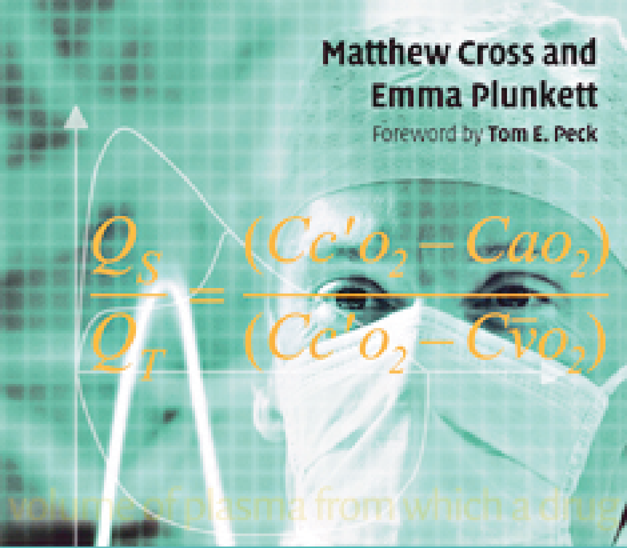
Matthew Cross and
Emma Plunkett

Foreword by Tom E. Peck



Physics, Pharmacology and Physiology for Anaesthetists

Key Concepts for the FRCA

CAMBRIDGE
Medicine

CAMBRIDGE
www.cambridge.org/9780521700443


Medical book
MedWedi.ru

Physics, Pharmacology and Physiology for Anaesthetists

Key concepts for the FRCA

Physics, Pharmacology and Physiology for Anaesthetists

Key concepts for the FRCA

Matthew E. Cross MB ChB MRCP FRCA
Specialist Registrar in Anaesthetics, Queen Alexandra Hospital, Portsmouth, UK

Emma V. E. Plunkett MBBS MA MRCP FRCA
Specialist Registrar in Anaesthetics, St Mary's Hospital, London, UK

Foreword by

Tom E. Peck MBBS BSc FRCA
Consultant Anaesthetist, Royal Hampshire County Hospital, Winchester, UK

CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo

Cambridge University Press
The Edinburgh Building, Cambridge CB2 8RU, UK
Published in the United States of America by Cambridge University Press, New York

www.cambridge.org
Information on this title: www.cambridge.org/9780521700443

First published in print format 2008

ISBN-13 978-0-511-38857-6 eBook (NetLibrary)

ISBN-13 978-0-521-70044-3 paperback

To Anna and Harvey for putting up with it all
and for Dad

MC

For all my family
but especially for Adrian

EP

Contents

Acknowledgements

We are grateful to the following individuals for their invaluable help in bringing this book to publication

Dr Tom Peck MBBS BSc FRCA
Anaesthetics Department, Royal Hampshire County Hospital, Winchester, UK

Dr David Smith DM FRCA
Shackleton Department of Anaesthetics, Southampton General Hospital, Southampton, UK

Dr Tom Pierce MRCP FRCA
Shackleton Department of Anaesthetics, Southampton General Hospital, Southampton, UK

Dr Mark du Boulay BSc FRCA
Anaesthetics Department, Royal Hampshire County Hospital, Winchester, UK

Dr Roger Sharpe BSc FRCA
Anaesthetics Department, Northwick Park Hospital, London, UK

In addition we are grateful for permission to reprint the illustrations on pages 183 and 184 from International Thomson Publishing Services Ltd.
Cheriton House, North Way, Andover, UK

Preface

The examinations in anaesthesia are much feared and respected. Although fair, they do require a grasp of many subjects which the candidate may not have been familiar with for some time. This is particularly true with regards to the basic science components.

This book does not aim to be an all-inclusive text, rather a companion to other books you will already have in your collection. It aims to allow you to have an additional reference point when revising some of these difficult topics. It will enable you to quickly and easily bring to hand the key illustrations, definitions or derivations that are fundamental to the understanding of a particular subject. In addition to succinct and accurate definitions of key phrases, important equations are derived step by step to aid understanding and there are more than 180 diagrams with explanations throughout the book.

You should certainly find a well-trusted textbook of anaesthesia if you wish to delve deeper into the subject matter, but we hope to be able to give you the knowledge and reasoning to tackle basic science MCQs and, more crucially, to buy you those first few lines of confident response when faced with a tricky basic science viva.

Good luck in the examinations, by the time you read this the end is already in sight!

Foreword

Many things are currently in a state of flux within the world of medical education and training, and the way in which candidates approach examinations is no exception. Gone are the days when large weighty works are the first port of call from which to start the learning experience. Trainees know that there are more efficient ways to get their heads around the concepts that are required in order to make sense of the facts.

It is said that a picture says a thousand words and this extends to diagrams as well. However, diagrams can be a double-edged sword for trainees unless they are accompanied by the relevant level of detail. Failure to label the axis, or to get the scale so wrong that the curve becomes contradictory is at best confusing.

This book will give back the edge to the examination candidate if they digest its contents. It is crammed full of precise, clear and well-labelled diagrams. In addition, the explanations are well structured and leave the reader with a clear understanding of the main point of the diagram and any additional information where required. It is also crammed full of definitions and derivations that are very accessible.

It has been pitched at those studying for the primary FRCA examination and I have no doubt that they will find it a useful resource. Due to its size, it is never going to have the last word, but it is not trying to achieve that. I am sure that it will also be a useful resource for those preparing for the final FRCA and also for those preparing teaching material for these groups.

Doctors Cross and Plunkett are to be congratulated on preparing such a clear and useful book – I shall be recommending it to others.

