



Australian and New Zealand
College of Anaesthetists
ABN 82 055 042 852

Joint Faculty of Intensive Care Medicine



The Royal Australasian
College of Physicians

REPORT OF THE INTENSIVE CARE PRIMARY EXAMINATION

SEPTEMBER/NOVEMBER 2009

This report is prepared to provide candidates, tutors and their supervisors of training with information about the way in which the Examiners assessed the performance of candidates in the Examination. Answers provided are not model answers but guides to what was expected. Candidates should discuss the report with their tutors so that they may prepare appropriately for the future examinations.

The exam included two 2.5 hour written papers, each comprising of twelve short answer questions and twenty short fact questions. Candidates were required to perform at a satisfactory level in the written before being eligible to sit the oral part of the exam. The oral was comprised of eight, ten-minute Viva stations.

OVERALL STATISTICS

Total number of candidates presenting for the written examination	9
Number of candidates scoring >50% in the written	3
Number of candidates scoring 45-50% in the written	0
Total number invited to the Oral section based on written marks	3

Successful candidates:

Mahadev	Patil
Mohammed	Ruknudeen
Amit	Vaidya

WRITTEN SECTION

SAQ PAPER 1

- 1. Explain the mechanisms by which a bacterium may become resistant to an antimicrobial agent and provide an example (organism and antimicrobial) of each mechanism. (60% of marks) How is antimicrobial resistance spread? (40% of marks)**

Candidates were expected to explain and provide an example of an antimicrobial agent for mechanisms such as enzyme inactivation of the antimicrobial, alteration of antimicrobial binding/target sites, reduction of antimicrobial drug uptake or active efflux of drug by the bacteria and alteration in enzymatic pathways. Use of a table aided candidates expressing this information. Examples of the methods of spread of antibiotic resistance in bacteria that were expected were: transfer of resistant bacteria from person to person; horizontal gene transfer; transduction - acquisition of bacterial DNA from a phage (a virus that propagates in bacteria); transformation - uptake and incorporation of free DNA released into the environment by other bacterial cells; conjugation - gene transfer (usually on plasmids), by direct cell-to-cell contact through a bridge.

Most candidates could name various mechanisms of resistance but many failed to gain marks as they did not provide an example of an organism and antimicrobial. The second part of the question concerning the spread of resistance was generally done quite well.

Syllabus - M2a2c

Reference: Pharmacology, Rang and Dale Ch 46, Goodman & Gillman, Ch42

6 (67%) of candidates passed this question.

- 2. Describe the physiological consequences and responses after an acute haemorrhage of 2.0 litres in a healthy 70kg adult if there is no immediate fluid resuscitation.**

To adequately answer this question, candidates must be able to demonstrate that they recognised this to be a major haemorrhage. When a weight and a volume are supplied it is expected the percentage blood loss would be calculated and the shock graded or the haemorrhage at least described as severe. Often the consequences were omitted. Consequences were best described in organ systems e.g. CV, renal, metabolic. Many candidates failed to mention the patient would be hypotensive and tachycardic.

A good answer should include mention, and provide explanations, of the mechanisms for the following compensatory responses:

- Activation of both baroreceptors and chemoreceptors and their consequences
- The sympathetic nervous system response
- Fluid shifts
- Renal effects - most candidates mentioned the urine output would be decreased but did not provide a mechanism for this

Endocrine effects, eg secretion and actions of ADH, ACTH/Cortisol

Syllabus - C1e1

Reference: Textbook of Medical Physiology, Guyton and Hall, Foundations of Anaesthesia: Basic Clinical Science, Hemmings and Hopkins

5 (56%) of candidates passed this question.

3. Describe the factors that influence the speed of ONSET of neuromuscular blockade.

The better candidates had an organised approach to their answer. For example factors could be broadly classified as pharmacokinetic and pharmacodynamic factors or patient and drug factors. For example, pharmacokinetic factors could include dose, the use of a priming dose, patient's volume status, cardiac output, muscle group and skeletal muscle blood flow. Pharmacodynamic factors expected were those of mechanism of blockade, receptor affinity, agent potency, neuromuscular disorders, age, drug interactions and electrolyte disorders.

Many answers listed factors which affect the duration of neuromuscular blockade instead of the onset. Marks were not allocated for information provided by candidates that did not address the question asked. It is important that candidates provide an answer specific to the question asked. Many candidates applied Fick's Law inappropriately. Lipid solubility and pKa are not relevant as these drugs do not cross the nerve membrane.

Syllabus - H2a, 2c

Reference: Pharmacology and Physiology in clinical practice, Stoelting Pg 186, Foundations of Anaesthesia: Basic clinical Science, Hemmings and Hopkins (2nd ed)

0 (0%) of candidates passed this question.

4. Describe the body's mechanisms for regulating blood glucose.

This question sought a candidate's knowledge of the basic science underpinning a topical area of clinical Intensive Care practice. Candidates were expected to mention normal values of blood glucose and detail the relevant humoral (dominant) and neural (sympathetic) factors. These included mention of, description of and mechanisms for the stimulation/inhibition and actions of humoral factors such as insulin, glucagon, cortisol, etc as the specifically apply to blood glucose control, neural stimulation and the liver's role as a glucostatic organ. Good candidates would demonstrate a structured response to their answer.

Syllabus - N12b

Reference: Textbook of Medical Physiology 11th ed Guyton and Hall, Ch. 78

4 (44%) of candidates passed this question.

5. Outline the kinetic characteristics and the mode of action of digoxin. (75% of marks) List the cardiovascular effects of digoxin (25% of marks).

The Syllabus for the Primary examination describes an outline to be “Provide a summary of the important points.” Thus candidates were expected to briefly mention the fundamental pharmacokinetic characteristics (eg highly lipid soluble, well absorbed from small intestine, oral bioavailability of 60 - 90%, protein binding of 20 - 30%, volume of distribution, half life, etc) and mode of action. This was poorly done and candidates’ answers often lacked structure.

The question outlines the distribution of marks, being 25% for listing cardiovascular effects. Thus candidates were expected to broadly list the important cardiovascular effects relating to mechanical (eg increase intensity of myocardial contraction, direct venous and arteriolar constriction, etc) and electrical (increase phase 4 slope & automaticity, hyperpolarization, shortening of atrial action potentials, decrease AV conduction velocity and prolong AV refractory period, increase PR & QT intervals, dose and baseline autonomic activity dependent actions, etc).

Syllabus – C2c 2a, b

Reference: Basic and Clinical Pharmacology, Katzung. 9TH Ed. Chapter 13 page 206
Goodman & Gilman's The Pharmacological Basis of Therapeutics

0 (0%) of candidates passed this question.

6. Define venous admixture and list its causes. (50% of marks) How is it diagnosed and how is it quantified? (50% of marks)

This question related to an area of basic respiratory physiology. A good answer necessitated the precise meaning of venous admixture, being that amount of mixed venous blood which would have to be added to ideal pulmonary end-capillary blood to explain the observed pulmonary end-capillary to arterial PO₂ difference. Diagnosis required the candidate to mention, a demonstrated increase in the Aa-DO₂, what are normal values. For quantification mention and description of the shunt equation was required. Candidates lacked a definition for venous admixture, were inaccurate with their description of the shunt equation and often overlooked mentioning calculation of arterial and mixed venous blood oxygen content.

Syllabus - B1a

Reference: Nunn’s Applied Respiratory Physiology 6th Ed p122

5 (56%) of candidates passed this question.

7. Compare and contrast the anatomy of the upper airway of a term newborn with that of an adult.

Good answers to this question directly compared the anatomical differences using two columns: one for the newborn and the other for the adult airway. They further divided the differences anatomically into mouth/naso and oro pharynx, the glottis (and epiglottis), the larynx, and the trachea (main carina and main bronchi).

Common omissions were failure to mention that neonates do not have dentition, have more compliant tissues and reduced muscle tone, that the neonates' larynx lies more cephalad and anteriorly, is covered by a large floppy epiglottis and that the main carina also lies more cephalad.

Few candidates were able to list more than 4 differences between the anatomy of the two airways and none mentioned the possibility of disease affecting the neck in the adult.

Syllabus – P2e

Reference: Anatomy for anaesthetists and T K Oh Chp95, Anatomy at a glance.

2 (22%) of candidates passed this question.

