



REPORT OF THE FIRST PART WRITTEN EXAMINATION

MARCH 2020

This report is prepared to provide candidates, tutors and their Supervisors of Training with information about the examination. Answers provided are not model answers but a guide as to what was expected.

Candidates should read and then discuss the report with their tutors to prepare appropriately for future examinations.

The exam included two 2.5 hour written papers, each comprised of ten short answer questions and fifty multiple-choice questions. Candidates are required to perform at a satisfactory level in the written before being eligible to present for the oral part of the exam.

MORNING PAPER (PAPER 1)

1. Describe the carriage of carbon dioxide in blood.

68% of candidates passed this question.

A detailed understanding of the carriage of carbon dioxide (CO₂) in the blood is essential to the practice of intensive care medicine. Comprehensive answers classified and quantified the mechanisms of CO₂ carriage in the blood and highlighted the differences between the arterial and venous systems. An explanation of the physiological principles surrounding these differences and the factors which may affect them was expected. The changes that occur at the alveolar and peripheral tissue interfaces with a similar explanation of process was also required. Candidate answers were often at the depth of knowledge required for an 'outline question' and a more detailed explanation was required to score well.

2. Describe the pharmacology of glyceryl trinitrate (GTN).

69% of candidates passed this question.

GTN is a commonly used 'level 1' drug. The most comprehensive answers included information on available drug preparations, indications, mechanism of action, pharmacodynamics and pharmacokinetics and its side-effect profile. It was expected that significant detail be included in the pharmacodynamic section (e.g. preferential venodilation, reflex tachycardia, effects on myocardial oxygen demand etc). Common omissions included tachyphylaxis, dosing and its metabolism. Many answers didn't mention the first pass effect.

3. Outline the potential adverse consequences of blood transfusion.

43% of candidates passed this question.

As only an outline was asked for, a brief statement about each complication was sufficient. Better answers were structured using a classification of: Acute Immunological, Acute Non-

Immunological, Delayed Immunological and Delayed Non-immunological. Examples of expected detail would include the following:

E.g. Bacterial infection – a statement outlining the incidence of bacterial infection, a common causative organism or why bacterial infections are more commonly associated with platelet transfusions than red cells would have scored the marks allocated to 'bacterial infection'.

E.g. Acute Haemolytic Transfusion Reaction – a statement about red cells being destroyed due to incompatibility of antigen on transfused cells with antibody of the recipient and an approximate incidence scored the marks allocated to AHTR.

An excellent resource is the Australian Red Cross transfusion website as listed in the suggested reading section of the syllabus.

4. Explain the counter-current mechanism in the kidney.

63% of candidates passed this question.

Higher scoring candidates described the counter-current multiplier mechanism, the counter-current exchanger and the contribution of urea cycling to the medullary osmotic gradient. Detailing the mechanisms as to how they may be established, maintained and or regulated. Descriptions of the multiplier (LOH) alone did not constitute a passing score. Values for osmolality at the cortex & medulla and within the different parts of the LOH was required. A description of the counter-current exchanger system where inflow runs parallel to, counter to and in close proximity to the outflow was expected. This could have been achieved by describing the anatomical layout of the loop of Henle and the vasa recta.

5. Outline the mechanisms of antimicrobial resistance (50% of marks). Briefly outline the pharmacology of ciprofloxacin (50% of marks).

71% of candidates passed this question.

Most candidates had a structured answer to mechanisms of resistance that covered the major categories (alter target protein, prevent entry, efflux, degrade drug) and provided an example of a bacteria and the affected antibiotic, as was required to answer the question in full. Ciprofloxacin, whilst perhaps not a first line drug in the ICU, was not well known by many candidates. Better answers included a brief outline of class, mechanism of action (action on DNA gyrase to inhibit replication), spectrum (Gram negatives particularly mentioning *Pseudomonas*, lesser Gram-positive cover, not anaerobes, some atypical), PK (with correct dose, wide penetration into tissues including bone/prostate etc., predominantly renal excretion), side effects/toxicity (common or specific to cipro e.g. QT, tendinitis, arthropathy) and an example of resistance.

6. Outline how the respiratory system of a neonate differs from that of an adult.

20% of candidates passed this question.

