due to pathological disturbance with special reference to cardiac, respiratory, renal and hepatic disease
- f. To classify and describe adverse drug effects
- g. To classify and describe mechanisms of drug interaction
- h. To explain the mechanisms and significance of pharmacogenetic disorders such as malignant hyperpyrexia, porphyria, atypical cholinesterase and disturbance of cytochrome function

- i. To describe immune mechanisms which may result in reactions to drugs, intravenous fluids and latex.

PHARMACEUTICAL ASPECTS AND DRUG DEVELOPMENT

4.7 General Instructional Objective

An appreciation of how drugs are developed, formulated and the importance of additives in drugs.

4.8 Required Abilities

- a. To define shelf-life and outline factors that may influence drug potency during storage
- b. To describe methods of preserving shelf-life of drugs.
- c. To describe the mechanisms of action and potential adverse effects of buffers, anti-oxidants, anti-microbial and solubilizing agents added to drugs
- d. To outline the variations in generic nomenclature of commonly used drugs (e.g. epinephrine/adrenaline, lidocaine/lignocaine)
- e. To define isomerism and provide a classification with examples. To describe the clinical importance of isomerism
- f. To 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)

PHARMACOLOGICAL BASIS OF POISONING

4.9 General Instructional Objectives

An understanding of the general principles of treating poisoning and the pharmacology of specific treatments (see also Section in Generic Pharmacodynamics).

4.10 Required Abilities

- a. To outline methods which decrease absorption and enhance drug elimination such as activated charcoal, emetic agents, gastric lavage, haemodialysis, charcoal haemoperfusion and whole bowel irrigation.
- b. To describe the physiological effects and principles of management of agents toxic in overdose (including, cyanide, carbon monoxide, organophosphates/nerve agents/herbicides, illicit drugs, alcohols/glycols)
- c. To describe the physiological and pharmacological basis for the treatment of poisoning with select agents with specific antidotes

5. PHYSIOLOGY

Introduction: An understanding of physiology and its application to clinical practice is expected. This also includes relevant applied anatomy (as related to commonly performed Intensive Care procedures). In all areas of physiology, in addition to an understanding of the specific physiology as listed, an understanding of the effects of commonly used drugs on that relevant system is expected.

6. SPECIFIC SYSTEMS

SECTION A - CELLULAR PHYSIOLOGY

1. General Instructional Objectives

An understanding of basic cellular physiology

2. Required Abilities

- a. To describe the cell membrane and its properties
- b. To describe the functions of mitochondria, endoplasmic reticulum, and other organelles
- c. To explain mechanisms of transport of substances across cell membranes including diffusion, facilitated diffusion, primary active transport and secondary active transport
- d. To outline the role of cellular receptors and the function of secondary messengers within the cell
- e. To outline the sources of energy available to cells through metabolic processes
- f. To describe the composition and control of intracellular fluid and its regulation including the role of the sodium-potassium pump

SECTION B - RESPIRATORY SYSTEM

B1: RESPIRATORY PHYSIOLOGY

B1a GENERAL RESPIRATORY PHYSIOLOGY

1. General Instructional Objectives

An understanding of the function and control of the respiratory system and the application of this knowledge

An understanding of the changes in abnormal physiological and common pathological conditions

2. Required Abilities

- a. To give a detailed account of basic applied respiratory physiology
- b. To explain the mechanisms by which respiratory function is altered
- c. To describe the interactions of respiratory function with that of the other body systems

B1b ANATOMY OF THE RESPIRATORY SYSTEM

1. General Instructional Objectives

An understanding of the anatomy of the respiratory system and its relation to function

2. Required Abilities

- a. To relate function of the upper airway to its structure
- b. To describe the anatomy of the upper airway and understand the differences encountered in the neonate, paediatric and adult populations
- c. To explain the structure of the chest wall and diaphragm and to relate these to respiratory mechanics
- d. To describe the anatomy relevant to the insertion of an intercostal catheter.
- e. To outline the tracheal and bronchial anatomy and structure.
- f. To outline the vascular anatomy and structure of the pulmonary and bronchial circulations
- g. to describe the anatomy relevant to the performance of a surgical airway or tracheostomy.

B1c CONTROL OF VENTILATION

1. General Instructional Objectives

An understanding of the control of ventilation and an appreciation of the changes in ventilation in abnormal physiological and common pathological conditions

2. Required Abilities

- a. To describe the medullary and pontine respiratory control centres and explain how the ventilatory pattern is generated and controlled
- b. To describe the chemical control of breathing via central and peripheral chemoreceptors, and indicate how this is altered in abnormal clinical states
- c. To describe the reflex control of ventilation

B1d MECHANICS OF BREATHING**1. General Instructional Objectives**

An understanding of the elastic properties (static mechanics) and the flow resistive properties of the airways (dynamic mechanics) as well as the forces acting on the ventilatory system. The application of this knowledge to changes within intensive care.

2. Required Abilities

- a. To describe the inspiratory and expiratory process involving the chest wall, diaphragm, pleura and lung parenchyma
- b. To define compliance (static, dynamic and specific), its measurement and relate this to the elastic properties of the lung
- c. To explain the concepts of time constants and relate these to "fast" and "slow" alveoli
- d. To describe the elastic properties of the chest wall and to plot pressure and flow-volume relationships of the lung, chest wall and the total respiratory system
- e. To describe the properties, production and regulation of surfactant and relate these to its role in influencing respiratory mechanics
- f. To explain the significance of the vertical gradient of pleural pressure and the effect of positioning
- g. To explain the physics of gas flow and the significance of the relationship between resistance and flow in the respiratory tract
- h. To describe the factors affecting airway resistance, and how airway resistance may be measured
- i. To define closing capacity and its relationship to airway closure and explain its clinical significance and measurement
- j. To describe the work of breathing and its components
- k. To describe altered lung mechanics in common disease states.