8. Describe the blood brain barrier. (50% of marks) What characteristics does a drug need to effectively penetrate into the central nervous system? (50% of marks)

Candidates were expected to state the purpose of the blood brain barrier (BBB), define what constituted the BBB, what its function is, and what parts of the brain lie outside of this barrier (and why). Further candidates should have mentioned what substances cross the BBB, and how this is achieved.

Common omissions included not mentioning the presence of astrocyte foot processes in addition to the tight junctions between the capillary endothelial cells, the presence of active pumps for sugars amines, and some ions, and what parts of the brain lay outside of the BBB.

Characteristics of a drug that will penetrate the BBB included low molecular weight, good lipid solubility, a low volume of distribution, low potency and low protein binding. Also expected was a discussion of Fick's Law and the drug features that would allow a high concentration gradient in the cerebral blood vessels to be achieved and a high diffusion coefficient and mention of drugs that resemble natural ligands for active transport mechanisms.

Syllabus - G12d G2a

References: Pharmacology, Rang and Dale 6th edition page 476, Principles of physiology for the anaesthetist, Kam page39-40, Pharmacology and Physiology in Anaesthetic Practice, Stoelting, Pg 681, Textbook of medical physiology, Guyton and Hall 11th edition page 766. Foundations of Anesthesia. Hemmings and Hopkins. 2nd edition.

2 (22%) of candidates passed this question.

- 9. A six (6) month old child is diagnosed with a gastric outlet obstruction. Investigations reveal a metabolic alkalosis and a urine pH of 5. Describe the physiological basis of these results.**

Candidates were expected to identify what compounds are lost during vomiting associated with gastric outlet obstruction and that intravascular volume depletion is likely. Furthermore the candidate was then expected to explain that overall the child's body will defend volume – then tonicity – then acid base status, in this order. An outline of the major physiological defences of volume status (e.g. the renin-angiotensin-aldosterone system), and how these will perpetuate a metabolic alkalosis (prevent the kidney from clearing the excess bicarbonate in the form of an *alkaline* urine) was then expected.

A common omission was to not appreciate that the preservation of volume (sodium or chloride) by the kidneys conflicts with the physiological mechanisms that would allow bicarbonate loss through the kidneys' tubules. Restoration of normovolaemia would allow an 'alkaline tide' or bicarbonate loss by the kidneys (alkaline urine production).

Syllabus - G12d G2a

References: Power and Kam. P247-266

3 (33%) of candidates passed this question.

- 10. Describe the changes in inspired and alveolar oxygen partial pressure with increasing altitude. (20% of marks) Outline the respiratory physiological responses to altitude. (80% of marks)**

Any description of the changes in inspired and alveolar PO₂ with altitude required the description of, and an understanding of, the equations for calculation of PiO₂ (PiO₂=0.21(BMP-47)mmHg or 0.21(BMP-6.3)kPa) and PAO₂ (PAO₂ =PiO₂ – PaCO₂/R). It was important to mention alteration in atmospheric pressure (BMP) with altitude and that saturated vapour pressure (SVP) is constant for the same body temperature.

A good answer to the second part of the question (respiratory physiological responses to altitude) was one that had some structure, eg responses divided into acute and chronic, respiratory, renal, haematological, cardiovascular and CNS categories, and relevant detail for each category. Candidates were expected to at least mention, but not restrict themselves to the following: acute responses, eg carotid/aortic body chemoreceptor stimulation hyperventilation, proportional to reduced BMP and hypoxia, limitations to hypocarbia (due to alterations in CSF pH) etc: physiological responses to early and chronic acclimatisation (eg renal HCO₃-excretion, respiratory centre CO₂ response curve resets to left, altered peripheral chemoreceptor sensitivity, 2,3, DPG levels and related right. Shift in HbO₂ curve, alterations in pulmonary diffusing capacity due to increased alveolar surface area and pulmonary blood volume, etc).

It is important that current and future candidates use the examination reports to guide their learning. Thus it is essential that candidates not just read the feedback provided to each exam question but also refer to the reference(s) supplied below and other relevant sources they find to be useful.

Syllabus – B1k, 2i

Reference – Nunn's Respiratory Physiology, Ch 17 and 5.

Power and Kam 432-4.

0 (0%) of candidates passed this question.

11. Describe and / or illustrate the anatomy relevant for the insertion of a central line into the left subclavian vein using any of the available techniques.

There are a few areas of anatomy that are essential for Intensivist to have a high level of knowledge of. The subclavian vein is one of them. Unfortunately the extent of knowledge displayed by the candidates was very shallow. A good answer required as a minimum, a clear description of the course of the vein. This included the following facts – it is a continuation of the axillary vein, it's relationship to the first rib, to the medial border of the scalenus anterior, the fact that it arches up, medial, then down and that it joins the internal jugular vein (behind the subclavian joint, anatomical relationships (eg Anterior – clavicle, subclavius muscle, Posterior – first rib, apex lung superiorly, first intercostal space inferiorly, Superior – subclavian artery, thoracic duct medially, phrenic nerve, lower trunk brachial plexus laterally and Medial – brachiocephalic artery, trachea, vagal trunk, thoracic duct and oesophagus posteriorly) and surface anatomy (related to the various available techniques (eg the infraclavicular and supraclavicular approach)

Syllabus – C1d, 2g

Reference: Anatomy for Anaesthetists, Ellis and Feldman

0 (0%) of candidates passed this question.

12. Outline the pharmacology of noradrenaline.

Candidates should expect that questions relating to “the pharmacology of” are likely to be common. Thus candidates should have prepared structured approach for any such question. For example, one that includes predefined major categories such as pharmacodynamics and pharmacokinetics and sub-categories such as mechanism of action, absorption, preparations, bioavailability, volume of distribution, metabolism, elimination, adverse effect, clinical indications, precautions/interactions, etc. and the information relevant to each category. Failure to take a structured approach to such questions, as was observed amongst some candidates within this exam, risks omission of vital facts (and not gaining marks) and errors. Noradrenaline is such a common drug within intensive care practice and so candidates would be expected to know it in great detail. There are many references for it, such as the ones listed below.

Syllabus – G3a, 2b

References – Goodman and Gillman Chp 10 and Katzung.

2 (22%) of candidates passed this question.

SAQ PAPER 2

- 1. Outline the ideal properties of a colloid intravenous fluid. (25% marks) Compare and contrast Gelatins, Hydroxyethyl starch and 4 % Albumin solutions. (75% marks)**

The ideal properties of a colloid include: stability at room temperature and long shelf life, lack of complications such as antigenicity, toxicity, pyrogenicity, disease transmission, or other adverse effects (eg coagulopathy) and plasma volume expansion lasting several hours. Candidates performed well in this section.

Marks were equally divided between each colloid, and this part of the answer was well suited to table format. Candidates were expected to compare and contrast fluid source, infection and antigenic risk, cost and resource issues, packaging and ease of administration, duration of effect, tonicity, and properties which determine their side effect profile etc. Common errors were omission of adequate detail for each colloid and not being aware that Dextran is not a Hydroxyethyl starch.

Syllabus – E2a 2a

Reference: Foundations of Anaesthesia: Basic clinical Science, Hemmings and Hopkins, pg 719

5 (55%) of candidates passed this question.

- 2. Classify antiemetic drugs and describe their mechanism of action.**

Antiemetics can be classified by their receptor actions including, dopamine antagonists, serotonin antagonists, antihistamines, anticholinergics, antimotilinic etc or by their drug type – butyrophenones, phenothiazines, benzamides etc. Marks were divided between each class, and for “other/novel” antiemetics – such as, steroids, GABA agonists, alpha 2 agonists, mu receptor antagonists, cannabinoids, propofol and NK1 receptor antagonists.

Candidates were expected to mention the drug type, receptor interaction, the location of the receptors and the pathways inhibited by the drug – central CTZ, vestibular nuclei, solitary tract nucleus, vagal afferents or GIT motility and secretions. Most drugs work at one or more of these sites and marks were awarded for mention of this. Commonest errors were omission of adequate detail in each class. Antihistamines, anticholinergics and “others/novel” were frequently omitted.

Syllabus - Q12e and Q2b2a

Reference: Chp 37 Goodman and Gillman

3 (33%) of candidates passed this question.

