

MEDICAL AND DENTAL EDUCATION

A Core Syllabus for the Teaching of Gross Anatomy of the Thorax to Medical Students

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Discussion is ongoing concerning the need to ensure the clinical relevance of the biomedical sciences. However, clinical relevance within health care courses presupposes that there is internationally agreed core material to be taught and learned. For anatomy, by the initial use of Delphi Panels that comprise anatomists, scientists, and clinicians, the International Federation of Associations of Anatomists (IFAAs) is developing internationally accepted core syllabuses for all anatomical sciences disciplines in the health care professions. In this article, the deliberations of a Delphi Panel for the teaching of thoracic anatomy in the medical curriculum are presented, prior to their publication on the IFAA's website. To develop the syllabus further, it is required that anatomical societies, as well as individual anatomists and clinicians, comment upon, elaborate, and amend this draft recommended syllabus. The aim is to set internationally recognized standards and thus to provide guidelines concerning the knowledge of the human thorax expected of graduating medical professionals. Such information should be borne in mind by those involved in the development of medical courses. Clin. Anat. 00:000–000, 2019. © 2019 Wiley Periodicals, Inc.

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INTRODUCTION

Controversy persists concerning the development of medical curricula and the role of the anatomical sciences within them. Drake et al. (2002, 2009, 2014) and McBride and Drake (2018) have conducted a series of surveys of medical schools in the United States showing that the time devoted to teaching gross anatomy has declined from an average of approximately 170 hr in 2002 to 130 hr in 2018. It was also reported that this compares with approximately 350 hr in the 1950s. While 130 hr may seem a significant amount of time, in the context of the entire medical course, this corresponds merely with 3 full weeks of anatomy tuition in a year or 2% of the entire course. These changes are occurring despite anatomists, medical students and laypersons opining that gross anatomy is crucial and fundamental for medical education and training

(e.g., Patel and Moxham, 2006, 2008; Moxham and Plaisant, 2006; Moxham and Moxham, 2007; Pabst, 2009; Kerby et al., 2011; Moxham et al., 2016). Globally, the range and variety of medical curricula have changed markedly from the traditional model of 2 or 3 years "preclinical studies" followed by 2 or 3 years of "clinical studies" to systems-based integrated curricula. This has led to the significant decreases in the amount of time devoted to gross anatomy and the subject is nowadays taught less as a stand-alone course but more often within

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TABLE 1. [Color table can be viewed at wileyonlinelibrary.com]

Topic	Core	Recommended	Not recommended	Not core
<i>General topics</i>				
Location and general functions	■			
Regions of the thorax		■		
Size and shape of thorax		■		
Surface anatomy of the thorax	■			
Auscultatory points for heart valves	■			
Counting of ribs	■			
Outline of the heart		■		
Outline of pleura		■		
Apex beat		■		
The skin of the thorax			■	■
Cutaneous innervation of thorax (dermatomes)			■	■
Vasculature of the skin			■	■
Lymphatic drainage of the skin			■	■
Superficial and deep fascia of the thorax			■	■
Clavipectoral fascia			■	■
Deltpectoral triangle			■	■
<i>The breast</i>				
Position of the breast on thorax in relation to the ribs		■		
Position of the nipple and areola on thorax			■	■
Functions		■		
Development of the breasts			■	
Shape and size				■
Axillary tail		■		
Fascial relationships of breast			■	
Submammary space			■	
Subareolar muscle			■	■
Glands of the nipple and areola			■	
Montgomery's tubercles			■	
Lobes and ducts of the breast		■		
Suspensory ligaments		■		
Arterial supply of the breast	■			
Venous drainage of the breast	■			
Lymphatic drainage of the breast		■		
Innervation of the breast		■		
Accessory breast tissue				■
Accessory nipples				■
Changes with pregnancy and lactation		■		
Changes with age			■	
<i>The male breast</i>				
Milk line				■
Cooper's ligament		■		
Retromammary space			■	

horizontally and/or vertically integrated medical courses, or even as optional (elective) courses (see Moxham and Pais, 2016; McBride and Drake, 2018).

Adopting different approaches for teaching gross anatomy can be beneficial if they accord with an understanding of medical students' different learning styles. On the other hand, care must be taken to ensure that diversity does not lead to a lack of consistency, reliability, and transparency in medical education that renders great diversity in standards from medical school to medical school. Such concerns would not be so problematic if examination procedures and practices existed that ensured uniform standards both nationally and internationally and if there were internationally

recognized core syllabuses for the anatomical sciences.