B1e PULMONARY GAS VOLUMES AND VENTILATION**1. General Instructional Objectives**

An understanding of lung volumes and capacities and the application of this knowledge to normal and diseased respiratory states

2. Required Abilities

- a. To explain the measurement of lung volumes and capacities, and to indicate the normal values
- b. To describe the factors influencing lung volumes and capacities
- c. To define dead space and its components, and explain how these may be measured.

B1f DIFFUSIVE TRANSFER OF RESPIRATORY GASES**1. General Instructional Objectives**

An understanding of the laws of diffusion and their application to capillary exchange of oxygen and carbon dioxide in the lung

2. Required Abilities

- a. To describe and explain the oxygen cascade

- b. To explain the capillary exchange of oxygen and carbon dioxide, and the relationship of erythrocyte transit to oxygen and carbon dioxide transfer
- c. To explain perfusion-limited and diffusion-limited transfer of gases
- d. To define diffusing capacity and its measurement
- e. To describe the physiological factors that alter diffusing capacity

B1g VENTILATION-PERFUSION RELATIONSHIPS

1. General Instructional Objectives

An understanding of the normal matching of ventilation and perfusion, the mechanisms causing ventilation-perfusion inequality and an appreciation of its clinical significance

2. Required Abilities

- a. To describe West's zones of the lung and explain the mechanisms responsible for them
- b. To explain the shunt equation and the alveolar gas equation
- c. To explain normal ventilation-perfusion matching, including the mechanisms for these as well as the normal values
- d. To describe and explain regional ventilation-perfusion inequalities, their clinical importance, and changes with posture
- e. To outline the methods used to measure ventilation-perfusion inequalities
- f. To explain venous admixture and its relationship to shunt and ventilation-perfusion (V/Q) mismatch.
- g. To explain the effect of ventilation-perfusion inequality on oxygen transfer and carbon dioxide elimination

B1h GAS TRANSPORT IN THE BLOOD

1. General Instructional Objectives

An understanding of the principles involved in transport of oxygen and carbon dioxide in blood and their applications in clinical practice

2. Required Abilities

- a. To describe the carriage of oxygen in blood
- b. To explain the oxyhaemoglobin dissociation curve and factors that may alter it
- c. To describe the carbon dioxide carriage in blood including the Haldane effect, and the chloride shift
- d. To explain the carbon dioxide dissociation curve and its clinical implications
- e. To describe the oxygen and carbon dioxide stores in the body

B1i PULMONARY CIRCULATION

1. General Instructional Objectives

An understanding of the special features of the pulmonary circulation and their relevance in clinical practice

2. Required Abilities

- a. To describe the physiological features of the pulmonary circulation and compare them with those of the systemic circulation

- b. To explain the factors that affect pulmonary vascular resistance
- c. To describe the circulatory effects of increased pulmonary vascular resistance

B1j CLINICAL PULMONARY FUNCTION TESTS

1. General Instructional Objectives

An understanding of respiratory function tests that are routinely performed in a respiratory function laboratory and an ability to interpret the results

2. Required Abilities

- a. To distinguish between obstructive and restrictive lung disorders using the family of curves measuring respiratory volumes and flow rates
- b. To outline methods used for measuring mechanics of breathing, including flow-volume loops, and to interpret such results
- c. To describe the carbon dioxide and oxygen response curves and how these may be used to assess the control of breathing
- d. To interpret and explain normal and abnormal blood gases
- e. To outline the measurement of lung volumes including functional residual capacity and residual volume
- f. To understand measures of lung diffusing capacity

B1k APPLIED RESPIRATORY PHYSIOLOGY

1. General Instructional Objectives

The use of knowledge of basic respiratory physiology to understand applied aspects that are encountered in clinical practice

2. Required Abilities

- a. To describe the physiological consequences of intermittent positive pressure ventilation and positive end-expiratory pressure
- b. To explain the physiological effects of hypoxaemia, hyper and hypocapnia, and carbon monoxide poisoning
- c. To explain the effects of a change in posture on ventilatory function
- d. To define humidity and give an outline of the importance of humidification
- e. To explain the pathways and importance of the cough reflex
- f. To explain the effects of pregnancy on ventilatory function
- g. To explain the ventilatory changes accompanying the process of ageing
- h. To outline the non-ventilatory functions of the lungs
- i. To outline the effects of different physical environments on respiratory function

B2: RESPIRATORY PHARMACOLOGY**B2a RESPIRATORY PHARMACOLOGY AND THERAPEUTIC GASES****1. General Instructional Objectives**

An understanding of the pharmacological management of asthma and pulmonary hypertension. An understanding of the pharmacology of oxygen, helium and nitric oxide and their clinical applications.

2. Required Abilities

- a. To describe the pharmacology of anti-asthma drugs with particular reference to beta 2 agonists, corticosteroids, anticholinergics, leukotriene antagonists and theophylline
- b. To outline the pharmacology of drugs used to treat pulmonary hypertension
- c. To describe the pharmacology of oxygen
- d. To describe the pharmacology of nitric oxide with particular reference to its inhaled use
- e. To describe the pharmacology of prostacycline with particular reference to its inhaled use
- f. To describe the pharmacology of surfactant with particular reference to its inhaled use

SECTION C CARDIOVASCULAR SYSTEM

C1: CARDIOVASCULAR PHYSIOLOGY

C1a STRUCTURE AND FUNCTION OF THE HEART

1. General Instructional Objectives

An understanding of the functional anatomy of the heart and its relationship to cardiac function

