COLLEGE OF INTENSIVE CARE MEDICINE
OF AUSTRALIA AND NEW ZEALAND

REPORT OF THE FIRST PART EXAMINATION

March/May 2025

This report is prepared to provide candidates, educators and supervisors of training with information about the First Part examination. The report acts as a guide as to what examiners expected for each question. Unsuccessful candidates should read and then discuss the report with their supervisors to prepare for future exam sittings.

The written component included two 2.5-hour papers, each comprising fifty multi-choice questions and ten short answer questions. The MCQ pass mark was 57.88% and the SAQ pass mark was derived by the Angoff method and was 47.69%. To progress to the oral exam a candidate needed to achieve above the pass mark for both the MCQ and SAQ components of the exam.

The oral component was comprised of eight ten-minute oral examination stations. The pass mark for the oral exam was 56.95%.

OVERALL STATISTICS

Total number of candidates presenting for the written examination: 107
Number of candidates successful in the written component: 61
Number of candidates carrying a written pass: N/A
Total number invited to the oral component: 61
Total number of candidates successful at the CICM First Part Exam: 51

WRITTEN SECTION

EXAMINERS' COMMENTS

Candidates are reminded that all questions are scored equally, hence time should be apportioned accordingly. Candidates are encouraged to attempt all questions.

Candidates are expected to have detailed knowledge and depth of understanding of the syllabus and are strongly encouraged to read widely. Candidates should refer to the Glossary of Terms provided in the exam to determine the depth and breadth required to answer each question. Answers in point form are acceptable and encouraged.

SHORT ANSWER QUESTIONS

Question 1

(a) Define receptors and provide a brief outline of their classification. (20% of marks).

(b) Define the following terms and outline the receptor-drug binding and activation characteristics of each:

- **(i) Agonists (20% of marks).**
- **(ii) Partial agonists (20% of marks).**
- **(ii) Inverse agonists (20% of marks).**
- **(iv) Antagonists (20% of marks).**

33% of candidates passed this question.

The first part of the question required a definition of receptors and outline of their classification. Good answers described receptors as proteins or glycoproteins that are found on cell membranes, on membranes of intracellular organelles or in the cytosol / nucleus and contain a region to which a natural ligand or drug binds specifically (receptor site or recognition site) to bring about a **conformational change** and subsequent response. Receptors can be grouped into 3 classes depending on mechanism of action, altered ion permeability, production of intermediate messengers and regulation of gene transcription. Further descriptions of the different types of receptors/downstream messages were not required.

The second part of the question is well covered in the outlined pharmacology textbooks namely Peck and Hill, Stoelting and Goodman and Gillman's. This is best answered by applying receptor theory: namely that receptors can exist in two states, an active and inactive state. Agonists stabilise the receptor in the active state, partial agonists occupy (and block) the binding site but do not completely favour the active state, whilst inverse agonists stabilise the receptor in the inactive state. Antagonists simply block the binding site and prevent agonists from binding. A description then of affinity and intrinsic activity of each group would complete your answer.

Question 2

(a) Define closing capacity (10% of marks).

(b) With respect to closing capacity, describe the following:

- **(i) the physiological factors that alter it (30% of marks).**
- **(ii) the clinical significance (30% of marks).**
- **(iii) <u>ONE</u> method of measurement (30% of marks).**

34% of candidates passed this question.

(a) The definition of closing capacity was well answered and is relatively straight forward.

(b) (i) The main physiological factor is age (decreases from birth to 16 years and then increases to become higher than FRC in older adults). A discussion of the age at which it typically exceeds FRC in the supine and upright positions attracted marks. A mention of other factors that alter it like high expiratory flow rates and increased expiratory effort made for a comprehensive answer.

(ii) This part of the question required candidates to cover how increases in closing capacity effect VQ mismatch and PaO2 by air-trapping, reduced compliance, cyclical atelectasis (resulting in lung injury), slower de-nitrogenation during pre-oxygenation and increased work of breathing. These changes are pronounced in situations where FRC is also reduced. This was the section most candidates struggled with given the breadth of effects required.

(iii) Techniques used to measure closing capacity are well described in both Nunn's and West's respiratory physiology textbooks. One technique involves taking a vital capacity breath of 100% oxygen and then measuring exhaled nitrogen as the subject exhaled back to the residual volume. The closing capacity is the point at which the nitrogen concentration begins to rise above the alveolar plateau in phase III.

Question 3

(a) Define systemic blood pressure and provide a formula that best describes its determinants (10% of marks).

(b) Describe the factors that determine systemic blood pressure (90% of marks).