There have recently been worthy attempts to develop core syllabuses for gross anatomy in general (Leonard et al., 2000; Griffioen et al., 1999; McHanwell et al., 2007; Orsbon et al., 2014; Smith et al., 2016a, 2016b; Connolly et al., 2018; Finn et al., 2018). Most have been concerned with devising learning outcomes and not with listing core topics. Alternatively, more "specialized" core syllabuses for the anatomical sciences concerned with core topics have been published through the auspices of the IFAA for head and neck anatomy (Tubbs et al., 2014; Tubbs and Paulk, 2015), for neuroanatomy (Moxham et al., 2015), for embryology and teratology (Fakoya et al., 2017), for the musculoskeletal system

TABLE 2. [Color table can be viewed at wileyonlinelibrary.com]

Topic	Core	Recommended	Not recommended	Not core
<i>Thoracic walls</i>				
Size and shape of thoracic walls				
Osseous structures comprising thoracic walls				
<i>Sternum</i>				
Size, location, and orientation				
Bony composition				
Shape and location of manubrium				
Suprasternal (jugular) notch of manubrium				
Clavicular notches of manubrium				
Notches for first and second ribs on manubrium				
The sternoclavicular joint				
Interclavicular ligaments				
The first and second sternocostal joints				
The manubriosternal joint				
Plane of Louis and relationship of structures there				
Sternebrae of body of sternum				
Size, shape, and location of body of sternum				
Sternal foramen				
Notches for second to seventh ribs of body of sternum				
Xiphoid process (shape size and location)				
Xiphisternal joint				
Notch for seventh rib on xiphoid process				
<i>Muscle attachments to the sternum</i>				
Pectoral m.				
Sternocleidomastoid m.				
Sternothyroid m.				
Sternohyoid m.				
Transversus thoracis				
External intercostals (membrane)				
Rectus abdominalis				
External and internal oblique ms.				
Attachment of linea alba				
Diaphragmatic attachments				
Movements of sternum during respiration				
Vascular supply of sternum				
Innervation of the sternum				
Development and ossification of sternum				
<i>The clavicle</i>				
Size				
Shape				
Location and orientation				
Infraclavicular fossa and boundaries				
Side determination				
Functions				
Bony composition				
Gender differences				
Nutrient foramina				
Sternal part and sternoclavicular joint				
Acromial part and acromioclavicular joint				
<i>Muscle attachments to the clavicle</i>				
Sternocleidomastoid m				
Pectoralis major				
Trapezius				
Deltoid				
Sternohyoid				
Subclavius (inferior groove for subclavius)				
Attachment of costoclavicular ligament (conoid tubercle and trapezoid line)				
Relationship with brachial plexus				
Vascular impressions				
Development and ossification of clavicle				

TABLE 3. [Color table can be viewed at wileyonlinelibrary.com]

Topic	Core	Recommended	Not recommended	Not core
<i>The ribs (costae)</i>				
Number of ribs	■			
Sizes of ribs		■		
True, false, and floating ribs	■			
Side determination			■	
Bony composition of the ribs			■	
Movements of ribs during respiration	■			
Vasculature of the ribs			■	
Innervation of the ribs				■
Development and ossification of ribs				■
Features of a typical rib		■		
Shaft		■		
Head		■		
Neck and tubercle		■		
Anterior end and costal cartilage		■		
Costal groove		■		
Impressions			■	
Articulations of costal cartilages with sternum		■		
Articulations of the false ribs		■		
Cervical rib		■		
Atypical ribs—first		■		
Impressions on first rib			■	
Atypical ribs—second		■		
Impressions on second rib			■	
Atypical ribs—10th to 12th				■
Joints of costal heads with vertebrae		■		
Joints of tubercles with vertebrae		■		
<i>Muscle attachments to ribs</i>				
Scalene muscles from neck		■		
Serratus anterior	■			
Serratus posterior		■		
Subclavius				■
Pectoralis ms.		■		
Rectus abdominalis		■		
Levator costae			■	
Intercostal ms. and membranes		■		
Iliocostalis thoracis			■	
Erector spinae		■		
Latissimus dorsi	■			
<i>Ligaments attached to ribs</i>				
Radiate ligaments				■
Intraarticular				■
Costotransverse ligaments		■		
Thoracolumbar fascia		■		
The intercostal spaces and contents	■			
Thoracic vertebrae	■			
Number	■			
Size, shape, and location		■		
Development and ossification of thoracic vertebrae				■
Typical features of a thoracic vertebra	■			
Ligaments of the thoracic vertebrae			■	
<i>Vertebrae are assessed in detail within the core syllabus for the back</i>				

(Webb et al., 2018) and for oral anatomy, embryology, and histology for dentistry (Moxham et al., 2018).

Using the IFAA-approved methodologies (Moxham et al., 2014) previously used to devise their core syllabuses, we here present the findings of a Delphi Panel commissioned to develop a core syllabus within medicine for the gross anatomy of the human thorax.

