

JONATHAN M. FISHMAN  
VIVIAN A. ELWELL  
RAJAT CHOWDHURY

SECOND EDITION



# OSCEs for the MRCS Part B

*A Bailey & Love*  
REVISION GUIDE

WITH VITALSOURCE®  
EBOOK



CRC Press  
Taylor & Francis Group

# **OSCEs for the MRCS Part B**

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## **A Bailey and Love Revision Guide**

### **Second Edition**

**Jonathan M. Fishman**

BA (Hons), MA (Cantab), BM BCh (Oxon), PhD, MRCS (Eng),  
DOHNS (RCS Eng), FRCS (ORL-HNS)

ENT Senior Registrar and Honorary Clinical Lecturer University  
College London London, United Kingdom

**Vivian A. Elwell**

BA (Hons), MA (Cantab), MBBS, MRCS, FRCS (Neuro. Surg.)

*Consultant Neurosurgeon and Spinal Surgeon*

*Brighton and Sussex University Hospitals NHS Trust*

*Brighton, United Kingdom*

**Rajat Chowdhury**

BSc (Hons), MA (Oxon), BM BCh (Oxon), MRCS, FRCR, FBIR, PGCME

*Consultant Radiologist Oxford University Hospitals NHS Foundation*

*Trust Oxford, United Kingdom*

*All Managing Directors of Insider Medical Ltd*

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*In loving memory of Dr David S Fishman – we dedicate this book to you.*

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## Preface

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This book has been written as an accompaniment to *Bailey & Love's Short Practice of Surgery* (27th edition) with the Membership of the Royal College of Surgeons examination in mind. It is dedicated to the Membership of the Royal College of Surgeons Part B Objective Structured Clinical Examination, which is the final part of the Intercollegiate Membership of the Royal College of Surgeons examination. This new examination was introduced in the autumn of 2008 and was developed to reflect the changes in postgraduate surgical training in the United Kingdom. This exam is designed and set by the Royal Colleges of Surgeons to test the knowledge, skills and attributes acquired during core surgical training. Successful completion of the Membership of the Royal College of Surgeons will then allow surgical trainees to progress to specialty trainee 3 (ST3) in their chosen subspecialty.

Achieving success in the Membership of the Royal College of Surgeons Objective Structured Clinical Examination requires a thorough basic understanding of clinical medicine, professional examination and technical skills, problem solving and decision making, as well as excellent bedside manner and people skills. It is not difficult to appear hesitant and unintelligent under exam duress, even for the most gifted amongst us. However a precise, structured and systematic approach can easily transform the nervous candidate into one who appears confident, dynamic and multidimensional. A planned strategic approach, thus, ensures that candidates are equipped with the essential tools to face any challenge they may face.

The Membership of the Royal College of Surgeons Objective Structured Clinical Examination can be likened to a circuit training course, in that the stations are quick and candidates must immediately switch into their new task at the ring of a bell. It is inevitable that adrenaline is running high but, in our experience, it is those candidates that channel these emotions in a positive way that emerge with a positive Membership of the Royal College of Surgeons Objective Structured Clinical Examination result.

This book is based on our highly successful, 'Insider Medical Membership of the Royal College of Surgeons Part B Objective Structured Clinical Examination Course' ([www.insidermedical.co.uk](http://www.insidermedical.co.uk), [www.insidermedical.com](http://www.insidermedical.com)) and the feedback obtained from over a thousand candidates whom we have taught through these courses. We have, therefore, written this book with the aim of targeting high yield topics that are likely to be faced and offer methods to tackle the challenges that may be

posed in the exam. We have drawn from our breadth of experience of teaching at both the undergraduate and postgraduate levels and have identified common pitfalls. We, therefore, also include top tips on getting through those tricky situations, which can often be the fine line between success and failure.

We are confident that this book will assist any trainee surgeon to sail through the Medical Membership of the Royal College of Surgeons Objective Structured Clinical Examination with ease and we hope to make the time taken to prepare for the exam that much more enjoyable and rewarding. Our desired outcome is to secure the future of surgical science and practice, by guiding trainee surgeons in their quest for mastering their art.

**Jonathan M Fishman**  
**Vivian A Elwell**  
**Rajat Chowdhury**



## Acknowledgements

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## Authors

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**Jonathan M Fishman, BA (Hons), MA (Cantab), BM BCh (Oxon), PhD, MRCS (Eng), DOHNS (RCS Eng), FRCS (ORL-HNS)** is a senior specialty registrar in ENT, a Fellow of the Royal College of Surgeons and Senior Editor for *The Journal of Laryngology & Otology* (Cambridge University Press). He graduated with a ‘triple’ first class honours degree in Natural Sciences from Sidney Sussex College, University of Cambridge, and completed his clinical training at St John’s College, University of Oxford. He has held posts in accident and emergency, ENT, general surgery and neurosurgery, as part of the surgical rotation at St Mary’s Hospital, Imperial College, London.