- 3. Describe the mechanism of actions and duration of effect of drugs used to lower potassium in hyperkalaemia.**

A good answer to this question required the collation of knowledge from broad range of areas, ie drug activity. Marks were divided between each of the following: 8.4%NaHCO₃-,

insulin/glucose, K⁺ exchange resin, frusemide/loop diuretics, Beta2 agonists and K⁺ free fluid rehydration/dilution. Candidates often overlooked the fact that only loop diuretics and K⁺ exchange resins lower total body K⁺ content, whilst the others induce an intracellular K⁺ shift which is not sustained and do not directly result in body elimination of K⁺. Intravenous fluid rehydration lowers total body K⁺ if there is a resulting diuresis.

Most candidates just passed this question. Common omissions included NaHCO₃, loop diuretics and beta 2 agonists. No candidate mentioned rehydration/dilution. Calcium does not lower serum potassium.

Syllabus - various

Reference: various

5 (55%) of candidates passed this question.

4. Discuss the factors affecting pulmonary vascular resistance.

A good answer to this question required a discussion that focused on the following key points-

Recruitment and distension of pulmonary capillaries. Helps limit pulmonary vascular resistance as pressure and flow increase.

Lung volume. Lung inflation is thought to have a dual effect, expanding large vessels by traction while compressing smaller vessels and resistance is dependent upon lung volume, being lowest at approx FRC.

Gravity. Perfusion is distributed down a vertical gradient in the lung, reflecting the balance between intra-alveolar pressure and the distending vascular pressure. (West's Zones)

Oxygen. Hypoxia causes pulmonary vasoconstriction. Diverts blood away from hypoxic regions of the lung.

Hypercapnia and acidosis vasoconstriction

Autonomic innervation. Alpha -adrenergic stimulation - vasoconstrictor, Beta-adrenergic stimulation - vasodilatation, Parasympathetic stimulation - Vasodilatation

Local mediators. Vasoconstrictors (Serotonin, histamine, endothelins) and Vasodilators (NO, prostacyclin, isoprenaline)

The majority of these points could be efficiently explained through the use of graphs/figures, all of which are commonly found in the majority of physiology books that include respiratory physiology. Those candidates who failed to do so were also those who scored fewer points with this question.

Syllabus - B1i2b

Reference – Respiratory Physiology, the Essentials, West 5th Ed Chp4 p33-44

3 (33%) of candidates passed this question.

- 5. Explain the difference and the clinical relevance, between zero and first order kinetics. (60% marks) Give an example that is relevant to intensive care practice. (40% marks)**

For a good answer it was expected that candidates would mention that if mechanisms for elimination of a given drug become saturated, the kinetics approaches zero order, in which a constant **amount** of drug is eliminated per unit of time. First-order kinetics, is where a constant **fraction** of drug in the body is eliminated per unit of time – that is, systems for elimination of drugs such as metabolizing enzymes and transporters are not saturated, and thus the absolute rate of elimination of the drug is essentially a linear function of its concentration in plasma. Clearance varies with the concentration of drug. Drugs with a target concentration is more than the concentration at which half the maximal rate of elimination is reached have a narrow therapeutic index and zero order kinetics and therapeutic drug monitoring is most important – low therapeutic index and variable half life. In contrast to capacity-limited drug elimination, some drugs are cleared very readily by the organ of elimination, so that at any clinically realistic concentration of the drug, most of the drug in the blood perfusing the organ is eliminated on the first pass of the drug through it. The elimination of these drugs will thus depend primarily on the rate of drug delivery to the organ of elimination – have a high-extraction. Phenytoin provides an example of a drug for which metabolism becomes saturated in the therapeutic range of concentrations, and half-life can vary between 7 and 42 hours.

Syllabus – II 2a

Reference: Goodman and Gillman Chp 1

2 (22%) of candidates passed this question.

- 6. Outline the physiology of, and factors which regulate levels of angiotensin.**

For a good answer it was expected that candidates would mention the relationship of angiotensinogen, angiotensin I, renin and Angiotensin Converting Enzyme to angiotensin II production, the actions and fate of angiotensin II and factors that regulate angiotensin II. It was expected that candidates mention angiotensin acts as a potent vasoconstrictor, stimulates aldosterone secretion, facilitates noradrenaline release, preferentially vasoconstricts Efferent arteriole in nephron, preserving GFR in low perfusion states, increases renal tubular Na^+ reabsorption and increases secretion of vasopressin and ACTH.

Regulation of Angiotensin could be separated into factors increasing angiotensin levels (eg prostaglandins, low K^+ levels, Sympathetic stimulation, decreased Na^+ delivery at distal tubule, any factor contributing to reduced renal blood flow (eg hypovolaemia, cardiac failure, renal artery stenosis) and factors reducing angiotensin levels (eg hypervolaemia, afferent arteriolar dilatation and vasopressin).

Syllabus - N1 (h), C2b (f)

Reference: Textbook of medical Physiology, Guyton, Chp 26, Goodman and Gillman, Chp 30

4 (44%) of candidates passed this question.

7. Define the following terms (40%)

- 1. Saturated Vapour Pressure of Water**
- 2. Absolute Humidity**
- 3. Relative Humidity**
- 4. Latent heat of vaporisation**

Briefly outline how the humidity of air is altered during inspiration and expiration by the respiratory tract (60%)

It is essential that candidates read and respond to the question asked of them. The first part of the question required simple, accurate definitions, which the majority of candidates were unable to provide. Marks were awarded for the definition only. Descriptions of measurement, potential effects on oxygenation, etc. were not asked and gained no marks.

The core of the second part required an outline of the exchange of heat and moisture through the upper airways and bronchial tree, culminating in fully saturated gas at core body temperature by level of the 2nd generation bronchi. Whilst the question asked 'humidity' and not temperature, correct definitions in the first part would have dictated a joint outline of both. The effects of surface area, the nasal turbinates, mucosal secretion and blood flow were all relevant. The contribution to insensible moisture and heat loss should have been mentioned. No candidate considered the effects of respiratory rate, mouth versus nose breathing, or dry medical gases versus room air.

Syllabus – B1k2d

Reference: Nunn pages 15 and 26

1 (11%) of candidates passed this question.

8. Compare and contrast the pharmacology of heparin and enoxaparin.

The vast majority of candidates chose to answer this question in tabular format and in doing so were easily able to consolidate a high scoring answer. This also allowed clear identification of important differences, such as molecular weight, mechanism of action, half-life, dose-interval, monitoring, elimination, reversal of effect, the influence of renal impairment and potential side-effects.

One exception to this approach would be clinical indications, where these show marked similarity. Candidates should consider writing similarities once whilst incorporating both drugs so as to use the time allocated more efficiently.

Syllabus - J2 2a

Reference: Pharmacology and Physiology in Anaesthetic practice, Stoelting 505-511 Basic and Clinical Pharmacology, Katzung 546-548

8 (89%) of candidates passed this question.

9. List the hormones secreted by the pituitary gland. (30% marks) Outline the physiological factors that control secretion of hormones from the posterior pituitary. (70% marks)

Once again candidates are reminded to read and answer the question presented to them as well as take into consideration the proportion of marks allocated. The expectation from the first section of the question was for candidates to only “list” the hormones secreted by the pituitary gland. The main hormones expected were ACTH, TSH, GH, FSH, LH and prolactin anteriorly; and, ADH (vasopressin) and oxytocin posteriorly.

Unfortunately, a number of candidates confused which hormones come from which region and therefore were unable to score marks in the second part. The question clearly asked for factors controlling secretion of hormones from the posterior pituitary, therefore, detailed descriptions of the mechanism of action of ADH in the kidney, or of hormones arising from the anterior pituitary did not relate to the question and were not allocated marks.

With respect to ADH, most marks were gained by candidates who described not only osmolality and plasma volume, but the relative sensitivity of the pituitary to these and the pre-potent nature of volume over osmolality; also, the influence of other hormonal axes involved in plasma volume regulation. Marks were also available for other inputs including pain, stress, exercise, etc. A brief description of factors influencing oxytocin was also expected.

Syllabus – N12d

Reference: Gannong p383, Guyton p359

4 (44%) of candidates passed this question.