2. Required Abilities

- a. To describe the structure and functional significance of the excitatory, conductive and contractile elements of the heart
- b. To describe the anatomy of the heart and pericardium
- c. To describe the normal pressure and flow patterns (including velocity profiles) of the cardiac cycle

C1b ELECTRICAL PROPERTIES OF THE HEART

1. General Instructional Objectives

An understanding of the basis of electrical activity of cardiac muscle and its relationship to basic mechanical events

2. Required Abilities

- a. To explain the ionic basis of spontaneous electrical activity of cardiac muscle cells (automaticity)
- b. To describe the normal and abnormal processes of cardiac excitation
- c. To explain the physiological basis of the electrocardiograph in normal and common pathological states
- d. To describe the factors that may influence cardiac electrical activity
- e. To describe and explain the mechanical events of the cardiac cycle and correlate this with physical, electrical and ionic events

C1c DETERMINANTS AND CONTROL OF CARDIAC OUTPUT

1. General Instructional Objectives

An understanding of the factors that determine cardiac output and its control and the application of this knowledge to clinical practice

2. Required Abilities

- a. To explain the Frank-Starling mechanism and its relationship to excitation-contraction coupling
- b. To define preload, afterload and myocardial contractility
- c. To describe the factors that determine preload, afterload and myocardial contractility
- d. To describe myocardial oxygen demand and supply, and the conditions that may alter each
- e. To describe and explain cardiac output curves, vascular function curves and their correlation
- f. To describe the pressure-volume relationships of the ventricles and their clinical applications

- g. To integrate the factors that determine cardiac output

C1d THE PERIPHERAL VASCULAR SYSTEM

1. General Instructional Objectives

An understanding of the distribution and regulation of blood flow through the various components of the vasculature

2. Required Abilities

- a. To describe the distribution of blood volume and flow in the various regional circulations and to explain the factors that may result in redistribution of blood
- b. To explain the factors that determine systemic blood pressure and its regulation
- c. To describe total peripheral vascular resistance and factors that affect it
- d. To describe the mechanisms involved in local vascular control and autoregulation
- e. To describe the mechanisms involved in maintaining blood flow to individual organs in the presence of changed perfusion pressure (autoregulation)
- f. To describe the essential features of the micro-circulation including fluid exchange (Starling forces) and control mechanisms present in the pre- and post-capillary sphincters
- g. To describe the anatomy relevant to central venous cannulation (including femoral, internal jugular, external jugular and subclavian veins).
- h. To describe the anatomy relevant to the insertion of an arterial line into a brachial, axillary, posterior tibial, dorsalis pedis, radial or femoral artery.

C1e CONTROL OF CIRCULATION

1. General Instructional Objectives

An understanding of cardiovascular responses to physiological and common pathological changes.

2. Required Abilities

- a. To describe the role of the vasomotor centre and the autonomic nervous system in the regulation of cardiac output and venous return
- b. To describe the function of baroreceptors and to relate this knowledge to common clinical situations
- c. To explain the role of the autonomic nervous system in controlling systemic vascular resistance and redistribution of blood volume
- d. To explain the neural and humoral regulation of blood volume and flow
- e. To explain the integrated cardiovascular responses to pregnancy
- f. To explain the integrated cardiovascular responses to central neural blockade

C1f REGIONAL CIRCULATION

1. General Instructional Objectives

An understanding of the special features of regional circulations.

2. Required Abilities

- a. To describe the relationship between organ blood flow and demand, and the role of autoregulation

- b. To describe the features of the coronary circulation and to explain the clinical significance of these
- c. To describe the cerebral circulation, autoregulation in the cerebral circulation and the factors that may affect it
- d. To describe the renal circulation and to explain its significance in maintaining renal function
- e. To describe the hepatic and splanchnic circulation
- f. To describe utero-placental circulation

C1g APPLIED ASPECTS OF CVS PHYSIOLOGY

1. General Instructional Objectives

An understanding of the cardiovascular responses to common conditions in health and disease

2. Required Abilities

- a. To describe the responses to changes in posture
- b. To account for the cardiovascular changes seen in haemorrhage and hypovolaemia
- c. To explain the cardiovascular effects and responses in different forms of shock
- d. To explain the cardiovascular responses accompanying pregnancy, birth, ageing, cardiac failure, and during intermittent positive pressure ventilation, positive end-expiratory pressure, and the Valsalva manoeuvre.
- e. To describe the factors that affect mixed venous oxygen saturation

C1h MEASUREMENT OF CVS FUNCTION

1. General Instructional Objectives

An understanding of the physics and the application of the principles involved in the measurement of blood flow and pressures within the circulation.

2. Required Abilities

- a. To outline the physics of blood flow
- b. To give a detailed account of the various methods of measuring blood pressure
- c. To explain the various methods of measuring cardiac output as well as their limitations
- d. To outline methods and principles used to measure regional blood flow

C2: CARDIOVASCULAR PHARMACOLOGY

C2a ADRENOCEPTOR BLOCKING AGENTS

1. General Instructional Objectives

An understanding of the physiological consequences of alpha and beta receptor blocking agents as well as their detailed pharmacology

2. Required Abilities

- a. To explain mechanisms and physiological consequences of alpha 1, alpha 2, beta 1 and beta 2 receptor blockade
- b. To classify alpha and beta receptor blocking agents according to their pharmacokinetic and pharmacodynamic properties

- c. To describe the pharmacology of alpha receptor blocking agents and apply this to their clinical use
- d. To describe the pharmacology of beta blockers with particular reference to propranolol, atenolol, metoprolol, esmolol, carvedilol, sotalol and labetalol

C2b ANTI-HYPERTENSIVE DRUGS

1. General Instructional Objectives

An understanding of the pharmacology of anti-hypertensive agents and the clinical application of this knowledge