Jonathan has extensive teaching experience and is the primary author of three undergraduate and three postgraduate medical textbooks, including the highly successful *History Taking in Medicine and Surgery* (Pastest Publishing), now in its third edition. He spent part of his medical training at both Harvard University and the NASA Space Center.

Jonathan was awarded the ‘Royal Society of Medicine–Wesleyan Trainee of the Year’ award in 2012 across all specialties and has been awarded the highly prestigious title of ‘Lifelong Honorary Scholar’ by the University of Cambridge for his academic excellence. He was awarded a fellowship from the British Association of Plastic Surgeons for research at NASA and from Cambridge University for research at Harvard University. Jonathan has received personal research fellowships from the Academy of Medical Sciences, Medical Research Council, Sparks Children’s Charity, the Royal College of Surgeons of England, University College London and the Medical Research Council Centenary Award Scheme. He was awarded a PhD from University College London, in 2013 and is currently honorary clinical lecturer at University College London. He is committed to a career in academic ENT, with a strong emphasis on teaching, research and career development.



**Vivian A Elwell, BA Hons., MA (Cantab.), MBBS, MRCS, FRCS (Neuro. Surg.)** is a consultant neurosurgeon and spinal surgeon at the Brighton and Sussex University Hospitals NHS Trust. She has a special interest in complex spinal surgery. She obtained her bachelor's degree in biological sciences from Columbia College, Columbia University in New York City, and obtained her master's degree from the University of Cambridge. She then obtained a Bachelor of Medicine and Bachelor of Surgery from the Imperial College School of Medicine, London.

She held posts in accident and emergency, orthopaedics, neurosurgery and general surgery within her surgical rotation at St Mary's Hospital, Imperial College Healthcare NHS Trust, London. She completed her neurosurgical training on the North Thames Neurosurgery Training Programme, London. Thereafter, she completed the Central London Senior Spinal Fellowship and is committed to coupling her neurosurgical practice with education and research.

Vivian has extensive teaching experience for undergraduate and postgraduate medical education. She is an Instructor for Advanced Trauma Life Support (ATLS<sup>®</sup>) and Care of the Critically Ill Surgical Patient (CCrISP) Courses. She is an author of five medical textbooks, including *Neurosurgery: The Essential Guide to the Oral and Clinical Neurosurgical Examination* (CRC Press, 2014). She regularly teaches clinical and surgical skills to medical students, doctors and surgical trainees.

Vivian's awards include: the Swinford Edward Silver Medal Prize for her Objective Structured Clinical Examination, the Columbia University Research Fellowship at Columbia College of Physicians and Surgeons the Columbia University King's Crown Gold and Silver Medal Awards, the Kathrine Dulin Folger Cancer Research Fellowship and the 'Who's Who of Young Scientists Prize'. In 2010, she was a finalist for the British Medical Association's Junior Doctor of the Year award. She is noted in 'Who's Who in Science and Engineering' (2011–2012 and 2016–2017).



**Rajat Chowdhury, BSc (Hons), MA (Oxon), BM BCh (Oxon), MRCS, FRCR, FBIR, PGCME** is a consultant musculoskeletal radiologist at Oxford University Hospitals, a Member of the Royal College of Surgeons and a Fellow of the Royal College of Radiologists. He was awarded an undergraduate Honours degree from University College London, and read medicine at Oxford University. He completed his clinical training at Oxford, Mayo Clinic and Harvard University. He then trained on the surgical rotation at St Mary's Hospital, Imperial College, London, and held posts in accident and emergency, orthopaedics and trauma, cardiothoracic surgery, general surgery, and plastic surgery. He then trained in radiology before subspecialising in musculoskeletal radiology, completing his fellowship at Chelsea and Westminster Hospital and an honorary fellowship at the Nuffield Orthopaedic Centre, Oxford.

Rajat has a diverse teaching record. He has taught clinical medicine to students and doctors in Oxford and London, and has tutored biochemistry and genetics to undergraduate students at Oxford University. He was an anatomy demonstrator at the Imperial College School of Medicine, London, and was President of the Queen's College Medical Society, Oxford, and of the Hugh Cairns Surgical Society.