10. Describe how the kidney handles sodium. (50 marks) What factors influence urinary sodium excretion (50 marks)

Candidates were essentially expected to describe the fate of sodium as it passes through the kidney from filtration at the glomerulus to ending up in the urine. Essentially, most Na⁺ is reabsorbed at the proximal tubule (65%), reabsorption being down an electrochemical gradient (inside cell negative and low Na⁺ concentration) which is maintained by active Na⁺/K⁺ ATPase activity at the basolateral membrane. Then Loop of Henle reabsorbs a further 15% of filtered Na⁺. At descending limb – no Na⁺ reabsorption. At ascending limb, thick segment – active process as per proximal tubule, but mostly coupled to K⁺ and Cl⁻ and paracellular diffusion through tight junctions. Finally the distal convoluted tubule and collecting ducts, a further almost 20% reabsorbed – leaving < 1%

Factors influencing loss are

- aldosterone = stimulates Na⁺ reabsorption at the collecting tubules
- intra renal factors such as interstitial pressure which is lowered during hypovolaemia and reduced renal perfusion, thus promoting Na⁺ reabsorption gradient
- sympathetic nervous system – influences interstitial pressure and increases renin production
- angiotensin II – stimulates reabsorption at proximal tubule
- Atrial Natriuretic Peptide/Factor – inhibits Na⁺ reabsorption
- Others – dopamine, cortisol, insulin => increase Na⁺ reabsorption, but minor factors

Syllabus – D1, 2f

Reference – Textbook of medical Physiology, Guyton, Chp 28

2 (22%) of candidates passed this question.

11. Outline the principal functions of the Liver, and give examples.

For a good answer candidates were expected to at least mention the following --

Formation and secretion of bile

Carbohydrate metabolism (Glycogen synthesis and breakdown, Gluconeogenesis)

Lipid metabolism (Fatty acid oxidation, Synthesis of cholesterol and phospholipids,
Production of ketoacids)

Protein metabolism Breakdown

Metabolism of toxins, drugs (Phase I reactions - oxidation, reduction, hydrolysis,
Phase II reactions- conjugation/glucuronidation)

Storage (Vitamins B12, A, D 2, Iron as ferritin, Glycogen)

Immunity

Endocrine (Synthesis of 25 OH cholecalciferol, Metabolism of steroid hormones, Synthesis
of somatomedins, Erythropoietin)

Miscellaneous (Acid base role – lactate metabolism, Blood store)

Syllabus – I2a

Reference: Gannong p485, Power and Kam p185

4 (44%) of candidates passed this question.

12. Describe how gas exchange is influenced across the placenta near the term of pregnancy.

For a good answer candidates were expected to account how the placenta allows for effective diffusion to occur. Good answers incorporated the parameters within the Fick equation (eg. area of placental gas exchange, pressure of gas in maternal sinuses ($PO_2 = 50$ mmHg), pressure of gas in umbilical vein ($PO_2 = 30$ mmHg). Also expected was an explanation of the role of foetal haemoglobin, the double Bohr and double Haldane effects. These were commonly omitted.

Syllabus – O12d

Reference: Power and Kam p354

1 (11%) of candidates passed this question.

PAPER 1 and 2 CLOZE QUESTIONS

6 (67%) candidates passed these questions.

PAPER 1 and 2 RANK QUESTIONS

4 (44%) candidates passed these questions.

PAPER 1 and 2 MATCH QUESTIONS

5 (56%) candidates passed these questions.

ORAL SECTION

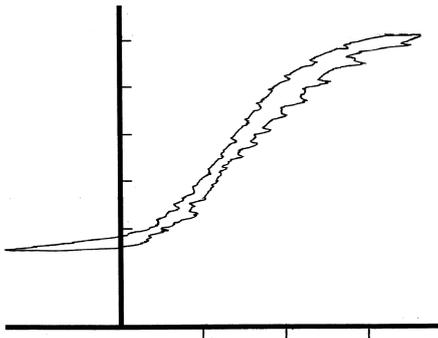
3 candidates were invited to attend the oral section based on their written marks.

VIVA 1

The initial information given to the candidates was –

This VIVA will assess your knowledge of pulmonary mechanics

Can you identify this curve and label the axes?



Candidates were tested on their knowledge of pulmonary compliance, its measurement, factors that influence it, surfactant and interpretation of common ventilator waveforms.

1 (33%) of 3 candidates passed this VIVA.

VIVA 2

The initial information given to the candidates was –

This viva will test your knowledge on temperature control and measurement.

Candidates were asked about temperature and thermoregulation, various means of measuring temperature and metabolic rate and factors that influence metabolic rate.

3 (100%) of 3 candidates passed this VIVA.

VIVA 3

The initial information given to the candidates was –

*This question is about the anatomy of the nephron and its blood supply.
Please draw a picture of a nephron and label it.*

This viva explored a candidates understanding of anatomy of the nephron, unique details of renal blood flow, macula densa, glomerular filtration rate and its determinants, generation of a concentrated urine.

3 (100%) of 3 candidates passed this VIVA

VIVA 4

The initial information given to the candidates was –

This is an analysis of urine from a patient on the intensive care unit:

<i>Glucose</i>	<i>negative</i>
<i>Ketones</i>	<i>trace</i>
<i>pH</i>	<i>6.0</i>
<i>urobilinogen</i>	<i>moderate</i>
<i>Specific gravity</i>	<i>>1.030</i>

You will be asked to comment upon these findings

In this viva candidates were asked to explain the physiological basis to the urinalysis provided above. Further knowledge was sought in reference to ketones and ketone body generation and metabolism, generation of urobilinogen and significance of specific gravity.

3 (100%) of 3 candidates passed this VIVA.

VIVA 5

The initial information given to the candidates was –

An anaesthetist calls you to request an ICU bed for a patient suffering from spina bifida who has just suffered what is believed to be an adverse reaction shortly after induction of anaesthesia.

Classify allergic reactions.

In this viva candidates were asked to explain and classify allergic reactions, the pharmacological basis to their treatment (eg what are the mechanisms by which adrenaline is used for anaphylaxis) and to list common agents (latex was commonly overlooked) in ICU practice that are associated with allergic reactions.

3 (100%) of 3 candidates passed this VIVA.

VIVA 6

The initial information given to the candidates was –

This viva will test your knowledge about the use of diuretics, pharmacokinetics and dynamics.

And

Use of drugs during a cardiac arrest.

Candidates were asked to explain mechanism of action of diuretics, in particular frusemide. Candidates were also tested upon the basis that various vasoactive drugs (eg adrenaline and vasopressin) are used in cardiac arrest, in particular their mechanism of action and routes of administration.

0 (0%) of 3 candidates passed this VIVA.

VIVA 7

The initial information given to the candidates was –

*This will explore your knowledge of cardiovascular physiology.
Draw a normal ECG tracing , indicate waves and intervals*

And

Statistics

Candidates were asked to draw a normal ECG trace and to explain the ionic mechanisms that form the basis to that trace and the consequences of hyperkalaemia.

In relation to statistics, candidates were shown a series of blood pressure values on a range of patients, asked to describe what type of data was being represented, how it may be displayed, what is normal distribution and what test may be used to compare the blood pressure values between the two groups. It is important for candidates to understand that generally only knowledge of fundamental, common and fairly simple statistical tests would be asked from them.

2 (66%) of 3 candidates passed this VIVA.

VIVA 8

The initial information given to the candidates was –

*This station will explore your knowledge of the following areas:
Neurophysiology and Opioid pharmacology*

Candidates were asked about cerebral blood flow, it's measurement, regulation and opioids and their CNS effects

1 (33%) of 3 candidates passed this VIVA.

Summary of Examination

A detailed syllabus has been developed and forms the foundation for the knowledge base for the JFICM Primary Examination. All questions are sourced directly from that syllabus and candidates should have a sound understanding of those topics, and confidence to express their understanding of the subject material in both written and oral form. The candidates should be able to integrate and express basic physiological and pharmacological principles as to how they relate to various scenarios relevant to Intensive Care practice.

The JFICM Primary Examination explores knowledge of the basic science that forms the foundation to Intensive Care practice. For example, in this exam there were many questions that sought knowledge of the basic sciences as they applied to everyday clinical occurrences, eg blood loss, glucose control, noradrenaline, CVC line insertion, gastric outlet obstruction, potential life threatening hyperK+, applied pharmacokinetics and many others. This aspect is a particular strength of, and differentiates the, JFICM Primary Examination from other primary examinations.

Candidates are strongly encouraged to allow sufficient period of study prior to undertaking this exam. Many candidates are still presenting very much under prepared. Candidates are encouraged to discuss with their Supervisor of Training their level of preparedness prior to undertaking the JFICM Primary Examination.

A great deal of effort is made to ensure that the exam process is robust and non discriminatory to any candidate. Candidates are reminded that they must adhere to the examination rules. A penalty may apply if an examination rule is not followed.