30% of candidates passed this question.

(a) A definition of systemic blood pressure is found in most physiology textbooks and describes this as the pressure exerted on the arterial walls in the systemic circulation. It is a product of vascular resistance and blood flow. An expected formula would be: Pa-Pv (arterial venous pressure difference) = QR where Q is blood flow and R is peripheral arterial resistance. An alternative formula of MAP = CO X TPR was also accepted and provided a structure for the second part of the question.

(b) This section required a more detailed discussion of the factors in the equation including determinants of cardiac output, arterial blood volume, arterial elastance and peripheral arterial resistance (based on the Poiseuille equation). Your discussion should include naming the factor and then providing a description of how that factor increases/decreases or contributes to systemic blood pressure relating this to the formula provided in the first part of the question.

Question 4

(a) Define a buffer (10% of marks).

(b) Describe the buffer systems of the body (90% of marks).

69% of candidates passed this question.

(a) A definition of a buffer such as that found in a general physiology textbook such as Power and Kam were required (i.e. "a solution consisting of a weak acid and it's conjugate base which resists a change in pH when a stronger acid or base is added").

(b) The major buffer systems in the body are bicarbonate, haemoglobin, protein, phosphate and ammonia. Full marks were awarded for answers that included a description of each system, their pKa, whether they are 'open' or 'closed' and their relative importance.

Question 5

With respect to the blood brain barrier (BBB), outline the following:

(a) the structure (15% of marks).

(b) its function (25% of marks).

(c) the mechanisms by which substances, including drugs move across the BBB and explain how this is determined or regulated (45% of marks).

(d) the regions that lie outside the BBB and their purpose (15% of marks).

24% of candidates passed this question.

The most effective way to approach this question was to structure information into the headings provided and consider the mark allocation to determine the level of detail for each section. High scoring answers described the unique physical and biochemical features that make up the blood barrier (such as the capillary endothelial cells with tight junctions and numerous mitochondria), and relate these to its barrier and regulation functions. Part (c) required detailed information about the factors affecting permeability across the blood brain barrier and includes transporters and efflux pumps. Answers that provided examples of specific substances and how they move across the blood brain barrier scored best. When responding to the areas outside the blood brain barrier, answers that included not just the area but the rationale similarly scored higher.

Question 6

(a) With respect to red blood cell production, outline the following:

(i) the site (10% of marks).

(ii) the stimuli (5% of marks).

(iii) the process (15% of marks).

(b) With respect to red cell breakdown, outline the following;

(i) the usual lifespan in neonates and adults (10% of marks).

(ii) the process of red cell aging, degradation and clearance (40% of marks).

(iii) the process of haemoglobin breakdown (20% of marks).

72% of candidates passed this question.

The explicit structure and mark allocation provides a guide to answering this question and was applied appropriately in most instances. There were no marks awarded for the structure-function relationship of red cells and this information may reflect awareness of past questions on the topic with a different emphasis. More detailed answers included information such as different site of production in the fetus, duration of time for erythropoesis (7 days), changes in aging red blood cells, and different clearance pathways [haemolysis (10%) and spleen and liver phagocytosis (90%)]. Haemoglobin breakdown in general was well answered and needed to include heme breakdown into iron and biliverdin and a description of the fate of each of these components.

Question 7

(a) List the hormones secreted by the anterior pituitary gland (10% of marks).

(b) For each hormone listed, briefly outline the following:

(i) the effects on their target organs (50% of marks).

(ii) the positive and negative control and/or feedback mechanisms (40% of marks).

60% of candidates passed this question.

The hormones secreted from the anterior pituitary include TSH, ACTH, LH/FSH, prolactin and growth hormone. For each of these, marks were allocated for a list of the effects on target organs and the control. Better answers followed a clear structure that included the hormone, the target organ and immediate effect and the control/feedback. For example, TSH stimulates thyroid hormone (T3/T4) synthesis from the thyroid gland. TSH release is stimulated by TRH from the hypothalamus and inhibited by T3/T4 plasma levels.

Question 8

Describe the anatomy of the femoral vein as it relates to central venous cannulation.

45% of candidates passed this question.

High scoring answers had a good structure utilising the following headings: location; femoral triangle boundaries; relations and contents including the femoral sheath; origin and tributaries; and the important surface anatomy for insertion of a femoral line. Commonly omitted were descriptions of the femoral sheath; the surface anatomy including the ideal puncture site; and anatomical pitfalls. A description of the procedure of central line insertion was not required for this question.

