

CONTENTS

Preface	ix
Acknowledgements	xi
Contributors to the forty-second edition	xii

 Historical introduction	
A brief history of <i>Gray's Anatomy</i>	
<i>Ruth Richardson</i>	
Anatomical nomenclature	xvi

SECTION 1: CELLS, TISSUES AND SYSTEMS

Section Editor: Caroline B Wigley

1. Basic structure and function of cells	4
<i>Abraham L Kierszenbaum</i>	
2. Integrating cells into tissues	29
<i>Caroline B Wigley</i>	
3. Nervous system	43
<i>Nobutaka Hirokawa, Shigeo Okabe, Yosuke Takei</i>	
4. Blood, lymphoid tissues and haemopoiesis	71
<i>Andrew George, Uday Kishore</i>	
5. Functional anatomy of the musculoskeletal system	85
<i>Michael A Adams</i>	
6. Smooth muscle and the cardiovascular and lymphatic systems	127
<i>Jeremy PT Ward</i>	
7. Skin and its appendages	145
<i>John A McGrath, Joey Edward Lai-Cheong</i>	

Commentaries

- 1.1. Fluorescence microscopy today: a perspective
Dylan M Owen, M Makarova
- 1.2. Electron microscopy in the twenty-first century
Roland A Fleck
- 1.3. Metaplasia
Jonathan MW Slack
- 1.4. Merkel cells
Ellen A Lumpkin
- 1.5. The reaction of peripheral nerves to injury
Rolfe Birch, Praveen Anand
- 1.6. A critical evaluation of the current status of myofascial chains
Jan Wilke, Winfried Banzer

Videos

- Video 1.1** – Mitosis in a cell with fluorescently labelled chromosomes and microtubules
Jonathon Pines, Daisuke Izawa
- Video 1.2.1** – Diagnostic histopathology by electron microscopy
Roland A Fleck

SECTION 2: EMBRYOGENESIS AND DEVELOPMENT

Section Editor: Patricia Collins

8. Preimplantation development	170
<i>Alison Campbell</i>	
9. Implantation and placentation	178
<i>Eric Jauniaux, Graham J Burton</i>	
10. Cell populations at gastrulation	188
<i>Patricia Collins</i>	
11. Overarching concepts in development	196
<i>Patricia Collins</i>	
12. Cell populations at the start of organogenesis	201
<i>Patricia Collins</i>	
13. Development of the heart and circulation	208
<i>Patricia Collins, Antoon FM Moorman, Jaeike Welmoed Faber, Bjarke Jensen, Michael A Hall</i>	
14. Development of the nervous system	233
<i>Zoltán Molnár, Patricia Collins</i>	
15. Development of the eye	264
<i>Jane C Sowden</i>	
16. Development of the ear	269
<i>Abigail Saffron Tucker</i>	
17. Development of the head and neck	273
<i>Gillian Morriss-Kay</i>	
18. Development of the back	292
<i>Martin Scaal</i>	
19. Development of the limbs	303
<i>Cheryll Tickle</i>	
20. Development of the lungs, thorax and respiratory diaphragm	314
<i>Andrew Bush, Patricia Collins</i>	
21. Development of the peritoneal cavity, gastrointestinal tract and its adnexae	323
<i>Patricia Collins</i>	
22. Development of the urogenital system	341
<i>Patricia Collins</i>	
23. Pre- and postnatal growth and the neonate	365
<i>Patricia Collins, Michael A Hall, Kelly Brown</i>	

Commentaries

- 2.1. Head-trunk interface in the vertebrate embryo
Shigeru Kuratani

Videos

- Video 8.1** – Human *in vitro* fertilization and early development
Alison Campbell
- Video 9.1** – Ultrasound features of the maternal placental blood flow
Eric Jauniaux
- Video 13.1** – Animation of the pattern of contraction of the early heart tube
Antoon FM Moorman
- Video 13.2** – Ultrasound features of a four-chambered fetal heart
Warren Foster
- Video 23.1** – Ultrasound features of a fetus at 26 weeks
Patricia Collins, Jonathan D Spratt