This question required an outline of the anatomical, mechanical and functional differences. It was expected that factors leading to an increased work of breathing and oxygen cost would be mentioned. The mechanics of expiration were not often included in candidates' answers. Immaturity of the alveoli and peripheral chemoreceptors were common omissions. Inaccuracies regarding upper airway anatomy and compliance of the chest wall cost some candidates marks. The question did not call for an explanation of the relative difficulty of intubation. Discussion of pathophysiology due to airway obstruction, causes of central apnoea or sensitivity to drugs was not required. Many answers included inaccurate information. Points which were often missed

were difference in bronchial angles, number of alveoli, number of type 1 fibres in diaphragm, ciliary function and peripheral chemoreceptors.

7. Describe the physiological control of systemic vascular resistance (SVR).

21% of candidates passed this question.

This question invited a detailed discussion of the physiological control mechanisms in health, not pathophysiology nor drug-mediated effects. The central and reflex control mechanisms that regulate SVR over time are distinct from the local determinants of SVR. There was often confusion between dependent and independent variables. Cardiac output is generally depended upon SVR, not vice versa, even though SVR can be mathematically calculated from CO and driving pressures. The question asked about systemic vascular resistance and did not require a discussion of individual organs except for a general understanding that local autoregulation versus central neurogenic control predominates in different tissues. Emotional state, temperature, pain and pulmonary reflexes were frequently omitted. Peripheral and central chemoreceptors and low-pressure baroreceptors were relevant to include along with high pressure baroreceptors.

8. Describe the production, metabolism and role of lactate.

16% of candidates passed this question.

Better answers used the categorisation in the question as a structure for their answer. Many candidates gave a good description of lactate production from glycolysis, increasing with accumulation of NADH and pyruvate, when these are unable to enter Krebs cycle. There were however, many vague and incorrect descriptions as to what lactate is and its physiological role. Many candidates suggested that its presence is abnormal or pathological. Most answers demonstrated a superficial understanding and physiological detail of lactate's role as an energy currency in times of oxygen debt. Higher scoring candidates often mentioned non-hypoxic causes of pyruvate accumulation which include; circulating catecholamines, exercise, sepsis or lack of mitochondria (RBCs). Mention of the relative ATP production of the two fates of pyruvate was also noted in more complete answers. The Cori cycle was generally superficially described. A key role of lactate is the 'lactate sink', allowing a period of ongoing ATP production from glycolysis when cells become oxygen deplete or the Krebs cycle is inhibited; few candidates detailed or highlighted this.

9. Outline the changes to drug pharmacokinetics and pharmacodynamics that occur at term in pregnancy.

7% of candidates passed this question.

Answers framed around absorption, distribution, metabolism and excretion performed better. Some brief comments on physiology are required as the basis for pharmacokinetic change, but discussion of physiology that was not then specifically related to pharmacology did not score marks. Specific 'real life' examples necessitating change in practice or prescribing were well regarded e.g. reduction in spinal/epidural local anaesthetic dosing. Vague statements about possible or theoretical changes were less well regarded.

10. Compare and contrast the pharmacology of noradrenaline and vasopressin.

49% of candidates passed this question.

These are both level 1 drugs regularly used in intensive care. Significant depth and detail of each drug were expected. Overall knowledge was deemed to be superficial and lacked integration. Better answers identified key points of difference and overlap in areas such as structure, pharmacetics, pharmacokinetics, pharmacodynamics, mechanism of action, adverse effects and contraindications. A tabular list of individual drug pharmacological properties alongside each other did not score as well as answers which highlighted key areas of difference and similarities.

AFTERNOON PAPER (PAPER 2)

11. Describe the structure and function of adult haemoglobin.

57% of candidates passed this question.

Marks were awarded for the two components of this question – structure and function. The structure component was often only briefly described with a cursory overview provided; however, this component contributed around half of the available marks. Many candidates were unable to accurately describe the structural components of the haemoglobin molecule. The functional component was handled better – however much time was wasted with detailed drawings of the oxyhemoglobin curve (not many marks awarded for this). The basic function of haemoglobin carriage of oxygen and carbon dioxide was known, but detail was often missing about its role as a buffer or its role in the metabolism of nitric oxide.

12. Explain resonance and its significance and the effects of damping on invasive arterial blood pressure measurement.

23% of candidates passed this question.

Many candidates gave detailed answers that involved the set up and components of the arterial line system that was not asked for in the question and did not attract marks. There was confusion around the correct use of the terms natural frequency, resonance frequency and harmonics – candidates that were able to describe these frequencies correctly went on to achieve a good mark – the graphs and discussion around optimal dampening, over and underdamped traces were often drawn poorly or without sufficient detail, and at times were not used within in the context of the answer. Descriptions of the clinical effect seen with over / under dampened traces on blood pressure was well described.