2. Required Abilities

- a. To classify the mechanisms of action of the anti-hypertensive agents
- b. To describe the pharmacology of centrally acting agents such as clonidine and alpha-methyl dopa
- c. To describe the physiology and pharmacology of the vascular endothelium and smooth muscle with particular reference to nitric oxide
- d. To describe the pharmacology of calcium antagonists with reference to the management of hypertension
- e. To describe in detail the pharmacodynamics and pharmacokinetics of sodium nitroprusside and glyceryl trinitrate including their adverse effects
- f. To describe the pharmacology of the ACE inhibitors and angiotensin receptor antagonists with reference to the management of hypertension
- g. To outline the pharmacology of hydrallazine and the potassium channel activators (nicorandil and minoxidil)

C2c ANTI-ARRHYTHMIC DRUGS

1. General Instructional Objectives

An understanding of the physiological and pharmacological basis of antiarrhythmic therapy. An understanding of the pharmacology of antiarrhythmic agents and their clinical applications.

2. Required Abilities

- a. To classify antiarrhythmic agents by their electro-physiological activity and mechanisms of action
- b. To describe the pharmacology, with particular reference to the antiarrhythmic properties, of:
 - the sodium channel blocking agents (e.g. lignocaine and flecainide)
 - the beta blockers
 - amiodarone, sotalol and ibutilide
 - the calcium antagonists
 - digoxin
 - adenosine
 - magnesium

- c. To describe the adverse effects of the anti-arrhythmic agents with particular reference to the potential pro-arrhythmic properties

C2d INOTROPES & VASOPRESSORS

1. General Instructional Objectives

An understanding of the pathophysiology and therapy of shock (including low output states)

2. Required Abilities

- a. To describe the pharmacology of the following agents with reference to their use in the treatment of shock (including low cardiac output states):
- Adrenaline
 - Noradrenaline
 - Vasopressin
 - Dobutamine
 - Dopamine
 - Isoprenaline
 - phosphodiesterase III inhibitors (e.g. milrinone)
 - calcium sensitizers (e.g. levosimendan)

SECTION D RENAL SYSTEM**D1: RENAL PHYSIOLOGY****1. General Instructional Objectives**

An understanding of the function of the kidneys and their control, including changes that occur in clinical practice.

2. Required Abilities

- a. To describe the functional anatomy of the kidneys and to explain the physiology of renal blood flow
- b. To describe glomerular filtration and tubular function
- c. To explain the counter-current mechanisms in the kidney
- d. To outline the endocrine functions of the kidney
- e. To describe the role of the kidneys in the maintenance of acid/base balance
- f. To describe the role of the kidneys in the maintenance of fluid and electrolyte balance
- g. To describe the role of the kidneys in the maintenance of osmolality
- h. To describe the role of the kidney in the handling of glucose, nitrogenous products and drugs
- i. To describe the principles of measurement of glomerular filtration rate and renal blood flow
- j. To describe the physiological effects and clinical assessment of renal dysfunction
- k. To explain the renal responses to hypovolaemia and shock

D2: RENAL PHARMACOLOGY**D2a DIURETICS****1. General Instructional Objectives**

An understanding of diuretics and their clinical implications.

2. Required Abilities

- a. To outline a physiological basis of classifying diuretics related to their site of action
- b. To describe the pharmacology of mannitol, loop diuretics, thiazides, aldosterone antagonists, other potassium-sparing diuretics and carbonic anhydrase inhibitors

SECTION E BODY FLUIDS AND ELECTROLYTES**E1: PHYSIOLOGY OF BODY FLUIDS AND ELECTROLYTES****1. General Instructional Objectives**

An understanding of the basics of body fluids and electrolyte physiology and their application in health and disease.

2. Required Abilities

- a. To explain the distribution of body fluids and their measurement
- b. To describe the function, distribution and physiological importance of sodium, potassium, magnesium, calcium and phosphate ions
- c. To outline the composition and functions of lymph
- d. To define osmotic pressure and to explain the factors that determine it
- e. To outline the significance of oncotic pressure, colloid osmotic pressure and reflection coefficients
- f. To describe the measurement of osmolality and the control mechanisms involving the regulation of osmolality

E2: PHARMACOLOGY RELATED TO BODY FLUIDS AND ELECTROLYTES**E2a INTRAVENOUS FLUIDS****1. General Instructional Objectives**

An understanding of the physiological basis of the use of colloids and crystalloids as intravenous fluids

2. Required Abilities

To describe, the pharmacology (including composition and osmolality) of crystalloids (including hypertonic fluids, and fluids used during renal replacement) and colloids (such as albumin, gelatin derivatives, polysaccharide derivatives and starch solutions) used in clinical practice

SECTION F ACID BASE PHYSIOLOGY**1. General Instructional Objectives**

An understanding of the chemistry and physiology of acid-base balance in the body and the application of this knowledge to clinical situations.