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Deputy Chair
Primary Examination Committee

Circulation:

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 Supervisors of Intensive Care Training
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Australian and New Zealand
College of Anaesthetists
ABN 82 055 042 852

Joint Faculty of Intensive Care Medicine



The Royal Australasian
College of Physicians

REPORT OF THE INTENSIVE CARE PRIMARY EXAMINATION

SEPTEMBER/NOVEMBER 2009

This report is prepared to provide candidates, tutors and their supervisors of training with information about the way in which the Examiners assessed the performance of candidates in the Examination. Answers provided are not model answers but guides to what was expected. Candidates should discuss the report with their tutors so that they may prepare appropriately for the future examinations.

The exam included two 2.5 hour written papers, each comprising of twelve short answer questions and twenty short fact questions. Candidates were required to perform at a satisfactory level in the written before being eligible to sit the oral part of the exam. The oral was comprised of eight, ten-minute Viva stations.

OVERALL STATISTICS

Total number of candidates presenting for the written examination	9
Number of candidates scoring >50% in the written	3
Number of candidates scoring 45-50% in the written	0
Total number invited to the Oral section based on written marks	3

Successful candidates:

Mahadev	Patil
Mohammed	Ruknudeen
Amit	Vaidya

WRITTEN SECTION

SAQ PAPER 1

- 1. Explain the mechanisms by which a bacterium may become resistant to an antimicrobial agent and provide an example (organism and antimicrobial) of each mechanism. (60% of marks) How is antimicrobial resistance spread? (40% of marks)**

Candidates were expected to explain and provide an example of an antimicrobial agent for mechanisms such as enzyme inactivation of the antimicrobial, alteration of antimicrobial binding/target sites, reduction of antimicrobial drug uptake or active efflux of drug by the bacteria and alteration in enzymatic pathways. Use of a table aided candidates expressing this information. Examples of the methods of spread of antibiotic resistance in bacteria that were expected were: transfer of resistant bacteria from person to person; horizontal gene transfer; transduction - acquisition of bacterial DNA from a phage (a virus that propagates in bacteria); transformation - uptake and incorporation of free DNA released into the environment by other bacterial cells; conjugation - gene transfer (usually on plasmids), by direct cell-to-cell contact through a bridge.

Most candidates could name various mechanisms of resistance but many failed to gain marks as they did not provide an example of an organism and antimicrobial. The second part of the question concerning the spread of resistance was generally done quite well.

Syllabus - M2a2c

Reference: Pharmacology, Rang and Dale Ch 46, Goodman & Gillman, Ch42

6 (67%) of candidates passed this question.

- 2. Describe the physiological consequences and responses after an acute haemorrhage of 2.0 litres in a healthy 70kg adult if there is no immediate fluid resuscitation.**

To adequately answer this question, candidates must be able to demonstrate that they recognised this to be a major haemorrhage. When a weight and a volume are supplied it is expected the percentage blood loss would be calculated and the shock graded or the haemorrhage at least described as severe. Often the consequences were omitted. Consequences were best described in organ systems e.g. CV, renal, metabolic. Many candidates failed to mention the patient would be hypotensive and tachycardic.

A good answer should include mention, and provide explanations, of the mechanisms for the following compensatory responses:

- Activation of both baroreceptors and chemoreceptors and their consequences
- The sympathetic nervous system response
- Fluid shifts
- Renal effects - most candidates mentioned the urine output would be decreased but did not provide a mechanism for this

Endocrine effects, eg secretion and actions of ADH, ACTH/Cortisol

Syllabus - C1e1

Reference: Textbook of Medical Physiology, Guyton and Hall, Foundations of Anaesthesia: Basic Clinical Science, Hemmings and Hopkins

5 (56%) of candidates passed this question.

3. Describe the factors that influence the speed of ONSET of neuromuscular blockade.

The better candidates had an organised approach to their answer. For example factors could be broadly classified as pharmacokinetic and pharmacodynamic factors or patient and drug factors. For example, pharmacokinetic factors could include dose, the use of a priming dose, patient's volume status, cardiac output, muscle group and skeletal muscle blood flow. Pharmacodynamic factors expected were those of mechanism of blockade, receptor affinity, agent potency, neuromuscular disorders, age, drug interactions and electrolyte disorders.

Many answers listed factors which affect the duration of neuromuscular blockade instead of the onset. Marks were not allocated for information provided by candidates that did not address the question asked. It is important that candidates provide an answer specific to the question asked. Many candidates applied Fick's Law inappropriately. Lipid solubility and pKa are not relevant as these drugs do not cross the nerve membrane.

Syllabus - H2a, 2c

Reference: Pharmacology and Physiology in clinical practice, Stoelting Pg 186, Foundations of Anaesthesia: Basic clinical Science, Hemmings and Hopkins (2nd ed)

0 (0%) of candidates passed this question.

4. Describe the body's mechanisms for regulating blood glucose.

This question sought a candidate's knowledge of the basic science underpinning a topical area of clinical Intensive Care practice. Candidates were expected to mention normal values of blood glucose and detail the relevant humoral (dominant) and neural (sympathetic) factors. These included mention of, description of and mechanisms for the stimulation/inhibition and actions of humoral factors such as insulin, glucagon, cortisol, etc as the specifically apply to blood glucose control, neural stimulation and the liver's role as a glucostatic organ.

Good candidates would demonstrate a structured response to their answer.

Syllabus - N12b

Reference: Textbook of Medical Physiology 11th ed Guyton and Hall, Ch. 78

4 (44%) of candidates passed this question.

5. Outline the kinetic characteristics and the mode of action of digoxin. (75% of marks) List the cardiovascular effects of digoxin (25% of marks).

The Syllabus for the Primary examination describes an outline to be “Provide a summary of the important points.” Thus candidates were expected to briefly mention the fundamental pharmacokinetic characteristics (eg highly lipid soluble, well absorbed from small intestine, oral bioavailability of 60 - 90%, protein binding of 20 - 30%, volume of distribution, half life, etc) and mode of action. This was poorly done and candidates’ answers often lacked structure.

The question outlines the distribution of marks, being 25% for listing cardiovascular effects. Thus candidates were expected to broadly list the important cardiovascular effects relating to mechanical (eg increase intensity of myocardial contraction, direct venous and arteriolar constriction, etc) and electrical (increase phase 4 slope & automaticity, hyperpolarization, shortening of atrial action potentials, decrease AV conduction velocity and prolong AV refractory period, increase PR & QT intervals, dose and baseline autonomic activity dependent actions, etc).

Syllabus – C2c 2a, b

Reference: Basic and Clinical Pharmacology, Katzung. 9TH Ed. Chapter 13 page 206
Goodman & Gilman's The Pharmacological Basis of Therapeutics

0 (0%) of candidates passed this question.

6. Define venous admixture and list its causes. (50% of marks) How is it diagnosed and how is it quantified? (50% of marks)

This question related to an area of basic respiratory physiology. A good answer necessitated the precise meaning of venous admixture, being that amount of mixed venous blood which would have to be added to ideal pulmonary end-capillary blood to explain the observed pulmonary end-capillary to arterial PO₂ difference. Diagnosis required the candidate to mention, a demonstrated increase in the Aa-DO₂, what are normal values. For quantification mention and description of the shunt equation was required. Candidates lacked a definition for venous admixture, were inaccurate with their description of the shunt equation and often overlooked mentioning calculation of arterial and mixed venous blood oxygen content.

Syllabus - B1a

Reference: Nunn’s Applied Respiratory Physiology 6th Ed p122

5 (56%) of candidates passed this question.

7. Compare and contrast the anatomy of the upper airway of a term newborn with that of an adult.

Good answers to this question directly compared the anatomical differences using two columns: one for the newborn and the other for the adult airway. They further divided the differences anatomically into mouth/naso and oro pharynx, the glottis (and epiglottis), the larynx, and the trachea (main carina and main bronchi).

Common omissions were failure to mention that neonates do not have dentition, have more compliant tissues and reduced muscle tone, that the neonates' larynx lies more cephalad and anteriorly, is covered by a large floppy epiglottis and that the main carina also lies more cephalad.

Few candidates were able to list more than 4 differences between the anatomy of the two airways and none mentioned the possibility of disease affecting the neck in the adult.

Syllabus – P2e

Reference: Anatomy for anaesthetists and T K Oh Chp95, Anatomy at a glance.

2 (22%) of candidates passed this question.