METHODS

Guiding principles for the development of core syllabuses have been approved by the IFAA and these have previously been published and extensively discussed (Moxham et al., 2014). Synoptically, the process involves three stages.

TABLE 4. [Color table can be viewed at wileyonlinelibrary.com]

Topic	Core	Recommended	Not recommended	Not core
<i>Thoracic inlet</i>				
Constituent parts	■			
Structures passing through the thoracic inlet	■			
Rotter's nodes			■	
Sentinel node		■		
<i>Diaphragm</i>				
Location and shape	■			
Changes to shape of diaphragm during respiration	■			
Changes to shape of diaphragm during standing and lying down		■		
Surface anatomy	■			
Function and movements during respiration	■			
Bucket handle		■		
Pump handle		■		
Paradoxical respiration		■		
Accessory muscles of respiration		■		
Development of the diaphragm				■
Central tendon		■		
Right, left, and middle folia		■		
Domes		■		
Attachments of the diaphragm		■		
Sternal		■		
Costal		■		
Lumbar		■		
Medial and lateral arcuate ligaments		■		
Crura	■			
Surface coverings superiorly		■		
The cardiac plateau		■		
Surface coverings of the inferior surface		■		
Apertures of the diaphragm	■			
Aortic hiatus	■			
Level of thoracic vertebra	■			
Oesophageal aperture	■			
Level of the thoracic vertebra	■			
Opening also for vagus, gastric nerves, and vessels	■			
Relationship with right crus		■		
Phrenoesophageal ligament		■		
Caval opening	■			
Level of eighth thoracic vertebra	■			
Opening in central tendon	■			
Openings for splanchnic nerves		■		
Openings for left phrenic nerve		■		
Blood supply of diaphragm				
Intercostal and subcostal as			■	
Inferior phrenic as		■		
Superior phrenic as.		■		
Venous drainage of diaphragm			■	
Lymphatic drainage of diaphragm			■	
Innervation of diaphragm	■			
Phrenic ns. (motor)	■			
Intercostal ns.				
Phrenic ganglia			■	
Accessory phrenic ns.			■	

Stage 1

A Delphi Panel is constructed consisting of between 20 and 30 experts in the specified field drawn from different countries. The panel is given a detailed list of topics within their remit to evaluate. Thus, the IFAA

syllabuses are not based upon a "broad brush" approach or involve the development of learning outcomes. The panel for thoracic anatomy for the medical course consisted of 22 members (6 from the United States; 2 from United Kingdom and Ireland; 2 from Greece; 2 from the West Indies; 1 from Italy;

TABLE 5. [Color table can be viewed at wileyonlinelibrary.com]

Topic	Core	Recommended	Not recommended	Not core
<i>Intrinsic chest wall muscles</i>				
External intercostals	■			
Attachments		■		
Functions		■		
Innervation		■		
Blood supply		■		
Internal intercostals	■			
Attachments		■		
Functions		■		
Innervation		■		
Blood supply		■		
Innermost intercostals	■			
Attachments		■		
Functions		■		
Innervation		■		
Blood supply		■		
Subcostales			■	
Attachments			■	■
Functions			■	
Innervation			■	
Blood supply			■	■
Transversus thoracis			■	
Attachments			■	■
Functions			■	
Innervation			■	
Blood supply			■	■
Levatores costarum			■	
Attachments				■
Functions				
Innervation				
Blood supply				
Serratus posterior superior			■	
Attachments				■
Functions				
Innervation				
Blood supply				
Serratus posterior inferior			■	
Attachments				■
Functions				
Innervation				
Blood supply				
Sternalis			■	
Attachments				■
Functions				
Innervation				
Blood supply				
<i>Arteries of the chest wall</i>				
Internal thoracic a	■			
Origin, course, and distribution		■		
Sternal branches		■		
Anterior intercostals		■		
Perforating branches		■		
Musculophrenic		■		
Superior intercostal a	■			
Origin, course, and distribution		■		
Posterior intercostals	■			
Origin, course, and distribution		■		
Dorsal branch		■		
Collateral intercostal branch		■		
Muscular branches		■		
Lateral cutaneous branch		■		
<i>Veins of the chest wall</i>				
Internal thoracic v.		■		
Course and drainage		■		
Left superior intercostal v.		■		

(Continues)

TABLE 5. Continued

Topic	Core	Recommended	Not recommended	Not core
Course and drainage Posterior intercostal vs. Course and drainage <i>Lymphatic drainage of chest wall</i> Parasternal (internal thoracic) nodes				
Intercostal nodes				
Diaphragmatic nodes				
<i>Innervation of the chest wall</i> Thoracic ventral spinal rami				
Intercostal ns. Course, functions, distribution				
Subcostal n. course, functions, distribution				
Thoracic dorsal spinal rami Medial and lateral branches				
Medial and lateral cutaneous branches				