13. Explain the control of breathing.

53% of candidates passed this question.

Most candidates provided a structured answer based around a sensor / central integration / effector model with appropriate weighting towards the sensor / integration component. Better answers provided an understanding of details of receptor function, roles of the medullary and pontine nuclei and how these are thought to integrate input from sensors. Marks were awarded to PaCO₂ ventilation and PaO₂ ventilation response when accurate, correctly labelled diagrams or descriptions were provided.

14. Describe the pharmacology of frusemide.

51% of candidates passed this question.

Most candidates presented a well-structured answer and provided a basic understanding. Answers that provided accurate indications and details of the mechanism underlying the actions of frusemide attracted more marks. Those recognising the increased delivery of sodium and chloride to the distal tubule (exceeding resorptive capacity) were awarded more marks than those answers that attributed the diuretic action solely to reduction in the medullary gradient. Frusemide has many potential adverse effects and a reasonable list was expected. Conflicting information was common (e.g. highly bound to albumin – Vd 4 L/kg) and better answers avoided this.

15. Define bioavailability (10% of marks). Outline the factors which affect it (90% of marks).

49% of candidates passed this question.

Many candidates spent time defining and describing aspects of pharmacokinetics which were not relevant to the question. E.g. clearance, volume of distribution and half-life. Candidates who scored well utilised a structure which incorporated the headings of the factors which affect the bioavailability of medications with a simple description as to the nature of the effect. These factors included: the physical properties of the drug, the preparation, patient factors, the route of administration and metabolism amongst others.

16. Outline the formation, circulation and functions of cerebrospinal fluid.

81% of candidates passed this question.

This is a three-part question and was marked as such. The circulation and functions of CSF was generally well answered. Formation of CSF, however, was answered poorly, with many candidates listing its composition instead. The examiners were looking for an understanding of the physiological processes of formation not the composition.

17. Discuss the advantages and disadvantages of the use of an intravenous infusion of fentanyl in comparison to morphine.

27% of candidates passed this question.

These are both level 1 drugs commonly used as an infusion in daily practice. This question specifically asked the candidates to frame their answers around an intravenous infusion of fentanyl in comparison to morphine. A tabular listing of general properties of the two drugs highlighting the differences between the drugs would not score well. The question asks for a considered response that should focus on context sensitive half-life, compartments and metabolism, instead many focused on the speed of onset and potency, which are minor considerations when drugs are given for long periods by infusion. Candidates often demonstrated a superficial knowledge of key pharmacokinetic concepts with limited application of these principles in the context of an intravenous infusion. Better answers also related the above to various relevant pharmacodynamic influences such as age, liver and renal impairment.

18. Describe the respiratory changes that occur throughout pregnancy.

31% of candidates passed this question.

The question asked for a description of the respiratory changes throughout pregnancy, which includes labour. Simple lists of changes did not score highly. A straightforward structure including; first, second and third trimester delineation would have elevated many answers from below par to a pass. Many good answers gave succinct detail on both mechanical respiratory changes and the hormonal mechanisms behind them. Higher scoring answers also described the overall effect of individual changes to spirometry, geometry or respiratory control.

19. Discuss the determinants of venous return to the heart.

67% of candidates passed this question.

The factors that influence VR are captured in 2 formulae; $VR = CO$, and $VR = (MSFP-RAP) / \text{Venous Resistance}$. Candidates that used these as the backbone structure of their answer scored well. Quite a few candidates failed to consider factors that affect left heart CO also effect VR. Recognising that $CO \text{ does} = VR$ appeared to elude some candidates.

20. Outline the distribution, absorption, elimination, regulation and physiological role of phosphate.

29% of candidates passed this question.

The answer structure should have utilized the headings provided in the question. Many candidates described the physiology of calcium, which while related, did not attract marks. The distribution section required not only the sites of distribution but also the percentages found in each. The regulation should have included both primary and secondary mechanisms and an outline on the factors affecting renal excretion, intestinal absorption and release from bone etc. An outline of the physiological role of phosphate required a broad knowledge of physiological processes.

MULTIPLE-CHOICE QUESTIONS – PAPERS 1 AND 2

95% of candidates passed the multiple-choice section.

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