8. Describe the blood brain barrier. (50% of marks) What characteristics does a drug need to effectively penetrate into the central nervous system? (50% of marks)

Candidates were expected to state the purpose of the blood brain barrier (BBB), define what constituted the BBB, what its function is, and what parts of the brain lie outside of this barrier (and why). Further candidates should have mentioned what substances cross the BBB, and how this is achieved.

Common omissions included not mentioning the presence of astrocyte foot processes in addition to the tight junctions between the capillary endothelial cells, the presence of active pumps for sugars amines, and some ions, and what parts of the brain lay outside of the BBB.

Characteristics of a drug that will penetrate the BBB included low molecular weight, good lipid solubility, a low volume of distribution, low potency and low protein binding. Also expected was a discussion of Fick's Law and the drug features that would allow a high concentration gradient in the cerebral blood vessels to be achieved and a high diffusion coefficient and mention of drugs that resemble natural ligands for active transport mechanisms.

Syllabus - G12d G2a

References: Pharmacology, Rang and Dale 6th edition page 476, Principles of physiology for the anaesthetist, Kam page39-40, Pharmacology and Physiology in Anaesthetic Practice, Stoelting, Pg 681, Textbook of medical physiology, Guyton and Hall 11th edition page 766. Foundations of Anesthesia. Hemmings and Hopkins. 2nd edition.

2 (22%) of candidates passed this question.

- 9. A six (6) month old child is diagnosed with a gastric outlet obstruction. Investigations reveal a metabolic alkalosis and a urine pH of 5. Describe the physiological basis of these results.**

Candidates were expected to identify what compounds are lost during vomiting associated with gastric outlet obstruction and that intravascular volume depletion is likely. Furthermore the candidate was then expected to explain that overall the child's body will defend volume – then tonicity – then acid base status, in this order. An outline of the major physiological defences of volume status (e.g. the renin-angiotensin-aldosterone system), and how these will perpetuate a metabolic alkalosis (prevent the kidney from clearing the excess bicarbonate in the form of an *alkaline* urine) was then expected.

A common omission was to not appreciate that the preservation of volume (sodium or chloride) by the kidneys conflicts with the physiological mechanisms that would allow bicarbonate loss through the kidneys' tubules. Restoration of normovolaemia would allow an 'alkaline tide' or bicarbonate loss by the kidneys (alkaline urine production).

Syllabus - G12d G2a

References: Power and Kam. P247-266

3 (33%) of candidates passed this question.

- 10. Describe the changes in inspired and alveolar oxygen partial pressure with increasing altitude. (20% of marks) Outline the respiratory physiological responses to altitude. (80% of marks)**

Any description of the changes in inspired and alveolar PO₂ with altitude required the description of, and an understanding of, the equations for calculation of PiO₂ (PiO₂=0.21(BMP-47)mmHg or 0.21(BMP-6.3)kPa) and PAO₂ (PAO₂ =PiO₂ – PaCO₂/R). It was important to mention alteration in atmospheric pressure (BMP) with altitude and that saturated vapour pressure (SVP) is constant for the same body temperature.

A good answer to the second part of the question (respiratory physiological responses to altitude) was one that had some structure, eg responses divided into acute and chronic, respiratory, renal, haematological, cardiovascular and CNS categories, and relevant detail for each category. Candidates were expected to at least mention, but not restrict themselves to the following: acute responses, eg carotid/aortic body chemoreceptor stimulation hyperventilation, proportional to reduced BMP and hypoxia, limitations to hypocarbia (due to alterations in CSF pH) etc: physiological responses to early and chronic acclimatisation (eg renal HCO₃⁻-excretion, respiratory centre CO₂ response curve resets to left, altered peripheral chemoreceptor sensitivity, 2,3, DPG levels and related right. Shift in HbO₂ curve, alterations in pulmonary diffusing capacity due to increased alveolar surface area and pulmonary blood volume, etc).

It is important that current and future candidates use the examination reports to guide their learning. Thus it is essential that candidates not just read the feedback provided to each exam question but also refer to the reference(s) supplied below and other relevant sources they find to be useful.

Syllabus – B1k, 2i

Reference – Nunn's Respiratory Physiology, Ch 17 and 5.

Power and Kam 432-4.

0 (0%) of candidates passed this question.

11. Describe and / or illustrate the anatomy relevant for the insertion of a central line into the left subclavian vein using any of the available techniques.

There are a few areas of anatomy that are essential for Intensivist to have a high level of knowledge of. The subclavian vein is one of them. Unfortunately the extent of knowledge displayed by the candidates was very shallow. A good answer required as a minimum, a clear description of the course of the vein. This included the following facts – it is a continuation of the axillary vein, it's relationship to the first rib, to the medial border of the scalenus anterior, the fact that it arches up, medial, then down and that it joins the internal jugular vein (behind the subclavian joint, anatomical relationships (eg Anterior – clavicle, subclavius muscle, Posterior – first rib, apex lung superiorly, first intercostal space inferiorly, Superior – subclavian artery, thoracic duct medially, phrenic nerve, lower trunk brachial plexus laterally and Medial – brachiocephalic artery, trachea, vagal trunk, thoracic duct and oesophagus posteriorly) and surface anatomy (related to the various available techniques (eg the infraclavicular and supraclavicular approach)

Syllabus – C1d, 2g

Reference: Anatomy for Anaesthetists, Ellis and Feldman

0 (0%) of candidates passed this question.

12. Outline the pharmacology of noradrenaline.

Candidates should expect that questions relating to “the pharmacology of” are likely to be common. Thus candidates should have prepared structured approach for any such question. For example, one that includes predefined major categories such as pharmacodynamics and pharmacokinetics and sub-categories such as mechanism of action, absorption, preparations, bioavailability, volume of distribution, metabolism, elimination, adverse effect, clinical indications, precautions/interactions, etc. and the information relevant to each category. Failure to take a structured approach to such questions, as was observed amongst some candidates within this exam, risks omission of vital facts (and not gaining marks) and errors. Noradrenaline is such a common drug within intensive care practice and so candidates would be expected to know it in great detail. There are many references for it, such as the ones listed below.

Syllabus – G3a, 2b

References – Goodman and Gillman Chp 10 and Katzung.

2 (22%) of candidates passed this question.

SAQ PAPER 2

- 1. Outline the ideal properties of a colloid intravenous fluid. (25% marks) Compare and contrast Gelatins, Hydroxyethyl starch and 4 % Albumin solutions. (75% marks)**

The ideal properties of a colloid include: stability at room temperature and long shelf life, lack of complications such as antigenicity, toxicity, pyrogenicity, disease transmission, or other adverse effects (eg coagulopathy) and plasma volume expansion lasting several hours. Candidates performed well in this section.

Marks were equally divided between each colloid, and this part of the answer was well suited to table format. Candidates were expected to compare and contrast fluid source, infection and antigenic risk, cost and resource issues, packaging and ease of administration, duration of effect, tonicity, and properties which determine their side effect profile etc. Common errors were omission of adequate detail for each colloid and not being aware that Dextran is not a Hydroxyethyl starch.

Syllabus – E2a 2a

Reference: Foundations of Anaesthesia: Basic clinical Science, Hemmings and Hopkins, pg 719

5 (55%) of candidates passed this question.

- 2. Classify antiemetic drugs and describe their mechanism of action.**

Antiemetics can be classified by their receptor actions including, dopamine antagonists, serotonin antagonists, antihistamines, anticholinergics, antimotilinic etc or by their drug type – butyrophenones, phenothiazines, benzamides etc. Marks were divided between each class, and for “other/novel” antiemetics – such as, steroids, GABA agonists, alpha 2 agonists, mu receptor antagonists, cannabinoids, propofol and NK1 receptor antagonists.

Candidates were expected to mention the drug type, receptor interaction, the location of the receptors and the pathways inhibited by the drug – central CTZ, vestibular nuclei, solitary tract nucleus, vagal afferents or GIT motility and secretions. Most drugs work at one or more of these sites and marks were awarded for mention of this. Commonest errors were omission of adequate detail in each class. Antihistamines, anticholinergics and “others/novel” were frequently omitted.

Syllabus - Q12e and Q2b2a

Reference: Chp 37 Goodman and Gillman

3 (33%) of candidates passed this question.