TABLE 6. [Color table can be viewed at wileyonlinelibrary.com]

Topic	Core	Recommended	Not recommended	Not core
<i>Intrathoracic cavities</i> <i>The pleural cavity and lungs</i> Surface anatomy of the extent of the pleural cavities				
Development of the pleural cavities				
Functions of the pleura				
Layers of pleura				
The basic histological features of the pleura				
The pleural space and pleural fluid				
Functions of pleural fluid				
Secretion and absorption of pleural fluid				
Pleural fluid pressures				
Folds of pleura at reflection sites (retrosternal, interlobar fissures and the azygoesophageal recess) visualized radiographically				
Extent of the parietal pleura on thoracic structures (i.e., costovertebral, diaphragmatic, cervical and mediastinal pleura)				
Inferior pulmonary ligaments				
The costomediastinal recess				
The costodiaphragmatic recess				
The visceral pleura				
The innervation of the pleura				
The vasculature of the pleura				
The lymphatic drainage of the pleura				
The lungs—development of				
Functions of the lungs				
Appearances and texture of the lungs				
Surfaces of the lungs (apex, base, costal surface, medial surface)				
Impressions of mediastinal structures on the cadaveric lung				
Side determination of the lung				
Pulmonary borders				
The fissures and lobes of the lungs—differences between right and left				
Surface anatomy of the oblique and transverse fissures of the lungs				
The cardiac notch				

(Continues)

TABLE 6. Continued

Topic	Core	Recommended	Not recommended	Not core
Lingula				
Bronchopulmonary segments (concept)				
Bronchopulmonary segments (detailed description)				
Hilia (bare areas for transmission of structures in and out of lungs)				
Shape of hila and the pulmonary ligament				
The bronchi in the hila				
The pulmonary vessels in the hila				
Bronchial vessels				
Lymph nodes in and around the hilum				
Differences between right and left hila				
Pulmonary plexuses				

TABLE 7. [Color table can be viewed at wileyonlinelibrary.com]

Topic	Core	Recommended	Not recommended	Not core
<i>The mediastinum</i>				
Location and subdivisions				
Plane of Louis and relationships at this plane				
<i>The superior mediastinum</i>				
Relationship with neck and thoracic inlet				
List of contents within superior mediastinum				
Thymus—shape and functions				
Thymus—development and postnatal development				
Thymus—positions and relations				
Thymus—vascular supply				
Thymus—lymphatic drainage				
Thymus—innervation				
<i>The esophagus, trachea and bronchi</i>				
Functions of esophagus				
Course and relationships of esophagus				
Oesophageal sphincters				
The esophagus—vascular supply				
The esophagus—lymphatic drainage				
The esophagus—innervation				
Anatomical constrictions of the esophagus				
Trachea and bronchi				
Course of trachea				
Structure of trachea				
Relationships of structures with trachea				
Carina trachea				
Courses of bronchi				
Differences between right and left main bronchi				
Relationships of structures with bronchi				
Vasculature of trachea and bronchi				
Innervation of trachea and bronchi				
<i>Other superior mediastinal structures</i>				
Ascending aorta and aortic arch				
Origin of coronary arteries				
Origin of brachiocephalic artery				
Course and distribution of brachiocephalic artery				
Origin of the left carotid artery				
Origin of the left subclavian artery				
Course of the pulmonary trunk and arteries				

(Continues)