2. Required Abilities

- a. To explain and describe the principles underlying acid-base chemistry including the Gibbs-Donnan effect and the physical chemical approach (Stewart approach)
- b. To describe the chemistry of buffer mechanisms and to explain their relevant roles in the body
- c. To describe the regulation of acid-base balance
- d. To explain the principles of blood gas and acid-base analysis

SECTION G NERVOUS SYSTEM (including PAIN)

G1: PHYSIOLOGY OF THE NERVOUS SYSTEM

1. General Instructional Objectives

An understanding of basic neurophysiology and its application to clinical practice

2. Required Abilities

- a. To explain the basic electro-physiology of neural tissue
 - Resting membrane potential
 - Conduction of nervous impulses
 - Action potentials
 - Excitatory and inhibitory post-synaptic potentials
 - Synaptic function
- b. To describe the major sensory and motor pathways
- c. To describe the physiology of pain with respect to the mediators, pathways and reflexes. (see also section in Pharmacology section)
- d. To describe the physiology of cerebrospinal fluid
- e. To describe the autonomic nervous system and to explain its role in controlling body function
- f. To describe the major neurotransmitters and their physiological role
- g. To explain the physiology of the control of intra-cranial pressure
- h. To describe the physiology of sleep
- i. To outline the basis of the electroencephalogram, evoked potentials and nerve conduction studies
- j. To describe the anatomy relevant to the performance of a lumbar puncture and insertion of an epidural catheter

G2: PHARMACOLOGY RELATED TO THE NERVOUS SYSTEM

G2a INTRAVENOUS ANAESTHETIC AGENTS

1. General Instructional Objective

An understanding of the pharmacology of the intravenous anaesthetic agents and the clinical application of this knowledge to Intensive Care practice.

An understanding of the pharmacological differences between these agents and the clinical importance of these differences.

2. Required Abilities

- a. To describe the formulations of thiopentone, propofol, midazolam and ketamine
- b. To describe the central nervous system effects and proposed mechanisms of action of the intravenous anaesthetic agents
- c. To describe the pharmacokinetics of the intravenous anaesthetic agents. To compare the pharmacokinetics and the clinical implications of these differences
- d. To describe the factors which affect recovery from intravenous anaesthesia.

- e. To describe the pharmacodynamics of propofol, thiopentone, midazolam, and ketamine. Provide a detailed account of the cardiovascular and respiratory effects of these agents
- f. To describe the adverse effects of individual agents
- g. To outline how physiological and pathological disturbance can alter the pharmacology of the intravenous anaesthetic agents

G2b LOCAL ANAESTHETIC AGENTS

1. General Instructional Objectives

An understanding of the pharmacology of the local anaesthetic agents and the clinical application of this knowledge. An understanding of the pharmacological differences between these agents and the clinical importance of these differences.

2. Required Abilities

- a. To explain the factors that determine the clinical effects of local anaesthetic drugs
- b. To compare the pharmacology of the local anaesthetics with particular reference to lignocaine, bupivacaine, levobupivacaine, and ropivacaine,
- c. To describe local anaesthetic toxicity. To describe its prevention and management

G2c PAIN

1. General Instructional Objectives

An understanding of the basic physiological mechanisms involved in peripheral nociception, conduction, spinal cord modulation and central processing of pain. An understanding of the pharmacological agents used to provide acute pain relief.

2. Required Abilities

- a. To define pain
- b. To describe pain pathways and mediators involved in nociception. To describe peripheral and central sensitization, gate control theory, preemptive and preventive analgesia
- c. To describe the pharmacology as pertaining to pain management of:
 - opioids
 - tramadol
 - local anaesthetic agents
 - NSAIDs
 - COX II inhibitors
 - paracetamol
 - anticonvulsants
 - antidepressants
- d. To describe the different modes of administration of analgesic agents and evaluate their clinical applications

G2d OPIOID AGONISTS AND ANTAGONISTS**1. General Instructional Objectives**

An understanding of the pharmacology of the opioid agents and the clinical application of this knowledge. An understanding of the pharmacological differences between these agents and their clinical implications.

2. Required Abilities

- a. To describe opioid receptors
- b. To describe the mechanisms of action of opioids
- c. To describe the pharmacokinetics of different routes of administration and the clinical implications with reference to intravenous, oral, subcutaneous, intramuscular, transdermal and patient controlled administration
- d. To describe the pharmacokinetics of intravenous opioids and their clinical applications with particular reference to morphine, pethidine and fentanylalfentanil and remifentanil
- e. To describe the pharmacology of opioids deposited in the epidural space or cerebrospinal fluid
- f. To provide a detailed account of the pharmacodynamics of individual opioids and their clinical applications with particular reference to morphine, pethidine, fentanyl, codeine, methadone and oxycodone
- g. To describe the adverse effects of opioids. To describe the prevention and management of these adverse effects
- h. To describe the potential adverse drug interactions between opioids and other agents
- i. To describe the pharmacology of the opioid antagonist naloxone

G2e NON-STEROIDAL ANTI-INFLAMMATORY DRUGS**1. General Instructional Objective**

An understanding of the role of the prostaglandin pathway in the production of pain and the modulation of this pathway to provide pain relief.

2. Required Abilities

- a. To describe the eicosanoid pathway and the physiological role of prostaglandins
- b. To classify the non-steroidal anti-inflammatory drugs
- c. To describe the pharmacology of paracetamol and its toxicity
- d. To describe the pharmacology of aspirin and its adverse effects
- e. To outline the pharmacology of the other non-steroidal anti-inflammatory drugs (including COX inhibitors) and their adverse effects.

G2f NEUROPHARMACOLOGY**1. General Instructional Objectives**

An understanding of the pharmacology of neurotransmitters and their receptors.
An understanding of the pharmacology of anxiolytic, hypnotic, anti-depressant, anti-psychotic, anti-convulsant and anti-parkinsonian medication.

2. Required Abilities

- a. To describe the physiology and pharmacology of neurotransmitters and their receptors with particular reference to GABA, excitatory amino acids, acetylcholine, noradrenaline, dopamine and serotonin
- b. To describe the pharmacology of sedative/anxiolytic/hypnotic agents with particular reference to benzodiazepines, barbiturates and alpha-2 agonists (eg. dexmedetomidine)
- c. To describe the comparative pharmacology of the benzodiazepines with particular reference to midazolam, diazepam, lorazepam and their antagonist flumazenil
- d. To outline the pharmacology of the antidepressant medications and their adverse effects.
- e. To outline the pharmacology of antipsychotic medication
- f. To outline the mechanisms of action and pharmacology of the anticonvulsants drugs
- g. To outline the pharmacology of the antiparkinsonian drugs

G3 AUTONOMIC NERVOUS SYSTEM**G3a PHYSIOLOGY AND PHARMACOLOGY OF THE AUTONOMIC NERVOUS SYSTEM****1. General Instructional Objectives**

An understanding of the physiology and pharmacology of the autonomic nervous system.
An understanding of the clinical application of this knowledge.