Rajat's academic awards include Oxford University's Bristol Myers Squibb Prize in Cardiology, Radcliffe Infirmary Prize for Surgery, GlaxoSmithKline Medical Fellowship, Warren Scholarship to the University of Toronto and Exhibition Award to Harvard University. He was awarded a NICE Scholarship in 2011 and was National Representative of Leadership and Management at the Academy of Medical Royal Colleges. He is lead author of the undergraduate textbook, *Radiology at a Glance* (Wiley-Blackwell Publishing, 2010) amongst several other titles.

Learn from yesterday, live for today, hope for tomorrow.  
The important thing is not to stop questioning.

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**—Albert Einstein, 1879–1955**

## Introduction

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### **The MRCS Part B OSCE: The insider's guide to success**

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Successful completion of the MRCS Part A of the Intercollegiate MRCS examination allows passage to the MRCS Part B OSCE, which is your final stop on the road to becoming a member of one of the Royal Colleges of Surgeons. Furthermore, it marks reaching the landmark to be eligible to enroll on a programme that will train you to be an expert in your chosen sub-specialty. The MRCS OSCE is a truly dynamic exam that demands an equally dynamic response from you to acknowledge your prowess in surgical science and art, as well as your skill and integrity.

### **The structure of the MRCS Part B OSCE**

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The MRCS Part B Examination is an Objective Structured Clinical Examination. The MRCS Part B can be likened to a 3½ hour 'circuit course' comprising 18 examined stations each of a 9 minutes' duration. These stations are divided into broad content areas (BCAs):

- Anatomy and surgical pathology (five stations)
- Applied surgical science and critical care (three stations)

These two BCAs are grouped together for the purposes of passing the examination and will be known collectively as 'Applied Knowledge' (eight stations = 160 marks)

- Clinical and procedural skills (six stations)
- Communication skills (four stations)
  - Giving and receiving information
  - History taking

These two BCAs will be grouped together for the purpose of passing the examination and will be known collectively as 'Applied Skills' (10 stations = 200 marks).

In addition, there may be one or more preparation stations and one station that is being pre-tested. Candidates will not be informed which station is being pre-tested.

Each of the 18 examined stations is 'manned'. Some stations will have two examiners and some have only one. In stations with two examiners, each

examiner will examine different aspect of your performance.

In addition to the **four broad content areas** mentioned above, **four domains** have been identified to encompass the knowledge, skills, competencies and professional attributes of a competent surgeon. These domains represent the General Medical Council's (GMC) Good Medical Practice (2013) and are assessed in the OSCE, as follows:

- Clinical knowledge and its application
- Clinical and technical skill
- Communication
- Professionalism

MRCS OSCE proposed assessment grid and matrix	KNOWLEDGE BROAD CONTENT AREA		SKILLS BROAD CONTENT AREA		P I L O T	Optional – any station as required		
	Anatomy and surgical pathology	Applied surgical science and critical care	Communication skills				Clinical and procedural skills	
			Giving and receiving information	History taking			Physical examination	Procedural skills
Examiners required --	onc	onc	-	-	-	-		
							20	20
Domains tested ↓	onc	onc	-	-	-	-		
							20	20
Clinical knowledge and its application	onc	onc	-	-	-	-		
							20	20
Clinical and technical skill	onc	onc	-	-	-	-		
							20	20
Communication	onc	onc	-	-	-	-		
							20	20
Professionalism including: Decision making; problem solving; situational awareness and judgement; organisation and planning; patient safety	onc	onc	-	-	-	-		
							20	20
Total mark								

These four domains are assessed throughout the 18 stations of the OSCE. Your

performance on these domains will not be pass/fail criteria. Domains will be used primarily for structuring the scenarios and mark sheets.

During your 'circuit' each station will be of 9 minutes' duration. In addition, there may be one or more rest or preparation stations and one station that is being pretested. The total duration of the OSCE will be approximately 3½ hours; this may vary slightly depending on the time allowed between stations, on the rest break(s) and whether a pre-test station is included.

Each station will have detailed instructions on the outside of the test area about the task to be performed. One minute is allocated for reading the instructions which will also be available within the bay for reference if required. In stations that involve a task followed by interaction with the examiner, there will be an indication of the time allocated for each part. Normally, there will be 6 minutes for the task and 3 minutes for the examiner interaction. A bell will be sounded at this point and the examiner will commence their questioning.

A candidate has 9 minutes to complete each station. If you manage not to complete the task, you will be moved on promptly to the next station (even if you are in the middle of your answer).

Each station is marked out of a total of 20 points. The entire exam is marked out of a total of 360 points.