Dr Tom E. Peck MBBS BSc FRCA

Consultant Anaesthetist, Royal Hampshire County Hospital, Winchester, UK

Introduction

This book is aimed primarily at providing a reference point for the common graphs, definitions and equations that are part of the FRCA syllabus. In certain situations, for example the viva sections of the examinations, a clear structure to your answer will help you to appear more confident and ordered in your response. To enable you to do this, you should have a list of rules to hand which you can apply to any situation.

Graphs

Any graph should be constructed in a logical fashion. Often it is the best-known curves that candidates draw most poorly in their rush to put the relationship down on paper. The oxyhaemoglobin dissociation curve is a good example. In the rush to prove what they know about the subject as a whole, candidates often supply a poorly thought out sigmoid-type curve that passes through none of the traditional reference points when considered in more detail. Such an approach will not impress the examiner, despite a sound knowledge of the topic as a whole. Remembering the following order may help you to get off to a better start.

Size

It is important to draw a large diagram to avoid getting it cluttered. There will always be plenty of paper supplied so don't be afraid to use it all. It will make the examiner's job that much easier as well as yours.

Axes

Draw straight, perpendicular axes and label them with the name of the variable and its units before doing anything else. If common values are known for the particular variable then mark on a sensible range, for example 0–300 mmHg for blood pressure. Remember that logarithmic scales do not extend to zero as zero is an impossible result of a logarithmic function. In addition, if there are important reference points they should be marked both on the axis and where two variables intersect on the plot area, for example 75% saturation corresponding to 5.3 kPa for the venous point on the oxyhaemoglobin dissociation curve. Do all of this before considering a curve and do not be afraid to talk out loud as you do so – it avoids uncomfortable silences, focuses your thoughts and shows logic.

Beginning of a curve

Consider where a curve actually starts on the graph you are drawing. Does it begin at the origin or does it cross the *y* axis at some other point? If so, is there a specific value at which it crosses the *y* axis and why is that the case? Some curves do not come into contact with either axis, for example exponentials and some physiological autoregulation curves. If this is the case, then you should demonstrate this fact and be ready to explain why it is so. Consider what happens to the slope of a curve at its extremes. It is not uncommon for a curve to flatten out at high or low values, and you should indicate this if it is the case.

Middle section

The middle section of a curve may cross some important points as previously marked on the graph. Make sure that the curve does, in fact, cross these points rather than just come close to them or you lose the purpose of marking them on in the first place. Always try to think what the relationship between the two variables is. Is it a straight line, an exponential or otherwise and is your curve representing this accurately?

End of a curve

If the end of a curve crosses one of the axes then draw this on as accurately as possible. If it does not reach an axis then say so and consider what the curve will look like at this extreme.

Other points

Avoid the temptation to overly annotate your graphs but do mark on any important points or regions, for example segments representing zero and first-order kinetics on the Michaelis–Menten graph.

Definitions

When giving a definition, the aim is to *accurately* describe the principle in question in as few a words as possible. The neatness with which your definition appears will affect how well considered your answer as a whole comes across. Definitions may or may not include units.

Definitions containing units

Always think about what units, if any, are associated with the item you are trying to describe. For example, you know that the units for clearance are $ml.min^{-1}$ and so your definition must include a statement about both volume (ml) and time (min). When you are clear about what you are describing, it should be presented as succinctly as possible in a format such as

> '*x*' is the **volume** of plasma ...
> '*y*' is the **pressure** found when ...
> '*z*' is the **time** taken for ...
> Clearance **(ml.min^{-1})** is the volume **(ml)** of plasma from which a drug is completely removed per unit time **(min)**
> Pressure **(N.m^{-2})** describes the result of a force **(N)** being applied over a given area **(m^2)**.

You can always finish your definition by offering the units to the examiner if you are sure of them.

Definitions without units

If there are no units involved, think about what process you are being asked to define. It may be a ratio, an effect, a phenomenon, etc.

> Reynold's number is a **dimensionless number** ...
> The blood:gas partition coefficient is the **ratio** of ...
> The second gas effect is the **phenomenon** by which ...

Conditions

Think about any conditions that must apply. Are the measurements taken at standard temperature and pressure (STP) or at the prevailing temperature and pressure?

> The triple point of water is the temperature at which all three phases are in equilibrium at **611.73 Pa. It occurs at 0.01 °C**.

There is no need to mention a condition if it does not affect the calculation. For example, there is no need to mention ambient pressure when defining saturated vapour pressure (SVP) as only temperature will alter the SVP of a volatile.

Those definitions with clearly associated units will need to be given in a clear and specific way; those without units can often be 'padded' a little if you are not entirely sure.

Equations

Most equations need only be learned well enough to understand the components which make up the formula such as in

$$V = IR$$

where V is voltage, I is current and R is resistance.

There are, however, some equations that deserve a greater understanding of their derivation. These include,

The Bohr equation
The Shunt equation
The Henderson–Hasselbach equation

These equations are fully derived in this book with step by step explanations of the mathematics involved. It is unlikely that the result of your examination will hinge on whether or not you can successfully derive these equations from first principles, but a knowledge of how to do it will make things clearer in your own mind.

If you are asked to derive an equation, remember four things.

1. Don't panic!
2. Write the end equation down **first** so that the examiners know you know it.
3. State the first principles, for example the Bohr equation considers a single tidal exhalation comprising both dead space and alveolar gas.
4. Attempt to derive the equation.

If you find yourself going blank or taking a wrong turn midway through then do not be afraid to tell the examiners that you cannot remember and would they mind moving on. No one will mark you down for this as you have already supplied them with the equation and the viva will move on in a different direction.