2. Required Abilities

- a. To describe the physiological roles of the sympathetic and parasympathetic nervous systems
- b. To describe the physiological actions of adrenergic, cholinergic, and dopaminergic receptors including the subtypes and their cellular effects
- c. To describe the synthesis, fate and release of adrenergic and cholinergic transmitters and their end products
- d. To describe the structure activity relationships of adrenergic and cholinergic agents
- e. To compare and contrast the mechanism of action and effects of sympathomimetic and cholinomimetic agents used clinically
- f. To describe pharmacology of the alpha 1, alpha 2, beta 1 and beta 2 adrenergic agonists and their clinical applications
- g. To describe clinically important drug interactions with the autonomic nervous system

G3b ANTICHOLINERGIC DRUGS**1. General Instructional Objectives**

An understanding of the pharmacology of the anticholinergic drugs and their clinical applications

2. Required Abilities

- a. To describe the pharmacology of acetylcholine and the muscarinic and nicotinic receptors
- b. To compare and contrast the pharmacodynamics and pharmacokinetics of atropine and glycopyrrolate

SECTION H MUSCULOSKELETAL SYSTEM

H1: MUSCULOSKELETAL SYSTEM PHYSIOLOGY

1. General Instructional Objectives

An understanding of the physiology of striated and non-striated muscle and how structure and function are related. An understanding of the structure and function of the neuromuscular junction.

2. Required Abilities

- a. To describe the comparative anatomy and physiology of skeletal, smooth, and cardiac muscle
- b. To describe the physiology of the neuromuscular junction and its receptors
- c. To describe the mechanism of excitation-contraction coupling
- d. To explain the concept of motor units
- e. To describe the monosynaptic stretch reflex
- f. To define single twitch, tetanus and Treppe effect, and explain their physiological basis
- g. To describe the relationship between muscle length and tension
- h. To understand the concept of muscle fatigue

H2: MUSCULOSKELETAL SYSTEM PHARMACOLOGY

H2a NEUROMUSCULAR BLOCKING AGENTS

1. General Instructional Objectives

An understanding of the pharmacology of neuromuscular blocking agents and the clinical application of this knowledge. An understanding of the pharmacological differences between these agents and the clinical importance of these differences.

2. Required Abilities

- a. To explain the physiology of neuromuscular transmission and how this may be interfered with to produce muscle relaxation
- b. To describe and evaluate different methods of monitoring the neuromuscular junction
- c. To describe the pharmacology of depolarizing (suxamethonium) and non-depolarising agents (with particular reference to cisatracurium and vecuronium) and factors that may modify their actions in the critically ill

H2b ANTICHOLINESTERASE DRUGS

1. General Instructional Objectives

An understanding of the pharmacology of anticholinesterase drugs and their clinical applications.

2. Required Abilities

- a. To classify the anti-cholinesterase drugs in relation to mechanism of action
- b. To compare and contrast the pharmacodynamics and pharmacokinetics of neostigmine, edrophonium, and pyridostigmine
- c. To describe the adverse effects of anticholinesterase agents

SECTION I LIVER PHYSIOLOGY**1. General Instructional Objectives**

An understanding of hepatic function and the changes that are relevant to intensive care.

2. Required Abilities

- a. To describe the storage, synthetic, metabolic and excretory functions of the liver and to identify the physiological consequences of hepatic disease
- b. To describe the laboratory assessment of liver function and hepatic failure
- c. To describe the formation, composition of bile and the handling of bilirubin in the body
- d. To describe the anatomical and physiological considerations in hepatic blood flow
- e. To outline the reticulo-endothelial functions of the liver
- f. To explain the protective function of the liver between the gut and the body
- g. To describe the portal circulation and its significance

SECTION J HAEMATOLOGICAL SYSTEM

J1: PHYSIOLOGY OF HAEMATOLOGICAL SYSTEM

1. General Instructional Objectives

An understanding of the normal physiology of blood and its constituents. An understanding of the mechanisms of haemostasis and coagulation relevant to anaesthesia, surgery and intensive care.

2. Required Abilities

- a. To explain the origin and importance of blood groups
- b. To outline the constituents and functions of plasma
- c. To describe the processes involved in haemostasis and coagulation
- d. To describe the normal mechanisms of preventing thrombosis including endothelial factors and natural anticoagulants
- e. To describe fibrinolysis and its regulation
- f. To outline the methods for assessing coagulation, platelet function and fibrinolysis
- g. To explain the physiological consequences of acute and chronic anaemia
- h. To outline the production of blood constituents including red blood cells, haemoglobin, plasma proteins, white blood cells and platelets
- i. To describe abnormal haemoglobins and their clinical significance

J2: PHARMACOLOGY OF HAEMATOLOGICAL SYSTEM

J2a DRUGS AND COAGULATION

1. General Instructional Objectives

An understanding of the physiological basis of clotting and thrombolysis and the application of this knowledge to the pharmacology of coagulation factor replacement, anti-coagulants, anti-platelet drugs, thrombolytic agents and anti-fibrinolytic agents.