- Each station is further awarded a global rating for competence marked as
  - Fail
  - Borderline
  - Pass

In order to pass the examination, you must obtain a pass mark in the two aggregated BCAs (knowledge and skills). Using information for the structured mark sheets for each station out of 20, and the global rating for each station, a mark will be calculated out of 160 for knowledge and 200 for skills, that is judged to be the mark required to pass each BCA.

- Knowledge (eight stations) incorporating the BCAs of anatomy and surgical pathology and applied science and critical care.
- Skills (10 stations) incorporating communication skills in giving and receiving information and history taking.

To be awarded a pass in the OSCE, you must pass **EACH** of the two grouped areas at the same sitting.

## **The mask of a professional**

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It is clear from the structure of the MRCS Part B OSCE that the experience of completing the exam is like being the only doctor in the hospital and managing



the entire surgical division! You are required to manage a trauma call for 1 minute, breaking bad news in clinic the next, suturing a wound seconds later, followed immediately by engaging in academic debate over anatomical dissections, and you have only just started! Furthermore, you are not just trying to maintain your nerve and sanity, you are trying to appear unflustered, confident and in top form every step of the way. This is indeed a very tall order and therefore, one of the most crucial parts of your preparation for this exam is trying to develop a flawless mask of professionalism, composure and control that cannot be removed regardless of the changing challenges that are thrown at you. It is only through maintaining placid composure that you will create the space to have clarity in thought to put together a strategic plan of action and answer questions intelligibly. Many candidates are guilty of the common pitfall of spending disproportionate time on acquiring 'clinical knowledge' and are often careless and lack confidence in their approach. However, equal points are awarded for skill, communication, decision making, organisation and planning. In many ways, the clinical skills (physical examination) stations can be classed in the same genre as the driving test where an exaggerated display of the 'mirror, signal, manoeuvre' protocol is displayed for the benefit of the examiner. In most stations, fastidious attention to basic protocol rituals, such as handwashing and appropriate patient introductions, will not only win favour of the examiners but will also score easy points that could make all the difference between failing and passing comfortably.

### **Practice makes perfect**

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The best preparation for this exam is to work with your fellow candidates as a team. You should unashamedly practise and critique each other's performance on systematic physical examinations, practical procedures, viva voce style questioning, as well as discussing and rehearsing communication skills vignettes. You must practise until the step of handwashing, for example, becomes almost an automatic involuntary action. Moving through the exercise of history taking and physical examinations should become swift, smooth and natural so that you can then optimise your efforts on eliciting the salient signs. It is only in this way that you will feel confident to generate an appropriate differential diagnosis for what may seem like a baffling case when under the pressures of extreme exam stress. Examiners will generally not interrupt or prompt you during the examination of patients and so it is up to you to move through the OSCE station picking up all the points available. The best way to achieve this is, therefore, planning every second of your 9-minute routine and practising it to pure perfection. It is only through rigorous rehearsal that a theatrical stage show is perfected for public performance and unforeseen mishaps are managed professionally on opening night. To augment your reading and preparation for this exam, we recommend that you attend our Insider Medical MRCS Part B OSCE Revision Course in London

(visit [www.insidermedical.co.uk](http://www.insidermedical.co.uk), or [www.insidermedical.com](http://www.insidermedical.com) for details).

## **A day in the life of a Specialist Trainee Year 3**

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An important concept that you should consider is the benchmark your examiners are assessing you against. The MRCS part B OSCE is a window into the life of you as a potential ST3 to see how you perform and if you are up to the task. You should therefore unofficially rename your preparation for the exam as 'preparing to be an ST3'. You should approach the exam with your 'ST3 hat' on and demonstrate appropriate levels of confidence, gravitas, maturity, safe decision-making and management skills, in addition to your core surgical knowledge and skills. Successful candidates are those who possess flair and finesse, deliver safe logical workups and in essence, portray themselves as a contender to take on the role as a consultant's deputy.

## **Style over substance**

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The power of the first impression you create cannot be underestimated and how you look speaks volumes through your non-verbal communication. Modern infection control practices have impacted on dress codes for all healthcare professionals and this now reflects in the exam. Polo shirts and T-shirts are not considered acceptable items of clothing. Best to present yourself as you would for a job interview. Some golden nuggets for portrayal as a responsible, respectable, knowledgeable and safe surgeon include:

### ***Ladies***

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- Business blouse (arms to be bare below the elbows)
- Minimal jewellery (with the exception of wedding rings) and makeup
- If you have long hair, please tie it back
- Comfortable shoes
- Anti-perspirant and perhaps subtle perfume

### ***Gentlemen***

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- Business shirt (arms to be bare below the elbows)
- No tie
- Decent, smart haircut
- No jewellery (with the exception of wedding ring)
- Clean and polished shoes
- Anti-perspirant and perhaps subtle aftershave

Mobile phones or other electronic/communication devices must not be carried.