TABLE 7. Continued

Topic	Core	Recommended	Not recommended	Not core
Ligamentum arteriosum	Core			
Course of the pulmonary veins	Core			
Course of left vagus and recurrent laryngeal n.	Core			
Brachiocephalic veins	Core			
Superior vena cava	Core			
Azygos v.	Core			
Thoracic duct	Core			
Course of thoracic duct within the thorax	Core			
Development of thoracic duct			Not recommended	
Lymphatics in superior mediastinum		Recommended		
Cardiac plexus		Recommended		
Right vagus	Core			
Phrenic ns	Core			
Origins of sternhyoid and sternothyroid ms		Recommended		
<i>Anterior mediastinum</i>				
Location of anterior mediastinum	Core			
Course and branches of the internal thoracic artery	Core			
Course and tributaries of the internal thoracic vein	Core			
Remains of thymus		Recommended		
Sternopericardial ligaments				Not core
Lymph nodes in the anterior mediastinum		Recommended		
Mediastinal branches of the internal thoracic as		Recommended		
Pleural reflections	Core			
<i>Posterior mediastinum</i>				
Location of the posterior mediastinum	Core			
Boundaries of the posterior mediastinum	Core			
Pleural recesses in the posterior mediastinum (interaorticooesophageal, interazygooesophageal)	Core	Recommended		
Descending thoracic aorta (location)	Core	Recommended		
Vertebral levels for beginning and end of descending thotacic aorta	Core	Recommended		
Descending thoracic aorta (branches)	Core	Recommended		
Pericardial branches	Core	Recommended		
Bronchial branches	Core	Recommended		
Oesophageal branches	Core	Recommended		
Mediastinal branches	Core	Recommended		
Posterior intercostal arteries	Core	Recommended		
Superior phrenic arteries	Core	Recommended		
Subcostal artery	Core	Recommended		
Descending thoracic aorta through diaphragm	Core			
Esophagus (location)	Core			
Esophagus through diaphragm	Core			
Azygos and hemiazygos venous system	Core			
Origin of azygos (right ascending lumbar v. and right subcostal v.)	Core			
Origin of hemiazgos (left ascending lumbarv and left subcostal v.)	Core			
Tributaries of azygos v.	Core			
Right superior intercostal vein		Recommended		
5th to 11th posterior intercostal veins		Recommended		
Hemiazygos vein	Core			
Lowest 4/5 left posterior intercostal veins		Recommended		
Oesophageal and mediastinal vs.		Recommended		
Accessory hemiazygos v.		Recommended		
4th to 8th left posterior intercostal veins		Recommended		
Occasional left bronchial veins				Not core
Oesophageal veins		Recommended		
Mediastinal veins		Recommended		
Pericardial veins		Recommended		

(Continues)

TABLE 7. Continued

Topic	Core	Recommended	Not recommended	Not core
Right bronchial veins		█		
Variations of the azgos system				█
Thoracic duct (location)	█			
Tributaries of the thoracic duct		█		
Cisterna chyli	█			
Rt lymphatic duct	█			
Sympathetic trunks and splanchnic nerves				
Ganglia and gray and white rami communicantes		█		
Branches from upper five thoracic ganglia		█		
Postganglionic fibers to viscera		█		
Branches from lower seven thoracic ganglia		█		
Greater splanchnic nerve	█			
Lesser splanchnic nerve				
Least splanchnic nerve		█		
Vagal trunks	█			
Mediastinal lymph nodes	█			
Middle mediastinum (location and boundaries)	█			
Inferior vena cava	█			

TABLE 8. [Color table can be viewed at wileyonlinelibrary.com]

Topic	Core	Recommended	Not recommended	Not core
<i>Pericardium</i>				
Layers of pericardium	█			
Fibrous pericardium	█			
Parietal layer of serous pericardium	█			
Visceral layer of serous pericardium (epicardium)	█			
Vasulature of pericardium		█		
Innervation of pericardium		█		
Lymphatic drainage of pericardium		█		
Pericardial space and fluid	█			
Oblique sinus		█		
Transverse sinus		█		
<i>Heart</i>				
Orientation	█			
Size and shape	█			
External feature	█			
Grooves on cardiac surface	█			
Surfaces and borders	█			
Crux of the heart	█			
Base and apex	█			
Chambers	█			
Right atrium—general features	█			
Crista terminalis	█			
Pectinate muscles	█			
Sinus venosus	█			
Sinus venarum		█		
Right atrium proper	█			
Foramen ovale	█			
Fossa ovalis	█			
Limbus fossa ovalis		█		
Patent probe foramen ovale	█			
Membranous septum	█			
Venae chordae minimae		█		
Internal and external features	█			
Venous openings into the right atrium	█			
Right ventricle—general features	█			

(Continues)

TABLE 8. Continued

Topic	Core	Recommended	Not recommended	Not core
Internal and external features	Core			
Septomarginal trabeculations	Core			
Moderator band	Core			
Septoparietal trabeculations		Recommended		
Crista supraventricularis		Recommended		
Subpulmonary infundibulum		Recommended		
Medial papillary muscle complex (muscle of Lansici)			Not recommended	Not core
Parietal free wall		Recommended		
Trabeculae carnae	Core			
Left atrium—general features	Core			
Internal and external features	Core			
Body		Recommended		
Vestibule		Recommended		
Venous component		Recommended		
Fossa ovalis	Core			
Pectinate muscles	Core			
Opening of pulmonary veins	Core			
Auricle/appendage	Core			
Left ventricle—general features	Core			
Internal and external features	Core			
Fine trabeculations		Recommended		
Inlet component		Recommended		
Outlet component		Recommended		
Aortic to mitral valve fiber continuity	Core			
Valves	Core			
Inferior vena cava valve (Eustachian)		Recommended		
Chiari's network			Not recommended	Not core
Valve of coronary sinus (Thebesian)		Recommended		
Valve of great cardiac vein (Vieussen)		Recommended		
Tricuspid valve	Core			
Tricuspid valve leaflets	Core			
Chordae tendinae	Core			
Papillary muscles	Core			
Pulmonary valve	Core			
Opening of the pulmonary valve	Core			
Mitral valve	Core			
Mitral valve leaflets	Core			
Chordae tendinae	Core			
Papillary muscles	Core			
Aortic valve	Core			
Aortic valve leaflets	Core			
Conducting system of the heart	Core			
Sinatrial node	Core			
Atrioventricular node	Core			
AV bundle of HIs	Core			
Purinje fibers	Core			
Right bundle branch	Core			
Left bundle branch	Core			
Accessory bundle of Kent		Recommended		
Internodal pathways		Recommended		