Question 9

Compare and contrast milrinone and dobutamine using the following headings:

(a) Class and indications for use (20% of marks).

(b) Mechanisms of action (20% of marks).

(c) Pharmacodynamics and adverse effects (60% of marks).

66% of candidates passed this question.

High performing answers were structured according to the headings provided and used tables. They emphasised the shared features of milrinone and dobutamine under each heading, but also clearly pointed out the important differences and why they matter. Some candidates were unable to obtain sufficient marks as entire section/s of the answer were omitted. Milrinone & dobutamine are both level one medications in the syllabus and thus a detailed working knowledge of all content asked in the question was expected.

Question 10
With respect to enteral feeds, outline the following;
(a) the dose (10% of marks).
(b) the composition and common ingredients; include in your answer the role of each ingredient, its form and caloric contribution if applicable (75% of marks).
(c) the adverse effects (complications related to feeding tubes are <u>NOT</u> required) (15% of marks).

***Note. Paediatric <u>OR</u> adult descriptions acceptable*.**

62% of candidates passed this question.

(a) The dose of enteral feeds was generally well answered. Marks were awarded for the mention of methods used to estimate energy requirements (such as indirect calorimetry or the Harris-Benedict equation.
(b) The composition of enteral feeds should include the macronutrients (fat, CHO, protein), micronutrients and water and what form they are presented in. The quantities of each constituent and the contribution of each to the daily caloric goal was also required. Mention of alternate formulations such as soy-based feeds or elemental feeds in pancreatic disease scored additional marks.
(c) Adverse effects were well covered and included gastrointestinal, metabolic and long-term consequences. As noted, in the question, marks were not allocated for complications related to feeding tubes.

Question 11
Outline the physiological factors that affect arterial carbon dioxide tension ($PaCO_2$).
(Measurement factors are <u>NOT</u> required.)

39% of candidates passed this question.

This is a broad question that tested the application of knowledge regarding carbon dioxide transport and effect of ventilation on CO_2 content. A structured approach to this question includes a description of how the production, carriage and elimination of CO_2; including normal values where relevant and factors that may affect these, alter CO_2 tension. Minute ventilation is the major mechanism of CO_2 elimination and therefore a more detailed discussion of the control of minute ventilation was required

to score well and accounted for half of the marks. This discussion includes the role of chemoreceptors and other factors that affect minute ventilation such as exercise, J receptor and baroreceptor stimulation.

Question 12

(a) Outline the structural features of the capillary membrane that facilitate the movement of water (15% marks).

(b) Outline the mechanisms by which water moves across the capillary membrane (10% marks).

(c) Describe the forces that influence fluid movement across the capillary membrane (75% marks).

34% of candidates passed this question.

Parts (a) and (b) required a description of the general capillary structure (single cell layer, thin etc) with specific unique features relevant to capillary membranes (fenestrated, non-fenestrated and sinusoidal), and a discussion of water movement across capillary membranes via ultrafiltration primarily.

Majority of marks were allocated for part (c), and the following headings provide a useful structure: hydrostatic pressure, oncotic pressure, net-filtration pressure and the filtration coefficient. The contribution of the Gibb's Donnan effect to plasma oncotic pressure attracted a small amount of additional marks, as did the glycocalyx and its influence on fluid movement. The effect of arterial and venous tone on the capillary hydrostatic pressure was a common omission.

Question 13

(a) Explain how the kidneys handle glucose (70% of marks).

(b) Outline the <u>renal</u> consequences of glycosuria (30% of marks).

45% of candidates passed this question.

(a) The expected information in this question included discussion of the sites at which glucose transport occurs (primarily glomerulus and proximal convoluted tubule) and the transport mechanisms involved including specific transporters. A discussion of the maximum transport concept was also required.
(b) This section required a discussion of the glucose induced osmotic diuresis and subsequent electrolyte loss. Additional marks were available for answers which recognised that this diuresis was not able to be overcome by ADH.

Question 14

(a) Describe the structure of the neuromuscular junction (NMJ), including the location of receptors and enzymes (a diagram may assist in your answer but is not required to achieve full marks) (30% of marks).

(b) Explain the events that occur at the NMJ that lead to the onset and offset of a muscle/motor end plate action potential (a description of excitation/contraction coupling is <u>NOT</u> required) (70% of marks).

76% of candidates passed this question.

(a) Diagrams were useful for many candidates, however others chose to provide a detailed description and also scored well. High scoring answers outlined the structure of the neuromuscular junction (NMJ) including all key functional elements.