2. Required Abilities

- a. To describe the pharmacology of heparin and low molecular weight heparins
- b. To describe the pharmacology of protamine
- c. To describe the pharmacology of warfarin
- d. To classify and describe the pharmacology of anti-platelet drugs
- e. To describe the fibrinolytic pathway and outline the pharmacology of the thrombolytic agents
- f. To outline the pharmacology of antifibrinolytic agents such as epsilon aminocaproic acid, tranexamic acid and aprotinin
- g. To describe the pharmacology of heparin alternatives/analogues with particular reference to direct thrombin inhibitors h. To describe the pharmacology of activated protein C, and activated factor VII.
- i. To describe the pharmacology of blood products

SECTION K NUTRITION & METABOLISM**1. General Instructional Objectives**

An understanding of metabolic physiology, the nutritional requirement of critically ill patients, and the means available for the provision of nutrition.

2. Required Abilities

- a. To define basal metabolic rate
- b. To describe the factors that influence metabolic rate, and to describe its measurement
- c. To describe relevant, cellular biochemical pathways and the control of fat, carbohydrate and protein metabolism, including the role of vitamins and trace elements
- d. To explain the physiological principles of nutrition
- e. To describe the consequences of anaerobic metabolism
- f. To describe the physiological consequences of starvation
- g. To describe the relevant biochemical pathways for lactate and ketone production and metabolism

SECTION L THERMOREGULATION**1. General Instructional Objectives**

An understanding of the significance of temperature control, and the physiological mechanisms controlling and regulating body temperature. An understanding also of the differences between physiological processes available to neonates as compared with adults.

2. Required Abilities

- a. To outline the mechanisms for heat transfer between the body and its environment
- b. To describe the mechanisms by which heat is produced by the body
- c. To describe the physiological mechanisms by which a normal body temperature is maintained
- d. To define thermoneutral zone, and describe the energy requirements for maintaining normal body temperature
- e. To understand the physiological response to and consequences of hypo- and hyperthermia

SECTION M IMMUNOLOGY & HOST DEFENCE

M1: PHYSIOLOGY OF IMMUNOLOGY & HOST DEFENCE

1. General Instructional Objectives

An understanding of basic immunological principles and their application to intensive care.
An understanding of basic pathological principles and their application to intensive care.

2. Required Abilities

- a. To explain how the body defends against infection
- b. To describe the pathological basis of inflammation, and relevant factors in the intensive care unit which can limit or augment this.
- c. To outline the role of important pro- and anti-inflammatory mediators in the inflammatory cascade
- d. To describe the principles of wound healing and tissue repair (including bone)
- e. To describe the process and significance of apoptosis
- f. To identify effects of critical illness on immune function
- g. To explain the immunological basis and pathophysiological effects of hypersensitivity
- h. To describe the roles of complement
- i. To describe passive and active immunity
- j. To outline the mechanisms of rejection of allogeneic organs and to understand the principles of tissue typing
- k. To outline the principles of isolation and universal precautions

M2: PHARMACOLOGY RELATED TO IMMUNOLOGY & HOST DEFENCE

M2a ANTI-MICROBIAL & CHEMOTHERAPEUTIC AGENTS

1. General Instructional Objectives

An understanding of basic microbiological principles and their application to intensive care.
An understanding of the general principles of treating infections and the pharmacology of specific antimicrobials.
An understanding of the principles of cancer chemotherapy and potential adverse effects.

2. Required Abilities

- a. To describe the features of various categories of micro-organisms, including viruses, bacteria, protozoa and fungi.
- b. To outline the way bacteria are classified (including gram positive versus gram negative, and aerobic versus anaerobic).
- c. To outline the principles of anti-microbial resistance, and the factors that influence this
- d. To outline the pharmacology of antimicrobial drugs commonly used in Intensive Care (including anti-bacterials, anti-virals, anti-fungals, and anti-protozoals)
- e. To explain the principles of antibiotic prophylaxis
- f. To outline the pharmacology of antiseptics and disinfectants
- g. To outline the pharmacology of cancer chemotherapeutic agents with particular reference to problems in the intensive care setting.

M3: PHYSIOLOGY AND PHARMACOLOGY OF HISTAMINE AND SEROTONIN

1. General Instructional Objectives

An understanding of the pharmacology of histamine, serotonin and the agents acting at these receptors.

2. Required Abilities

- a. To describe the roles of histamine and serotonin receptor subtypes
- b. To outline the pharmacology of histamine and serotonin antagonists

SECTION N ENDOCRINE SYSTEM

N1: ENDOCRINE PHYSIOLOGY

1. General Instructional Objectives

An understanding of the physiological effects of hormones and the derangements that result from dysfunction, including the various mechanisms by which hormones affect target cells.

2. Required Abilities

- a. To describe the actions of pancreatic hormones and the control of their secretion
- b. To explain the control of blood glucose levels
- c. To describe the role of the hypothalamus in the integration of neuro-humoral responses
- d. To describe the control of secretion and the functions of pituitary hormones
- e. To describe the synthesis and functions of thyroid and parathyroid hormones and how their secretion is regulated
- f. To describe the control of secretion and the functions of adreno-cortical hormones
- g. To describe the control of secretion and the functions of adrenal medullary hormones
- h. To describe the control of secretion and the functions of renin and angiotension
- i. To describe the regulation of plasma calcium including the actions and control of vitamin D, parathormone and calcitonin
- j. To describe the role of prostaglandins and other autocooids
- k. To describe control of secretion and the functions of natriuretic peptides
- l. To describe the multi-system response to stress (with particular reference to sepsis burns and trauma)

N2: ENDOCRINE PHARMACOLOGY

1. General Instructional Objectives

An understanding of the physiological and pharmacological basis of drugs used in endocrine disorders.