- 3. Describe the mechanism of actions and duration of effect of drugs used to lower potassium in hyperkalaemia.**

A good answer to this question required the collation of knowledge from broad range of areas, ie drug activity. Marks were divided between each of the following: 8.4%NaHCO₃-,

insulin/glucose, K⁺ exchange resin, frusemide/loop diuretics, Beta2 agonists and K⁺ free fluid rehydration/dilution. Candidates often overlooked the fact that only loop diuretics and K⁺ exchange resins lower total body K⁺ content, whilst the others induce an intracellular K⁺ shift which is not sustained and do not directly result in body elimination of K⁺. Intravenous fluid rehydration lowers total body K⁺ if there is a resulting diuresis.

Most candidates just passed this question. Common omissions included NaHCO₃, loop diuretics and beta 2 agonists. No candidate mentioned rehydration/dilution. Calcium does not lower serum potassium.

Syllabus - various

Reference: various

5 (55%) of candidates passed this question.

4. Discuss the factors affecting pulmonary vascular resistance.

A good answer to this question required a discussion that focused on the following key points-

Recruitment and distension of pulmonary capillaries. Helps limit pulmonary vascular resistance as pressure and flow increase.

Lung volume. Lung inflation is thought to have a dual effect, expanding large vessels by traction while compressing smaller vessels and resistance is dependent upon lung volume, being lowest at approx FRC.

Gravity. Perfusion is distributed down a vertical gradient in the lung, reflecting the balance between intra-alveolar pressure and the distending vascular pressure. (West's Zones)

Oxygen. Hypoxia causes pulmonary vasoconstriction. Diverts blood away from hypoxic regions of the lung.

Hypercapnia and acidosis vasoconstriction

Autonomic innervation. Alpha -adrenergic stimulation - vasoconstrictor, Beta-adrenergic stimulation - vasodilatation, Parasympathetic stimulation - Vasodilatation

Local mediators. Vasoconstrictors (Serotonin, histamine, endothelins) and Vasodilators (NO, prostacyclin, isoprenaline)

The majority of these points could be efficiently explained through the use of graphs/figures, all of which are commonly found in the majority of physiology books that include respiratory physiology. Those candidates who failed to do so were also those who scored fewer points with this question.

Syllabus - B1i2b

Reference – Respiratory Physiology, the Essentials, West 5th Ed Chp4 p33-44

3 (33%) of candidates passed this question.

- 5. Explain the difference and the clinical relevance, between zero and first order kinetics. (60% marks) Give an example that is relevant to intensive care practice. (40% marks)**

For a good answer it was expected that candidates would mention that if mechanisms for elimination of a given drug become saturated, the kinetics approaches zero order, in which a constant **amount** of drug is eliminated per unit of time. First-order kinetics, is where a constant **fraction** of drug in the body is eliminated per unit of time – that is, systems for elimination of drugs such as metabolizing enzymes and transporters are not saturated, and thus the absolute rate of elimination of the drug is essentially a linear function of its concentration in plasma. Clearance varies with the concentration of drug. Drugs with a target concentration is more than the concentration at which half the maximal rate of elimination is reached have a narrow therapeutic index and zero order kinetics and therapeutic drug monitoring is most important – low therapeutic index and variable half life. In contrast to capacity-limited drug elimination, some drugs are cleared very readily by the organ of elimination, so that at any clinically realistic concentration of the drug, most of the drug in the blood perfusing the organ is eliminated on the first pass of the drug through it. The elimination of these drugs will thus depend primarily on the rate of drug delivery to the organ of elimination – have a high-extraction. Phenytoin provides an example of a drug for which metabolism becomes saturated in the therapeutic range of concentrations, and half-life can vary between 7 and 42 hours.

Syllabus – II 2a

Reference: Goodman and Gillman Chp 1

2 (22%) of candidates passed this question.

- 6. Outline the physiology of, and factors which regulate levels of angiotensin.**

For a good answer it was expected that candidates would mention the relationship of angiotensinogen, angiotensin I, renin and Angiotensin Converting Enzyme to angiotensin II production, the actions and fate of angiotensin II and factors that regulate angiotensin II. It was expected that candidates mention angiotensin acts as a potent vasoconstrictor, stimulates aldosterone secretion, facilitates noradrenaline release, preferentially vasoconstricts Efferent arteriole in nephron, preserving GFR in low perfusion states, increases renal tubular Na⁺ reabsorption and increases secretion of vasopressin and ACTH.

Regulation of Angiotensin could be separated into factors increasing angiotensin levels (eg prostaglandins, low K⁺ levels, Sympathetic stimulation, decreased Na⁺ delivery at distal tubule, any factor contributing to reduced renal blood flow (eg hypovolaemia, cardiac failure, renal artery stenosis) and factors reducing angiotensin levels (eg hypervolaemia, afferent arteriolar dilatation and vasopressin).

Syllabus - N1 (h), C2b (f)

Reference: Textbook of medical Physiology, Guyton, Chp 26, Goodman and Gillman, Chp 30

4 (44%) of candidates passed this question.

7. Define the following terms (40%)

- 1. Saturated Vapour Pressure of Water**
- 2. Absolute Humidity**
- 3. Relative Humidity**
- 4. Latent heat of vaporisation**

Briefly outline how the humidity of air is altered during inspiration and expiration by the respiratory tract (60%)

It is essential that candidates read and respond to the question asked of them. The first part of the question required simple, accurate definitions, which the majority of candidates were unable to provide. Marks were awarded for the definition only. Descriptions of measurement, potential effects on oxygenation, etc. were not asked and gained no marks.

The core of the second part required an outline of the exchange of heat and moisture through the upper airways and bronchial tree, culminating in fully saturated gas at core body temperature by level of the 2nd generation bronchi. Whilst the question asked 'humidity' and not temperature, correct definitions in the first part would have dictated a joint outline of both. The effects of surface area, the nasal turbinates, mucosal secretion and blood flow were all relevant. The contribution to insensible moisture and heat loss should have been mentioned. No candidate considered the effects of respiratory rate, mouth versus nose breathing, or dry medical gases versus room air.

Syllabus – B1k2d

Reference: Nunn pages 15 and 26

1 (11%) of candidates passed this question.

8. Compare and contrast the pharmacology of heparin and enoxaparin.

The vast majority of candidates chose to answer this question in tabular format and in doing so were easily able to consolidate a high scoring answer. This also allowed clear identification of important differences, such as molecular weight, mechanism of action, half-life, dose-interval, monitoring, elimination, reversal of effect, the influence of renal impairment and potential side-effects.

One exception to this approach would be clinical indications, where these show marked similarity. Candidates should consider writing similarities once whilst incorporating both drugs so as to use the time allocated more efficiently.

Syllabus - J2 2a

Reference: Pharmacology and Physiology in Anaesthetic practice, Stoelting 505-511 Basic and Clinical Pharmacology, Katzung 546-548

8 (89%) of candidates passed this question.

9. List the hormones secreted by the pituitary gland. (30% marks) Outline the physiological factors that control secretion of hormones from the posterior pituitary. (70% marks)

Once again candidates are reminded to read and answer the question presented to them as well as take into consideration the proportion of marks allocated. The expectation from the first section of the question was for candidates to only “list” the hormones secreted by the pituitary gland. The main hormones expected were ACTH, TSH, GH, FSH, LH and prolactin anteriorly; and, ADH (vasopressin) and oxytocin posteriorly.

Unfortunately, a number of candidates confused which hormones come from which region and therefore were unable to score marks in the second part. The question clearly asked for factors controlling secretion of hormones from the posterior pituitary, therefore, detailed descriptions of the mechanism of action of ADH in the kidney, or of hormones arising from the anterior pituitary did not relate to the question and were not allocated marks.

With respect to ADH, most marks were gained by candidates who described not only osmolality and plasma volume, but the relative sensitivity of the pituitary to these and the pre-potent nature of volume over osmolality; also, the influence of other hormonal axes involved in plasma volume regulation. Marks were also available for other inputs including pain, stress, exercise, etc. A brief description of factors influencing oxytocin was also expected.

Syllabus – N12d

Reference: Gannong p383, Guyton p359

4 (44%) of candidates passed this question.