They can be left (switched off) with your other property. Carrying such devices can result in disciplinary action.

## The dress rehearsal

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Revision courses that simulate the exam are excellent to give you a dry run. They can be done at any time but are probably best done when you are nearing the end of your preparation to highlight areas of refinement that can help to further raise your game. You can learn from your own mock exam experience, viewing others in action, and the feedback from the tutors and your colleagues. This is a time to allow others to critique your performance and point out any bad habits that you may be oblivious to. If you attend the course wearing the attire you are likely to be wearing on the day of the actual exam, you will reveal whether your shoes and clothes are comfortable for the 3½ hour OSCE experience.

## One night to go

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Preparation, of course, begins long before the big day. However, on the night before, you should ensure your equipment that you want to take is ready and in order. All equipment that is required for the OSCE will be provided at the exam. However, for familiarity, you might like to take with you the following pieces of equipment:

- Stethoscope
- Tape measure
- Pen
- Pen torch
- Tongue depressor
- Opaque tube (e.g. smartie tube) for transillumination
- Tourniquet (for varicose veins)
- Hat pins (for neurological examination)
- A piece of card for the ulnar nerve examination

Remember, you should test run putting the equipment you want to carry in your assigned pockets and ensure you are still comfortable to conduct the tasks required. Equipment that falls out of your pockets during a physical examination may tarnish your slick image.

You should arrange your travel itinerary as soon as possible and gentlemen should get a smart haircut in the week preceding the exam. On the evening before the big day, you should recheck your itinerary and prepare any paperwork (you will need to take **valid photo ID** (*including your name, signature and photograph*) that must be produced when registering at the exam centre). It is a good idea to

prepare your clothes, shoes and bag (including an anti-perspirant if you are prone to anxiety-related perspiration). It is probably not a good idea to experiment with a new restaurant or hit the town but instead set your alarm clock slightly earlier than you comfortably need and then get a good night's rest.

## **The last few hours**

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The first test on the big day is not hitting the 'snooze' button when the alarm rings. It is much better to take your time in getting ready than raising your stress levels by oversleeping and then rushing to make the train. Once you're up, it is worth checking the travel updates and then washing and dressing. You should definitely have a proper breakfast because you will need all your energy to be in peak form for the rest of the day. Before you leave, glance in the mirror and tell yourself, you are an ST3!

As a surgical trainee and indeed an ST3, you should conduct yourself professionally and be polite and courteous at all times. After all, you are potentially on display to the examiners before you even arrive at the exam centre, since they may be travelling on the same plane, train or bus as you. Examiners have a habit of sniffing out exam candidates, especially those that have their face buried in this book on the way to the exam!

## **Top tips for the exam**

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- Pay particular attention to the briefing before the start of the exam and follow the instructions exactly. You do not want to get noticed by your inability to follow instructions and disorganisation.
- Do not carry your mobile phone/communication device during the exam. This is a disciplinary offence.
- You cannot be too polite and courteous to patients.
- Do not forget to enter your candidate number in unmanned written answer stations.
- You must use the handwash gel before and after every clinical skills station.
- You must listen to the examiner's instructions carefully and follow his or her instructions precisely. If you are at all unclear on what is required of you, do not be afraid to ask the examiner to repeat or rephrase the question.
- Aim to maintain eye contact with the examiners when speaking to them.
- Keep your answers simple and clear – always speak slowly and articulate decisively.
- You will not be interrupted or prompted unless the examiner wants to redirect you. If the examiners are trying to redirect you, do not continue in your current path. You must take the hint and follow their instructions.

- You should execute your well-oiled routine and give an exhibitionary performance. You will not be required to give a running commentary but you may do so if you prefer.
- Summaries must be concise and only contain salient positive and negative findings, followed by a differential diagnosis.
- If you feel one station has not gone particularly well, you must erase it from your mind and stop any rumination in their tracks. It is imperative that you proceed to your next station unflustered and unphased. As an ST3, you may be required to lead a team safely through situations of crisis by maintaining excellent performance – so the show must go on!

### **The bottom line**

---

Your key for entry into the surgeons' club lies in your ability to think and perform like an ST3!