SECTION 3: NEUROANATOMY

Section Editors: Alan R Crossman, Marco Catani

- | | |
|---|-----|
| 24. Overview of the nervous system | 386 |
| <i>Alan R Crossman, Marco Catani</i> | |
| 25. Meninges and ventricular system | 398 |
| <i>Ranjeev Singh Bhangoo, Francesco Vergani, Juan C Fernandez-Miranda</i> | |
| 26. Vascular supply and drainage of the brain | 415 |
| <i>Gerardo Conesa Bertran, Ignacio Delgado-Martínez</i> | |
| 27. Spinal cord | 425 |
| <i>Roger Lemon</i> | |
| 28. Brainstem | 442 |
| <i>Thomas P Naidich</i> | |
| 29. Cerebellum | 465 |
| <i>Jeremy D Schmahmann</i> | |
| 30. Diencephalon | 489 |
| <i>Carmen Cavada</i> | |
| 31. Basal ganglia | 503 |
| <i>Tipu Zahed Aziz, Erlick AC Pereira</i> | |
| 32. Cerebral hemispheres | 512 |
| <i>Marco Catani, Karl Zilles†</i> | |

Commentaries

- 3.1.** Comparative anatomy of the corticospinal system
Roger Lemon

Videos

- Video 26.1** – From angiography to anatomy: the internal carotid artery and its major branches
Gerardo Conesa Bertran
- Video 26.2** – From angiography to anatomy: veins of the cerebral system
Gerardo Conesa Bertran
- Video 32.1** – Tractography reconstruction of the corpus callosum and corticofugal pathways using spherical deconvolution tractography
Ahmad Beyh, Flavio Dell'Acqua

SECTION 4: HEAD AND NECK

Section Editor: Michael Gleeson

- | | |
|--|-----|
| 33. Head and neck: overview and surface anatomy | 546 |
| <i>Michael Gleeson, Richard Tunstall</i> | |
| Head and neck | |
| 34. The skull | 558 |
| <i>Craig Andrew Cunningham, Juan C Fernandez-Miranda</i> | |

- | | |
|--|-----|
| 35. Neck | 573 |
| <i>John C Watkinson, Michael Gleeson</i> | |
| 36. Face and scalp | 607 |
| <i>Simon Holmes</i> | |

Upper aerodigestive tract

- | | |
|---|-----|
| 37. Mouth | 636 |
| <i>Barrie KB Berkovitz</i> | |
| 38. Infratemporal and pterygopalatine fossae and temporomandibular joint | 664 |
| <i>Andrew J Sidebottom, Michael Gleeson</i> | |
| 39. Nose, nasal cavity and paranasal sinuses | 686 |
| <i>Claire Hopkins</i> | |
| 40. Pharynx | 702 |
| <i>Eitan Prisman, Emmanuel D'Heygere</i> | |
| 41. Larynx | 717 |
| <i>Declan Costello</i> | |
| Special senses | |
| 42. External and middle ear | 735 |
| <i>Michael Gleeson</i> | |
| 43. Inner ear | 752 |
| <i>David Nicholas Furness</i> | |
| 44. Orbit and accessory visual apparatus | 769 |
| <i>John Gerard Lawrenson, Ronald H Douglas</i> | |
| 45. Eye | 790 |
| <i>John Gerard Lawrenson, Ronald H Douglas</i> | |

Videos

- Video 38.1** – Temporomandibular joint arthroscopy demonstrating intracapsular anatomy
Gary Warburton
- Video 38.2** – Endoscopic anatomy of the infratemporal and pterygopalatine fossae
Carl H Snyderman, Juan C Fernandez-Miranda
- Video 41.1** – Stroboscopic examination of the vocal folds
Declan Costello

SECTION 5: BACK

Section Editor: Neel Anand

- | | |
|---|-----|
| 46. Back | 814 |
| <i>Eli Baron, Richard Tunstall</i> | |
| 47. Spinal cord and spinal nerves: gross anatomy | 856 |
| <i>Eli Baron, Guirish Solanki</i> | |