1 from Nigeria; 1 from South Africa; 1 from Turkey; 1 from New Zealand; 1 from Spain; 1 from Poland; 1 from India; 1 from Japan). The age ranged from 30s to 70+ years. 66% of the panelists were clinically qualified. All the panelists were full-time academics (clinical or scientific) and all but one were employed by universities. Of the nine panelists who have clinical responsibilities, 90% claimed to devote more than 20% of their time to their clinical practice and 45%

devoted 50% or more of their time. Four panelists were writers of anatomy textbooks. Thirteen panelists were/have been engaged in research related to thoracic anatomy. All but one of the panelists were teachers with substantial, or considerable, teaching experience, although few were educationalists involved in pedagogic research. All panelists stated that the teaching of embryology and teratology to medical students is important or very important.

TABLE 9. [Color table can be viewed at wileyonlinelibrary.com]

Topic	Core	Recommended	Not recommended	Not core
<i>Vasculature of the heart</i>				
Right coronary artery				
Origin and general course and distribution				
Atrial branch				
Conal branch				
Sinuatrial nodal branch				
Right marginal branch				
Artery to the atrioventricular node				
Posterior interventricular branch (posterior descending artery [PDA])				
Variations in right coronary artery				
Left coronary artery (aka left main stem vessel)				
Origin and general course and distribution				
Anterior interventricular branch (left anterior descending artery)				
Septal perforators				
Diagonal branches				
Circumflex branch				
Left marginal artery				
Posterior interventricular branch (PDA)				
Variations in left coronary artery				
Coronary anastomosis				
Cardiac veins				
Great cardiac vein (anterior interventricular v.)				
Middle cardiac vein (posterior interventricular v.)				
Small cardiac vein				
Right marginal vein				
Oblique vein of the left atrium				
Posterior cardiac vein				
Anterior veins of right ventricle (anterior cardiac vs.)				
Venae cordis minimae				
Coronary sinus				
Lymphatic drainage of the heart				
<i>Innervation of the heart</i>				
Superficial cardiac plexus				
Deep cardiac plexus				
Sympathetic innervation				
Parasympathetic innervation				
Visceral afferent fibers				
Cardiac skeleton				
Triangle of Koch				
Tendon of Todaro				
Tendon of Infundibulum				
Right fibrous trigone				
Left fibrous trigone				
Central fibrous body				
<i>Development of heart</i>				
Assessed by Delphi Panel dealing with embryology and teratology				

The coordinators of the panel (the authors of this article) provided a draft list of topics for the panel to consider, the list being liable for amendment following comments from the panelists. The panelists subsequently had to evaluate each item/topic in the list according to whether it should be regarded as having "essential," "important," "acceptable," or "not required" status. An example of the form used by the Delphi Panel for thoracic anatomy is shown in Table 1.

To enable further comments from the panelists, a blank section was available within the form for comments.

From the Delphi panelists' responses, every topic/item was analyzed by the project's coordinators in accordance with general rules followed for other core syllabuses published through the IFAA. Where more than 60% of the panelists considered an item as being essential, this was categorized as being "core". Where

TABLE 10. [Color table can be viewed at wileyonlinelibrary.com]