*All the very best of luck!*

# CHAPTER 1: ANATOMY

Introduction

Embryology

Head, Neck and Vertebral Column

Thorax

Abdomen and Pelvis

Upper and Lower Limbs

# INTRODUCTION

---

Many students find preparing for the anatomy part of the examination a daunting task. It has been many years since you were last in the dissection room and it feels like there is a vast amount of material to learn in a short space of time. It is all too easy to spend all your revision time on anatomy alone, at the expense of other areas of the exam. Although the examiners place a lot of emphasis on anatomy (and rightly so as after all you cannot be a surgeon without knowing your anatomy well), do not neglect other areas of the exam. After all, you must pass all the other areas of the objective structured clinical examination (OSCE) too in order to obtain an overall pass.

As a few top tips:

- Be concise and accurate in your answers.
- Do not say anything you have not been asked about.
- Be systematic and logical.
- Try to apply your answer to surgical practice. The emphasis now is on applied anatomy.
- Do not dig yourself into any holes!
- Remember images that you are asked to comment on in the exam may be normal and the emphasis is on pointing out the key anatomical features, rather than the pathology! So if you are asked to comment on a barium enema do not necessarily go looking for a stricture!

We would recommend that you

- Visit the dissection room prior to the exam and look at some prosections.
- Invest in a good atlas of anatomy.
- Know and be able to demonstrate surface anatomy on a model or patient actor.
- Familiarise yourself with the main bones (osteology).
- Be prepared to be handed 'props' in the exam – bones, prosections, images (e.g. plain radiographs, computed tomography [CT]/magnetic resonance imaging [MRI], contrast studies, angiograms), clinical photographs etc.
- Note that some of the images presented to you in the exam may in fact be normal.
- Know in detail the 'college favourites' which are listed below and also described in this chapter:

- Skull base, cavernous sinus and pituitary gland
- Thyroid and parathyroid glands
- Hand and shoulder joint
- Blood supply of the stomach
- Oesophagus and ureters
- Diaphragm and its openings
- Portosystemic anastomoses
- Brachial plexus and axilla
- Femur, hip and knee joints
- Heart and coronary artery circulation
- Surface anatomy (e.g. knee joint, posterior triangle of the neck)



# Embryology

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## Changes at birth

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### *What changes occur at birth?*

There are several important changes that take place at birth:

- The urachus (allantois) becomes the single, median umbilical ligament.
- The umbilical arteries become the right and left, medial umbilical ligaments, respectively.
- The left umbilical vein becomes the ligamentum teres (round ligament) in the free edge of the falciform ligament.
- The ductus venosus becomes the ligamentum venosum.
- The ductus arteriosus becomes the ligamentum arteriosum.
- In 2% of cases, the vitello-intestinal duct may persist as a Meckel's diverticulum.
- The foramen ovale in most cases obliterates at birth to become the fossa ovalis, but remains patent into adulthood in some 20% of cases.

### *Why is this important to know about?*

Aberrations of this normal developmental process may lead to pathology:

- Failure of the urachus (that normally connects the bladder to the umbilicus) to obliterate may lead to a urachal fistula, sinus, diverticulum or cyst, often with leakage of urine from the umbilicus.
- Failure of the ductus arteriosus to obliterate at birth leads to a patent ductus arteriosus, resulting in non-cyanotic congenital heart disease.
- In 2% of cases, the vitello-intestinal duct persists as a Meckel's diverticulum with its associated complications.
- In some 20% of cases, the foramen ovale fails to obliterate completely at birth resulting in a patent foramen ovale. This may become the site for paradoxical embolism (where venous thrombus migrates and enters the systemic circulation through a patent foramen ovale), resulting in stroke.

## **Branchial arches**

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### ***What are the branchial (pharyngeal) arches, clefts and pouches?***

The pharyngeal, or branchial, arches are the mammalian equivalent of the gill arches in fish. In humans, there are five pairs of branchial arches that develop in a cranio-caudal sequence (equivalent to gill arches 1, 2, 3, 4, 6). The fifth branchial arch never forms in humans, or forms as a short-lived rudiment and promptly regresses.

Each arch contains a central cartilaginous element, striated muscle, cranial nerve and aortic arch artery, surrounded by ectoderm on the outside and lined by endoderm.

The arches are separated externally by ectodermally lined branchial clefts and internally by endodermally lined branchial pouches. Branchial cleft derivatives arise from the ectoderm whereas branchial pouches are derived from endoderm.