SECTION 6: PECTORAL GIRDLE AND UPPER LIMB

Section Editor: Alistair Ross

- | | |
|---|-----|
| 48. Pectoral girdle and upper limb: overview and surface anatomy | 871 |
| <i>Alistair Ross, Richard Tunstall</i> | |
| 49. Shoulder girdle and arm | 890 |
| <i>Simon Lambert</i> | |
| 50. Elbow and forearm | 930 |
| <i>Adam C Watts</i> | |
| 51. Wrist and hand | 955 |
| <i>David Warwick, James Logan</i> | |

Commentaries

- 6.1. Nerve biomechanics
Kimberly S Topp
- 6.2. The anatomy and variation of the coracoid attachment of the subclavius muscle and its relation to the clavi-coraco-axillary aponeurosis
Simon Lambert
- 6.3. Instability of the shoulder – a neurological disease
Simon Lambert

Videos

- Video 48.1** – Upper limb surface anatomy
Rolfe Birch
- Video 51.1** – Arthroscopic anatomy of the radiocarpal joint
Greg Couzens
- Video 51.2** – Movements of the wrist
James Logan
- Video 51.3** – Carpal mechanics and pathomechanics
James Logan
- Video 51.4** – Sagittal band function
James Logan
- Video 51.5** – Function of the intrinsic muscles of the hand
James Logan
- Video 51.6** – Movements of the thumb
James Logan
- Video 51.7** – Functional grips of the hand
James Logan
- Video 51.8** – Surface anatomy of the hand and wrist
James Logan
- Video 51.9** – Wrist block: surface anatomy
Dominic Harmon
- Video 51.10** – Wrist block: cadaveric anatomy
Dominic Harmon

SECTION 7: THORAX

Section Editor: Richard Tunstall

52. Thorax: overview and surface anatomy 990
Richard Tunstall
53. Chest wall and breast 997
James J Going, Erin P Fillmore, Donna Geddes
- Lungs and respiratory diaphragm**
54. Pleura, lungs, trachea and bronchi 1020
Quentin Fogg
55. Respiratory diaphragm and phrenic nerves 1038
Albert van Schoor
- Heart and mediastinum**
56. Mediastinum 1047
Peter J Ward
57. Heart 1068
Marios Loukas
58. Great vessels 1097
Marios Loukas

Commentaries

- 7.1. Breast cancer
Donna Geddes, James J Going
- 7.2. Computed tomography coronary angiography (CTCA) of anomalous coronary vasculature
Julia Sun, Jonathan Weir-McCall

SECTION 8: ABDOMEN AND PELVIS

Section Editor: R Shane Tubbs

59. Abdomen and pelvis: overview and surface anatomy 1107
R Shane Tubbs
60. Anterior abdominal wall 1122
Eric M Pauli
61. Posterior abdominal wall and retroperitoneum 1137
R Shane Tubbs
62. Peritoneum, mesentery and peritoneal cavity 1150
John Calvin Coffey, Peter Dockery

Gastrointestinal tract

63. Abdominal oesophagus and stomach 1160
James J Going, Stuart Ballantyne, Andrew MacDonald, Matthew J Forshaw
64. Small intestine 1173
Jeffrey L Ponsky, Andrew T Strong
65. Large intestine 1185
Jasneet Singh Bhullar

Abdominal viscera

66. Liver 1205
Charles B Rosen
67. Gallbladder and biliary tree 1217
Mark D Stringer
68. Pancreas 1223
Claudius Conrad
69. Spleen 1232
Koichi Watanabe
70. Suprarenal gland 1239
Mohamad E Allaf, Michael A Gorin

Urogenital system

71. Lesser pelvis and perineum 1244
Mickey Karram, Hoi Tik Hyde Yuen
72. Kidney and ureter 1259
Joe Iwanaga
73. Bladder, prostate and urethra 1276
Leonard G Gomella, Paul H Chung
74. Male reproductive system 1292
Justine Schober
75. Female reproductive system 1307
Patrick J Woodman

Commentaries

- 8.1. The mesentery and the mesenteric model of abdominal compartmentalization
John Calvin Coffey, Kevin Gerard Byrnes, Peter Dockery, Dara Walsh