Topic	Core	Recommended	Not recommended	Not core
<i>Clinical considerations</i>				
Carcinoma of breast	Core			
Tension of suspensory ligaments and pitting of skin	Core			
Spread of tumors via lymphatics and veins	Core			
Direct invasion of breast tumors	Core			
Peau d'orange and anatomical reasons	Core			
Anatomy associated with mastectomies	Core			
Damage to long thoracic nerve following mastectomy	Core			
Damage to intercostobrachial nerve following mastectomies		Recommended		
Polymastia				Not core
Polythelia				Not core
Gynecomastia			Not recommended	
Inverted nipples			Not recommended	
Damage to n. to latissimus dorsi m.		Recommended		
Effects of having cervical rib and cervical band		Recommended		
Thoracic outlet syndrome		Recommended		
Collection of sternal bone marrow	Core			
Rib fractures and flail chest	Core			
Surgical access to the chest		Recommended		
Insertion of a chest drain	Core			
Pneumothorax	Core			
Pain and referred pain associated with the pleura	Core			
Fluid aspiration from pleural recesses (thoracocentesis)	Core			
Hemothorax	Core	Recommended		
Tension pneumothorax	Core			
Pleural effusion		Recommended		
Pleuricy, pleuritis		Recommended		
Congenital diaphragmatic hernia			Not recommended	
Eventration of the diaphragm			Not recommended	
Congenital hiatal hernia		Recommended		
Lung percussion	Core			
Lung auscultation	Core			
Lung sounds and surface anatomy	Core			
Orientation of bronchi and inhalation of foreign objects	Core			
Plain chest radiography	Core			
CT imaging of chest				
Bronchoscopy		Recommended		
Lung cancers	Core			
Spread of tumors via lymphatics	Core			
Surgical opening of pericardium and the sinuses		Recommended		
Pain and referred pain associated with the pericardium	Core			
Pericardial effusions	Core			
Constrictive pericarditis (jugular venus pulse)		Recommended		
Pericardiocentesis		Recommended		
Pericardial tamponade	Core			
Beck's triad		Recommended		
Heart outline on chest radiographs	Core			
Cardiac valvular disease	Core			
Coronary heart disease	Core			
Coronary angioplasty (anatomy of)		Recommended		
Pain and referred pain associated with the heart	Core			
Interartrial septal heart defect	Core			
Patent foramen ovale	Core			
Probe patency	Core			
Ostium secundum ASD		Recommended		
Endocardial cushion with ostium primum ASD		Recommended		

(Continues)

TABLE 10. Continued

Topic	Core	Recommended	Not recommended	Not core
Sinus venosus defect		██████████		
Common atrium			██████████	
Ventriculoseptal heart defect		██████████		
Membranous VSD		██████████		
Muscular VSD		██████████		
Swiss cheese VSD				██████████
Common ventricle			██████████	
Transposition of the great arteries		██████████		
Patent ductus arteriosus	██████████			
Coarctation of the aorta		██████████		
Dextrocardia		██████████		
Ectopia Cordis			██████████	
Persistent truncus arteriosus		██████████		
Ectopic parathyroids			██████████	
Aorticopulmonary window defect			██████████	
Fallot's tetralogy		██████████		
Pulmonary atresia		██████████		
Hypoplastic left heart syndrome			██████████	
Pulmonary valve defects		██████████		
Aortic valve defects		██████████		
Appearance of great vessels of mediastinum on chest radiographs	██████████			
Anatomy of central venous access		██████████		
Trauma to aorta and aortic dissection		██████████		
Variations in origins of the great vessels		██████████		
The aortopulmonary window and left recurrent laryngeal n.		██████████		
Common sites for compression of the esophagus	██████████			
Lymphatics and oesophageal cancer	██████████	██████████		
Safe triangle for chest drain insertion	██████████	██████████		
Foreign bodies bronchi/lungs	██████████	██████████		
Compression of recurrent laryngeal n	██████████	██████████		
Tracheal compression	██████████			
Aortic aneurysm	██████████			
Tracheoesophageal fistula		██████████		
Achalasia		██████████		
Barrett's esophagus		██████████		
Chylothorax		██████████		

between 30 and 59% of the panelists classified an item as being essential, the topic was designated as being "recommended." Classification of "just acceptable" or "not required" came when the panelists only recorded essential designations between 20 and 29% and less than 20%, respectively. It is at this stage that our findings are presented to a wider-ranging audience through this article and on the IFAA website.

The Delphi panel is not involved in Stages 2 and 3 of the development of a core IFAA syllabus. At these stages, the IFAA relies upon comments from learned societies and from individual academics and medical clinicians from across the world. Thus, on a regular and continuous basis, further review and modification of a core syllabus takes place by the Federative International Programme for Anatomical Education (FIPAE) of the IFAA.

FINDINGS

The results of the Delphi Panel's deliberations for different topics related to thoracic anatomy are presented in Tables 1–10. Note that for consistency of

development of this initial syllabus, where a topic is classified as "recommended" but just approaches "core" (i.e., being classified as being "essential" by almost 60% of responding Delphi panelists), it is moved into the "core" category.

DISCUSSION

Although the IFAA, in commissioning the development of core syllabuses for the anatomical sciences through its international educational program (FIPAE), is committed to producing detailed syllabuses rather than adopt a "broad brush" approach, there will be a need to reconcile the findings from different approaches (i.e., developing learning outcomes or topic items). The time is not yet right for this "reconciliation" since, Stages 2 and 3 of the processes approved by the IFAA have yet to be completed and future projects will be required to develop IFAA core medical syllabuses for the abdomen and the pelvis and perineum.