(b) This section required a clear and ordered explanation from the arrival of a presynaptic action potential via motor axon until the restoration of a resting membrane potential in the post-synaptic motor endplate. Many answers ceased their description following the binding of acetylcholine to the nicotinic receptor and degradation by acetylcholinesterase omitting the final steps in returning the motor end plate to its resting state. Common errors arose from confusion between skeletal and cardiac myocyte action potentials.

Question 15

(a) Describe the physiological factors that influence gastric emptying (80% of marks).

(b) With respect to erythromycin, outline the following:

(i) mechanism of action on gastric emptying (10% of marks).

(ii) important gastrointestinal and non-gastrointestinal adverse effects (10% of marks).

32% of candidates passed this question.

(a) This component of the question required a detailed discussion of the mechanical/anatomical factors, chemical factors, enterogastric nervous reflexes, and hormonal factors (both local and systemic) that affect gastric emptying. Given the mark allocation of 80% to this section a reasonably detailed discussion of the mechanisms involved with each of the factors was expected.

(b) Erythromycin pharmacology knowledge was expected to address the headings provided. Descriptions regarding the mechanism of action of erythromycin in its antibiotic use was needed to score full marks. Adverse effects should be listed with a brief explanation or outline as to their mechanism when able.

Question 16

(a) Define the interthreshold range of body temperature and the thermoneutral zone and provide the normal values (25% of marks).

(b) Explain how the body detects (25% of marks) and defends (50% of marks) against cold exposure, including why neonates and the elderly may be more vulnerable to hypothermia.

76% of candidates passed this question.

(a) The first part of this question required clear definitions of interthreshold range (ITR) and thermoneutral zone (TNZ), relating each to the body and environment respectively. Normal values were a common omission.

(b) The second part of the question was best answered by explaining how the body detects and defends against a fall in environmental temperature using a sensor-controller-effector mechanism. Effector responses include mechanisms to reduce heat loss vs. those which generate heat and candidates were expected to explain vasomotor changes, shivering and non-shivering thermogenesis as a minimum. Discussion of other mechanisms (such as behavioral responses) attracted additional marks. Finally, candidates needed to explain how each component of the defense may be impaired in the neonate or elderly. High marks were awarded for answers that relate these explanations to the concepts of ITR and TNZ. Information about the response to warm environments or the physiological consequences of hypothermia was not required.

Question 17

(a) Define innate immunity including how it differs from adaptive immunity (10% of marks).

(b) Outline the components of the innate immune system including their role in the immune response (90% of marks).

59% of candidates passed this question.

(a) A good definition of innate immunity included the following information: present at birth, non-adaptive and responds to a limited set of foreign molecules. For full marks, it was expected that candidates would contrast this with the adaptive immune response including the requirement for sensitisation / pre-exposure and potential to respond to many unique antigens.

(b) It was helpful to divide the components of the innate immune system into physiochemical, humeral and cellular elements. Physiochemical elements included skin, mucus, cilia and secretions such as gastric acid. Additional marks were allocated for answers which also mentioned how each component acts to prevent infection (i.e. skin forms a physical barrier which prevents bacterial translocation). This part was generally answered very well. For humoral elements marks were apportioned between complement, lysosymes and acute phase proteins / Negative phase proteins. A brief outline of each was desirable with full marks given for detailed description of their role in immunity including their sites of production Lastly a good description of cellular elements included neutrophils, macrophages/monocytes, mast cells and natural killer cells. For each a brief outline of their role and function attracted full marks.

Question 18

(a) Describe how arterial haemoglobin oxygen saturation is measured using a pulse oximeter including the underlying scientific principles (60% of marks).

(b) Outline the limitations and sources of error of this method (40% of marks).

76% of candidates passed this question.

(a) The question involved describing the principles of measurement of arterial haemoglobin oxygen saturation i.e. provide a detailed account of this topic. The expected answer included describing the Beer Lambert Law correctly and describing the different absorption of light at different wavelengths by different haemoglobin species. Candidates were also expected to provide a description of the components and functioning of the components of a pulse oximeter such as LEDs, photodetectors and the algorithm used to provide the arterial Hb saturation and plethysmograph trace.

(b) The second part of the question involved outlining the limitations of the pulse oximetry. This was generally well answered by candidates, outlining patient and equipment factors that limit the accuracy of this technique.

Question 19

(a) Describe the intracellular events that occur following opioid receptor activation (25% of marks).
(b) Describe the locations where opioids produce analgesia and the mechanisms by which they exert these effects (45% of marks).
(c) Outline the mechanism by which morphine causes the following side effects:
(i) Respiratory depression (15% of marks).
(ii) Constipation (15% of marks).