- The first arch gives rise to the muscles of mastication
- The second arch gives rise to the muscles of facial expression
- The third and fourth arches give rise to the muscles of vocalisation and deglutition
- The sixth arch gives rise to the intrinsic muscles of the larynx

### ***What are the clinical implications?***

Certain key features concerning the branchial arches are worth remembering because of their clinical significance:

- The superior parathyroid glands develop from the fourth branchial pouch; the inferior parathyroids, along with the thymus, are third pouch derivatives. Consequently, the inferior parathyroids may migrate with the thymus down into the mediastinum, hence its liability to end up in unusual positions.
- The tongue is derived from several sources. The anterior two-thirds of the tongue mucosa is a first arch derivative, whereas the posterior one-third is derived from the third and fourth arches. The tongue musculature, in contrast, arises from occipital somite mesoderm. For this reason, the motor and sensory (special taste and somatic touch) nerve fibres of the tongue are carried by separate sets of cranial nerves.
- The thyroid gland arises from between the first and second arch as a diverticulum (thyroglossal duct) which grows downwards leaving the foramen caecum at its origin. Incomplete thyroid descent may give rise to a lingual thyroid, a thyroglossal duct cyst or a pyramidal thyroid lobe. If the thyroid

gland descends too far, it may result in a retrosternal goitre.

- Apart from the first branchial cleft (which forms the external ear), the other clefts are normally obliterated by overgrowth of the second pharyngeal arch, enclosing the remaining clefts in a transient, ectoderm-lined, lateral cervical sinus. This space normally disappears rapidly and completely. It may persist in adulthood as a second branchial cleft cyst or fistula.

***Name the muscles of mastication and what are their innervation?***

There are four muscles of mastication:

- Temporalis
- Masseter
- Medial pterygoid
- Lateral pterygoid

They are all first branchial arch derivatives and are therefore all innervated by the same nerve (mandibular division of trigeminal, or Vc).

*Note:* The buccinator muscle is regarded as a muscle of facial expression and is, therefore, a second branchial arch derivative innervated by the facial, or seventh, cranial nerve. This is one of many situations in which a good knowledge of embryology and especially, the branchial arches may help to predict the anatomy.

## **Gonadal development**

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### ***Outline the development of the gonads.***

During embryonic and fetal life, the testes and the ovaries both descend from their original position at the 10th thoracic level. This explains the long course taken by the gonadal arteries and the site of referred pain from the gonads to the umbilicus (T10 dermatome).

Descent is genetically, hormonally and anatomically regulated and depends on a ligamentous cord known as the gubernaculum. Furthermore, descent of the testis through the inguinal canal into the scrotum depends on an evagination of peritoneum known as the processus vaginalis. This normally obliterates at birth.

### ***How may it go wrong?***

Gonadal descent is a complicated process and there are many ways in which it can go wrong. Most commonly, an undescended, or maldescended, testis may occur (cryptorchidism). A patent processus vaginalis may lead to the formation of a congenital hydrocele, or indirect inguinal hernia.

## Meckel's diverticulum

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### ***What is a Meckel's diverticulum?***

A Meckel's diverticulum is the anatomical remnant of the vitello-intestinal duct. In the developing fetus, the vitello-intestinal duct connects the primitive midgut to the yolk sac and also plays a part in intestinal rotation.

The vitello-intestinal duct normally regresses between the 5th and 8th weeks of development, but in 2% of individuals it persists as a remnant of variable length and location, known as a Meckel's diverticulum, named after Johann Friedrich Meckel who first described the embryological basis of this anomaly in the nineteenth century.

Most often it is observed as a 2 inch (5 cm) intestinal diverticulum projecting from the anti-mesenteric wall of the ileum, about 2 feet (60 cm) from the ileo-caecal valve. It is about twice as common in males than in females. However, this useful mnemonic ('the rule of 2s') only holds true in two-thirds of cases; the length of the diverticulum is variable and its site may be more proximal.

### ***What complications might a Meckel's diverticulum undergo?***

- It is estimated that 15%–30% individuals with a Meckel's diverticulum develop symptoms from either one of the following:
  - Intestinal obstruction
  - Gastrointestinal bleeding
  - Acute inflammation (Meckel's diverticulitis)
  - Perforation
  - Intussusception
- Its blind end may contain ectopic tissue, namely gastric mucosa (in 10% of cases), liver, pancreatic tissue, carcinoid or lymphoid tissue. This is important because gastric mucosa contains parietal cells that secrete hydrochloric acid. Therefore, ulcers can form within the diverticulum (like a peptic ulcer) causing bleeding.
- Bowel obstruction may be caused by the trapping of part of the small bowel by a fibrous band (that represents a remnant of the vitelline vessels) connecting the diverticulum to the umbilicus. Symptoms may closely mimic appendicitis. Therefore, if a normal-looking appendix is found at laparoscopy, or during an open appendectomy, it is important to exclude a Meckel's diverticulum as a cause of the patient's symptoms. Mortality in untreated cases is estimated to be 2.5%–15%.
- Exceptionally, a Meckel's diverticulum may be found in an inguinal or a

femoral hernia sac (Littre's hernia).