Videos

- Video 59.1** – Dissection of the posterior abdominal wall
Shane Tubbs, Joe Iwanaga
- Video 59.2** – Dissection of the lumbosacral junction
Shane Tubbs, Joe Iwanaga
- Video 60.1** – Dissection of the anterior abdominal wall
Shane Tubbs, Joe Iwanaga

- Video 62.1** – Dissection of the peritoneal cavity
Shane Tubbs, Joe Iwanaga
Video 71.1 – Dissection of the sacral plexus
Shane Tubbs, Joe Iwanaga
Video 73.1 – Laparoscopic view of bladder filling and emptying in relation to the rectovesical pouch
Serge Ginzburg, Anthony T Corcoran, Alexander Kutikov
Video 73.2 – Laparoscopic view of the anterior abdominal wall and ligaments
Serge Ginzburg, Anthony T Corcoran, Alexander Kutikov
Video 74.1 – Dissection of the male pelvis and perineum
Shane Tubbs, Joe Iwanaga
Video 75.1 – Dissection of the female pelvis and perineum
Shane Tubbs, Joe Iwanaga

SECTION 9: PELVIC GIRDLE AND LOWER LIMB

Section Editor: Stephanie J Woodley

- | | |
|---|------|
| 76. Pelvic girdle and lower limb: overview and surface anatomy | 1333 |
| <i>Nihal Apaydin, Stephanie J Woodley</i> | |
| 77. Pelvic girdle, hip, gluteal region and thigh | 1352 |
| <i>Donald Anthony Neumann</i> | |
| 78. Knee and leg | 1395 |
| <i>Robert J Spinner, Aaron J Krych, Christopher D Bernard</i> | |
| 79. Ankle and foot | 1430 |
| <i>Anthony V D'Antoni, Garrett D Moore</i> | |

Commentaries

- 9.1.** Functional anatomy and biomechanics of the pelvis
Andry Vleeming, Frank H Willard
9.2. A proposed novel action of psoas minor
Donald Anthony Neumann
9.3. Anterolateral ligament of the knee
Robert F LaPrade

Videos

- Video 76.1** – Walking gait cycle
Stephanie J Woodley, Stuart MacKenzie, Thomas Heaton
Video 76.2 – Running gait cycle
Stephanie J Woodley, Stuart MacKenzie, Thomas Heaton
Video 76.3 – Lower limb surface anatomy
Rolfe Birch
Video 79.1 – Ankle block: surface anatomy
Dominic Harmon
Video 9.2.1 – Psoas minor
Donald Anthony Neumann, LR Garceau

SYSTEMATIC ANATOMY

- 80.** The anatomy of the peripheral nervous system
Susan Standring
81. The anatomy of the vascular and lymphatic systems
Susan Standring

IMAGING COLLECTION

Section 2

- 2.1.** Human oocyte undergoing fertilization, cell division, blastocyst development and hatching *in vitro*

Section 3

- 3.1.** MRI head: axial T2-weighted
3.2. MRI head: coronal T2-weighted
3.3. MRI head: sagittal T2-weighted

Section 4

- 4.1.** CT neck: axial post-IV contrast
4.2. CT neck: coronal post-IV contrast

Section 7

- 7.1.** CT chest, abdomen and pelvis: axial post-IV contrast
7.2. CT chest, abdomen and pelvis: coronal post-IV contrast
7.3. CT chest, abdomen and pelvis: sagittal post-IV contrast

Section 8

- 8.1.** MRI male pelvis: axial T1-weighted

Section 9

- 9.1.** MRI male pelvis: coronal T1-weighted

Commentaries

- I.1.** A note on anatomy from an imaging perspective
Tom Turmezei
I.2. Technical aspects and applications of diagnostic radiology
Jonathan D Spratt
I.3. Imaging the ageing musculoskeletal system
Andoni P Toms
I.4. Cinematic rendering offers entirely new possibilities for studying human anatomy
Andrea Hofbauer, Klaus Engel

EPONYMS

Harold Ellis and Susan Standring

Index

1465