43% of candidates passed this question.

(a) Opioids act on several receptors and a reasonable understanding of these is required to answer this question. A description of the intracellular events following ligand binding on G protein coupled opioid receptors, as well as pre and postsynaptic effects on calcium channels and potassium channels was required to score well in the first part.

(b) A detailed description of the peripheral, spinal cord and supra-spinal opioid receptors including their activation and transmission pathways was required for a comprehensive answer.

(c) Here the receptor, location and mechanism that brings about these common opioid side effects was needed to answer this component of the question.

Question 20
Fluconazole, amphotericin and caspofungin are anti-fungal drugs.
(a) For each drug listed above, outline the following:
(i) the class (15% of marks).
(ii) the mechanism of action (45% of marks).
(iii) <u>TWO</u> microbes against which they are active (30% of marks).
(marks in each section are equally distributed between the 3 drugs listed)
(b) List <u>TWO</u> serious side effects seen with <u>ANY</u> anti-fungal drug, include the agent most associated with each effect listed in your answer (10% of marks).

65% of candidates passed this question.

The question breakdown allowed for a simple but structured approach to this question. For common fungi like candida, full binomial names were required e.g. "candida albicans, candida glabrata". The mechanisms of actions were well outlined, and expected details included the target for the drug (e.g. enzyme or sterol), the effect on the cell membrane or wall, and whether it was fungicidal or fungistatic. A broad range of serious side effects were accepted for part b however specificity was required with respect to which drug is most likely linked to each.

MULTIPLE CHOICE QUESTIONS – PAPERS 1 AND 2

86% of candidates passed overall.
97% of candidates passed Paper 1.
93% of candidates passed Paper 2.

ORAL SECTION

DAY 1 – Wednesday 14th May 2025

VIVA 1

This VIVA will examine respiratory physiology.

How do changes in the elastic properties of the lung impact **lung** compliance?

56% of candidates passed this question.

VIVA 2

This VIVA will examine renal physiology and pharmacology.

How does the kidney concentrate urine?

(Image removed from report.)

77% of candidates passed this question.

VIVA 3

This VIVA will examine pharmacokinetics and antimicrobial pharmacology.

You are treating a patient in the ICU with intravenous vancomycin. The measured level is high.
Why might the level be high?

56 % of candidates passed this question.

VIVA 4

This VIVA will examine maternal-foetal physiology and pharmacology.

What is normal placental blood flow at term? How might foetal hypoxaemia occur in utero without a change in maternal oxygenation?

62% of candidates passed this question.

DAY 2 – Thursday 15th May 2025

VIVA 5

This VIVA will examine cardiovascular physiology and pharmacology.

Using this cardiac function curve (VR and CO); explain the physiological principles demonstrated by these curves and identify 'A'& 'B'

(image removed from report)

57% of candidates passed this question.

VIVA 6

This VIVA will examine neurophysiology and pharmacology.

Explain the intracranial pressure-volume relationship.

64% of candidates passed this question.

VIVA 7

This VIVA will examine hepatobiliary physiology and pharmacology.

How is oxygen delivered to the liver?

82% of candidates passed this question.

VIVA 8

This VIVA will examine haematology physiology and pharmacology.

Explain the role of platelets in haemostasis.

62% of candidates passed this question

SUMMARY OF THE EXAMINATION

The CICM First Part Examination explores the knowledge of the basic medical sciences that form the foundation of intensive care practice. A detailed syllabus has been developed and clearly sets out the level of understanding expected for each listed topic and drug. It is important that candidates study the syllabus in its entirety. All questions are sourced from the syllabus and the recommended texts are a guide to the level of information required. Some sections of the syllabus require more extensive research and the use of other textbooks.

Candidates are expected to attain a level of knowledge that goes beyond just the listing of pure facts but should be able to explain, describe, collate, and apply that knowledge across different circumstances relevant to intensive care practice. Sufficient depth of understanding and a structured approach to providing answers continues to remain an area of weakness for many candidates.

Candidates must allow sufficient time to prepare (typically 12 months). Candidates are strongly encouraged to discuss their level of preparedness and to trial written and oral questions, with their Supervisor of Training and other CICM Fellows, prior to undertaking the CICM First Part Examination. The examination reports are available as a guide to areas of the exam and syllabus that are covered and information expected for each question but are not model answers and should be read as such.

Dr Naomi Pallas
Chair
CICM First Part Exam Committee

Dr Samuel Marment and A/Prof Patricia Hurune
Deputy Chairs
CICM First Part Exam Committee

May 2025