2. Required Abilities

- a. To describe the pharmacology of oral hypoglycaemic agents and insulin preparations and their use
- b. To outline the pharmacology of thyroid hormones and anti-thyroid drugs
- c. To describe the pharmacology of glucocorticoids, mineralocorticoids and sex hormones,
- d. To describe the pharmacology of drugs which act on the hypothalamic/pituitary/adrenal axis.
- e. To outline the pharmacology of glucagon
- f. To describe the pharmacology of vasopressin and its analogues

SECTION O OBSTETRICS

O1: MATERNAL (OBSTETRIC) PHYSIOLOGY

1. General Instructional Objectives

An understanding of the physiological changes occurring during pregnancy and the application of this understanding to the management of the pregnant patient.

2. Required Abilities

- a. To explain the cardiovascular and respiratory changes during pregnancy
- b. To explain the consequences of the supine posture during pregnancy
- c. To outline the functions of the placenta, and factors influencing its blood flow
- d. To describe the transfer of gases between mother and fetus including the double Bohr and Haldane effects
- e. To describe the endocrine changes that occur during pregnancy
- f. To describe the haematological changes with pregnancy

O2: MATERNAL (OBSTETRIC) PHARMACOLOGY

1. General Instructional Objectives

An understanding of the physiological changes in pregnancy and their pharmacological implications

An understanding of the pharmacology of drugs used in pregnancy.

2. Required Abilities

- a. To relate the changes in pharmacokinetics and pharmacodynamics to the physiological consequences of pregnancy
- b. To describe the pharmacology of oxytocic agents with special reference to oxytocin derivatives, ergot derivatives and prostaglandins
- c. To describe the pharmacology of tocolytic agents with particular reference to beta 2 agonists, calcium antagonists, magnesium, nitrates and NSAIDS
- d. To explain the factors which influence the transfer of drugs across the placenta to the fetus
- e. To outline the potential effects on the fetus and neonate of drugs administered during pregnancy
- f. To outline the potential effects on the neonate of drug administration in association with lactation

SECTION P FETAL AND NEONATAL PHYSIOLOGY**1. General Instructional Objectives**

An understanding of fetal and neonatal physiology and the application of these to clinical practice.

2. Required Abilities

- a. To describe the fetal circulation
- b. To describe the circulatory and respiratory changes that occur at birth
- c. To explain temperature regulation in the neonate and how this differs from the adult
- d. To compare the physiological differences in organ function between the neonate and the adult
- e. To describe the anatomical differences between the fetal, paediatric and adult airway

SECTION Q GASTROINTESTINAL SYSTEM**Q1: GASTROINTESTINAL PHYSIOLOGY****1. General Instructional Objectives**

An understanding of basic gastrointestinal physiology and the application of this to the critically ill patient.

2. Required Abilities

- a. To outline the autonomic and hormonal regulation of secretion from the gut
- b. To outline the composition and volumes of secretions from the alimentary tract including saliva, gastric fluid, bile and intestinal fluid
- c. To outline basic aspects of fat, protein, and carbohydrate digestion and absorption
- d. To describe the control of gastric motility and emptying
- e. To describe the physiology of swallowing and vomiting
- f. To explain the factors preventing reflux of gastric contents into the oesophagus

Q2: GASTROINTESTINAL PHARMACOLOGY**Q2a GENERAL GASTROINTESTINAL PHARMACOLOGY****1. General Instructional Objectives**

An understanding of gastrointestinal physiology and its pharmacological manipulation.

2. Required Abilities

- a. To describe the pharmacology of prokinetic drugs
- b. To describe the pharmacology of the proton pump inhibitors
- c. To outline the pharmacology of misoprostol and sucralfate
- d. To describe the pharmacology of the octreotide
- e. To describe the pharmacology of lactulose and laxatives in general

Q2b ANTI-EMETIC DRUGS**1. General Instructional Objectives**

An understanding of the pharmacological basis of anti-emetic drugs.

2. Required Abilities

To describe the pharmacodynamics and pharmacokinetics of the anti-emetic drugs: dopamine antagonists, anti-cholinergic agents, serotonin antagonists, anti-histamines and steroids.

SECTION R PRINCIPLES OF MEASUREMENT**1. General Instructional Objectives**

An understanding of the physics involved in the measurement of relevant variables.

2. Required Abilities

- a. To explain mathematical concepts such as exponential functions, integration and differentiation
- b. To explain electrical concepts such as current, potential difference, resistance, impedance, inductance and capacitance as they relate to biomedical apparatus
- c. To describe the laws governing the behaviour of gases and liquids
- d. To describe the principles of measurement employed by apparatus in clinical use, including transducers, and to describe their calibration
- e. To describe the measurement of flow, pressure and velocity of fluids
- f. To describe the basic principles of ultrasound and the Doppler effect
- g. To describe the different methods of measurement of oxygen and CO₂ tension in blood

SECTION S CLINICAL MONITORING

1. General Instructional Objectives

An understanding of the principles of monitoring in clinical practice including the evaluation of the accuracy, reliability, convenience and hazards of methods of monitoring.

2. Required Abilities

- a. To describe in detail the measurement the electrocardiogram including calibration, sources of errors and limitations
- b. To describe and to compare the methods of measuring blood pressure
- c. To describe and to compare the methods of measuring cardiac output
- d. To describe and to compare the methods of measuring temperature
- e. To describe and to compare the methods of measuring humidity
- f. To explain in detail the principles of pulse oximetry including calibration, sources of errors and limitations
- g. To explain in detail the principles of capnography including calibration, sources of errors and limitations
- h. To explain the principles of analysis of other gases relevant to intensive care (e.g. O₂, NO).
- i. To describe and to compare the methods of measuring gas flow
- j. To explain the principles involved in the electronic monitoring of depth of sedation, including the use of EEG analysis

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