10. Describe how the kidney handles sodium. (50 marks) What factors influence urinary sodium excretion (50 marks)

Candidates were essentially expected to describe the fate of sodium as it passes through the kidney from filtration at the glomerulus to ending up in the urine. Essentially, most Na⁺ is reabsorbed at the proximal tubule (65%), reabsorption being down an electrochemical gradient (inside cell negative and low Na⁺ concentration) which is maintained by active Na⁺/K⁺ ATPase activity at the basolateral membrane. Then Loop of Henle reabsorbs a further 15% of filtered Na⁺. At descending limb – no Na⁺ reabsorption. At ascending limb, thick segment – active process as per proximal tubule, but mostly coupled to K⁺ and Cl⁻ and paracellular diffusion through tight junctions. Finally the distal convoluted tubule and collecting ducts, a further almost 20% reabsorbed – leaving < 1%

Factors influencing loss are

- aldosterone = stimulates Na⁺ reabsorption at the collecting tubules
- intra renal factors such as interstitial pressure which is lowered during hypovolaemia and reduced renal perfusion, thus promoting Na⁺ reabsorption gradient
- sympathetic nervous system – influences interstitial pressure and increases renin production
- angiotensin II – stimulates reabsorption at proximal tubule
- Atrial Natriuretic Peptide/Factor – inhibits Na⁺ reabsorption
- Others – dopamine, cortisol, insulin => increase Na⁺ reabsorption, but minor factors

Syllabus – D1, 2f

Reference – Textbook of medical Physiology, Guyton, Chp 28

2 (22%) of candidates passed this question.

11. Outline the principal functions of the Liver, and give examples.

For a good answer candidates were expected to at least mention the following --

Formation and secretion of bile

Carbohydrate metabolism (Glycogen synthesis and breakdown, Gluconeogenesis)

Lipid metabolism (Fatty acid oxidation, Synthesis of cholesterol and phospholipids,
Production of ketoacids)

Protein metabolism Breakdown

Metabolism of toxins, drugs (Phase I reactions - oxidation, reduction, hydrolysis,
Phase II reactions- conjugation/glucuronidation)

Storage (Vitamins B12, A, D 2, Iron as ferritin, Glycogen)

Immunity

Endocrine (Synthesis of 25 OH cholecalciferol, Metabolism of steroid hormones, Synthesis
of somatomedins, Erythropoietin)

Miscellaneous (Acid base role – lactate metabolism, Blood store)

Syllabus – I2a

Reference: Gannong p485, Power and Kam p185

4 (44%) of candidates passed this question.

12. Describe how gas exchange is influenced across the placenta near the term of pregnancy.

For a good answer candidates were expected to account how the placenta allows for effective diffusion to occur. Good answers incorporated the parameters within the Fick equation (eg. area of placental gas exchange, pressure of gas in maternal sinuses ($PO_2 = 50$ mmHg), pressure of gas in umbilical vein ($PO_2 = 30$ mmHg). Also expected was an explanation of the role of foetal haemoglobin, the double Bohr and double Haldane effects. These were commonly omitted.

Syllabus – O12d

Reference: Power and Kam p354

1 (11%) of candidates passed this question.

PAPER 1 and 2 CLOZE QUESTIONS

6 (67%) candidates passed these questions.

PAPER 1 and 2 RANK QUESTIONS

4 (44%) candidates passed these questions.

PAPER 1 and 2 MATCH QUESTIONS

5 (56%) candidates passed these questions.

ORAL SECTION

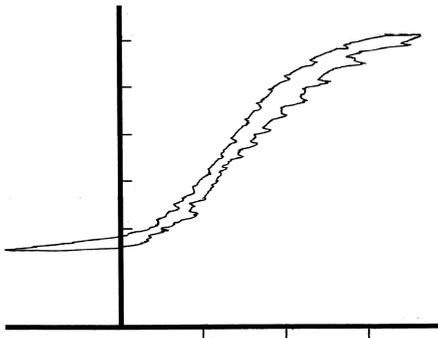
3 candidates were invited to attend the oral section based on their written marks.

VIVA 1

The initial information given to the candidates was –

This VIVA will assess your knowledge of pulmonary mechanics

Can you identify this curve and label the axes?



Candidates were tested on their knowledge of pulmonary compliance, its measurement, factors that influence it, surfactant and interpretation of common ventilator waveforms.

1 (33%) of 3 candidates passed this VIVA.

VIVA 2

The initial information given to the candidates was –

This viva will test your knowledge on temperature control and measurement.

Candidates were asked about temperature and thermoregulation, various means of measuring temperature and metabolic rate and factors that influence metabolic rate.

3 (100%) of 3 candidates passed this VIVA.

VIVA 3

The initial information given to the candidates was –

*This question is about the anatomy of the nephron and its blood supply.
Please draw a picture of a nephron and label it.*

This viva explored a candidates understanding of anatomy of the nephron, unique details of renal blood flow, macula densa, glomerular filtration rate and its determinants, generation of a concentrated urine.

3 (100%) of 3 candidates passed this VIVA

VIVA 4

The initial information given to the candidates was –

This is an analysis of urine from a patient on the intensive care unit:

<i>Glucose</i>	<i>negative</i>
<i>Ketones</i>	<i>trace</i>
<i>pH</i>	<i>6.0</i>
<i>urobilinogen</i>	<i>moderate</i>
<i>Specific gravity</i>	<i>>1.030</i>

You will be asked to comment upon these findings

In this viva candidates were asked to explain the physiological basis to the urinalysis provided above. Further knowledge was sought in reference to ketones and ketone body generation and metabolism, generation of urobilinogen and significance of specific gravity.

3 (100%) of 3 candidates passed this VIVA.

VIVA 5

The initial information given to the candidates was –

An anaesthetist calls you to request an ICU bed for a patient suffering from spina bifida who has just suffered what is believed to be an adverse reaction shortly after induction of anaesthesia.

Classify allergic reactions.

In this viva candidates were asked to explain and classify allergic reactions, the pharmacological basis to their treatment (eg what are the mechanisms by which adrenaline is used for anaphylaxis) and to list common agents (latex was commonly overlooked) in ICU practice that are associated with allergic reactions.

3 (100%) of 3 candidates passed this VIVA.

VIVA 6

The initial information given to the candidates was –

This viva will test your knowledge about the use of diuretics, pharmacokinetics and dynamics.

And

Use of drugs during a cardiac arrest.

Candidates were asked to explain mechanism of action of diuretics, in particular frusemide. Candidates were also tested upon the basis that various vasoactive drugs (eg adrenaline and vasopressin) are used in cardiac arrest, in particular their mechanism of action and routes of administration.

0 (0%) of 3 candidates passed this VIVA.

VIVA 7

The initial information given to the candidates was –

*This will explore your knowledge of cardiovascular physiology.
Draw a normal ECG tracing , indicate waves and intervals*

And

Statistics

Candidates were asked to draw a normal ECG trace and to explain the ionic mechanisms that form the basis to that trace and the consequences of hyperkalaemia.

In relation to statistics, candidates were shown a series of blood pressure values on a range of patients, asked to describe what type of data was being represented, how it may be displayed, what is normal distribution and what test may be used to compare the blood pressure values between the two groups. It is important for candidates to understand that generally only knowledge of fundamental, common and fairly simple statistical tests would be asked from them.

2 (66%) of 3 candidates passed this VIVA.

VIVA 8

The initial information given to the candidates was –

*This station will explore your knowledge of the following areas:
Neurophysiology and Opioid pharmacology*

Candidates were asked about cerebral blood flow, it's measurement, regulation and opioids and their CNS effects

1 (33%) of 3 candidates passed this VIVA.

Summary of Examination

A detailed syllabus has been developed and forms the foundation for the knowledge base for the JFICM Primary Examination. All questions are sourced directly from that syllabus and candidates should have a sound understanding of those topics, and confidence to express their understanding of the subject material in both written and oral form. The candidates should be able to integrate and express basic physiological and pharmacological principles as to how they relate to various scenarios relevant to Intensive Care practice.

The JFICM Primary Examination explores knowledge of the basic science that forms the foundation to Intensive Care practice. For example, in this exam there were many questions that sought knowledge of the basic sciences as they applied to everyday clinical occurrences, eg blood loss, glucose control, noradrenaline, CVC line insertion, gastric outlet obstruction, potential life threatening hyperK+, applied pharmacokinetics and many others. This aspect is a particular strength of, and differentiates the, JFICM Primary Examination from other primary examinations.

Candidates are strongly encouraged to allow sufficient period of study prior to undertaking this exam. Many candidates are still presenting very much under prepared. Candidates are encouraged to discuss with their Supervisor of Training their level of preparedness prior to undertaking the JFICM Primary Examination.

A great deal of effort is made to ensure that the exam process is robust and non discriminatory to any candidate. Candidates are reminded that they must adhere to the examination rules. A penalty may apply if an examination rule is not followed.

A/Prof Arthas Flabouris
Deputy Chair
Primary Examination Committee

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