# **HEAD, NECK AND VERTEBRAL COLUMN**

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## Thyroid gland

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### ***What is the blood supply to the thyroid gland?***

The blood supply to the thyroid is by way of the superior thyroid artery (a branch of the external thyroid artery), the inferior thyroid artery (a branch of the thyrocervical trunk of the first part of the subclavian artery) and rarely the small thyroidea ima which arises from the aorta to supply the isthmus. Venous drainage is through the superior and middle thyroid veins to the internal jugular veins and via the inferior thyroid veins to the brachiocephalic veins (usually on the left). This is important to know about when performing thyroid surgery.

### ***Why does the thyroid gland move upwards with swallowing?***

The thyroid gland is an endocrine gland that sits at the base of the neck like a bow-tie. It consists of two lateral lobes and an isthmus which is attached via Berry's ligament to the second to fourth tracheal rings (it is not attached to the thyroid cartilage!). The thyroid gland moves upwards with swallowing because

- It is attached to the trachea by Berry's ligament
- It is invested within pre-tracheal fascia

### ***Why is this clinically important?***

This is clinically important as it defines a swelling within the neck as being of thyroid origin.

### ***What is the innervation to the muscles of vocalisation?***

All the intrinsic muscles of the larynx are supplied by the recurrent laryngeal nerve of the vagus, with the exception of the important cricothyroid muscle, which is supplied by the external branch of the superior laryngeal nerve. Cricothyroid is the muscle which is principally concerned with altering voice pitch by altering the length of the vocal cords. Damage to the superior laryngeal or recurrent laryngeal nerves can occur during thyroid, parathyroid, oesophageal, carotid or aortic arch surgery. Damage to the external branch of the superior laryngeal nerve leads to changes in pitch of the voice whereas damage to the recurrent laryngeal nerve results in a vocal cord palsy leading to hoarseness or even airway compromise (Semon's law).

### ***How does the thyroid gland develop and what is its clinical significance?***

The embryology of the thyroid gland is clinically extremely important. It descends from the foramen caecum between the anterior two-thirds and posterior third of the tongue via the thyroglossal duct. Before reaching its final position in the neck, it loops under the hyoid bone. An incompletely descended

thyroid gland may persist in adult life as a lingual thyroid, pyramidal thyroid lobe or a thyroglossal duct cyst. If it descends too far, it can become a retrosternal thyroid. Thyroglossal duct cysts can become infected and form sinuses or fistulae. In removing a thyroglossal duct, it is important to remove the middle third of the hyoid bone and follow the tract up to the base of the tongue to prevent recurrence (Sistrunk's operation) ([Figure 1.1](#)). The ultimobranchial bodies (5th pouch derivatives) give rise to the calcitonin-secreting parafollicular cells ('C cells') of the thyroid gland.

***What does the thyroid gland do?***

The thyroid gland is stimulated by thyroid-stimulating hormone (TSH) (which is produced from the anterior lobe of the pituitary gland) to produce T3 and T4; hormones which play an important role in basal metabolic rate. The normal thyroid gland produced approximately 90% T4 and 10% T3 but T4 is converted into T3 in the periphery. T3 is the physiologically more active form of thyroxine.

## Tongue

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### ***What is the innervation of the tongue (sensory and motor)?***

Special taste sensation is by way of the chorda tympani division of the facial nerve for the anterior two-thirds of the tongue and the glossopharyngeal nerve for the posterior one-third of the tongue. Taste on the anterior two-thirds of the tongue is therefore commonly lost in a facial nerve (or Bell's) palsy.

Somatic sensation (light touch) is by way of the mandibular division of the trigeminal nerve for the anterior two-thirds of the tongue (lingual nerve) and the glossopharyngeal nerve for the posterior one-third of the tongue.

All the intrinsic and extrinsic (styloglossus, hyoglossus and genioglossus) muscles of the tongue are supplied by the hypoglossal, or 12th cranial nerve, with the exception of the palatoglossus muscle which is supplied by the pharyngeal plexus of nerves (IX, X and sympathetics).

### ***What are the muscles of the tongue?***

Intrinsic muscles (wholly within tongue and not attached to bone):

- Longitudinal
- Transverse
- Vertical