Both the authors, and the IFAA, are mindful that any team of experts cannot dictate what should, or

should not, be taught and the IFAA agrees with the principle that a core syllabus must be sufficiently flexible to be amenable to regular review and change. Indeed, the IFAA's approach recognizes the importance of the initial input of "experts" to the formulation of a core syllabus but holds to the view that there must be regular updating from the whole community of stakeholders (including anatomists, scientists, clinicians, students, administrators, and those politico-educational forces that govern medical schools). Moreover, syllabuses must evolve over time as new material comes along and as old material ceases to be academically or clinically relevant. Therefore, even at this point, the authors would welcome comments that will be passed to FIPAE for their consideration as the syllabus goes to the second phase of evaluation.

The IFAA syllabuses aim to present universities and the medical community with internationally accepted standards by which to assure the public about the quality of healthcare provision. In this regard, there are implications for the belief that the biomedical sciences should be made more clinically relevant. This of course presupposes that there is a clear understanding of what can be considered core material within the medical syllabus. It is our firm belief that this can only be properly accomplished by having internationally recognized core syllabuses.

One of the advantages of employing a Delphi process is that interesting questions often arise concerning the lack of consensus following analysis. Indeed, during Stages 2 and 3 of the IFAA processes, the reasons for the failure to agree consensus on a question, or series of questions, can be explored. In the present case, consensus across the panel was clearly evident for most, but not all, topics. However, in contrast to the IFAA syllabuses already published, we were surprised that the list of core topics accords with the authors' expectations. Thus, at this stage, we could not discern topics omitted from the list of core topics that we felt were incorrectly "judged".

Finally, it must be asked: what is the purpose of a core syllabus? This question we raised in previous papers on core syllabuses (Moxham et al., 2014, 2015, 2018; Tubbs et al., 2014; Fakoya et al., 2017; Webb et al., 2018) and our answer remains unaltered—"While recognizing that it may be hard to obtain universal agreement on the details, a core syllabus should provide the minimum level of knowledge expected of a recently qualified medical graduate in order to carry out many clinical procedures safely and effectively (thus to ensure that students are not overloaded with facts). The aim is to set standards not impose them. Thus, the core syllabus does NOT dictate WHEN or HOW the syllabus is delivered..." (Moxham et al., 2015). In this context, it is pertinent to ask questions about the use of the term "core"! It is the belief of some that ONLY core material should be taught and examined. We would counter that notion by reminding readers that the strength of universities lies in them possessing different schools of thought. Furthermore, for a university education to be worthy of its name, students should be taken to the frontiers of knowledge, at least in some areas. What

is however more concerning is the belief that core means ONLY that which is absolutely "essential" for the students to know. If this argument is followed then ONLY this "essential" knowledge is examined and the pass mark is, or approaches, 100%! Clearly, this would be impossible in practice and so by "core" we mean that material/items which the students should be taught. Should examiners just use very basic, and clinically very important, questions in their assessments then of course the pass mark will be high. This situation is to some extent ameliorated by courses where important material is returned to at different stages of a course (e.g., in a "spiral course"). In view of this, we would say that the core syllabus presented here for the teaching and learning of thoracic anatomy is the recommended syllabus of the IFAA and consequently we advocate that the material/topic we are recognizing as "essential" represents international norms that should be covered in a university's/medical school's curriculum.

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REFERENCES

- Connolly SA, Gillingwater TH, Chandler C, Grant AW, Greig J, Meskell M, Ross MT, Smith CF, Wood AF, Finn GM. 2018. The Anatomical Society's core anatomy syllabus for undergraduate nursing. *J Anat* 232:721–728.
- Drake RL, Lowrie DJ, Prewitt CM. 2002. Survey of gross anatomy, microscopic anatomy, neuroscience, and embryology courses in medical school curricula in the United States. *Anat Rec* 269: 118–122.
- Drake RL, McBride JM, Lachman N, Pawlina W. 2009. Medical education in the anatomical sciences: the winds of change continue to blow. *Anat Sci Educ* 2:253–259.
- Drake RL, McBride JM, Pawlina W. 2014. An update on the status of anatomical sciences education in United States medical schools. *Anat Sci Educ* 7:321–325.
- Fakoya FA, Emmanouil-Nikoloussi E, Sharma D, Moxham BJ. 2017. A core syllabus for the teaching of embryology and teratology to medical students. *Clin Anat* 30:159–167.
- Finn GM, Hitch G, Apama B, Hennessy C, Smith CF, Stewart J, Gard PR. 2018. The Anatomical Society core anatomy syllabus for pharmacists: outcomes to create a foundation for practice. *J Anat* 232:729–738.
- Griffioen FMM, Drukker J, Hoogland PVJM, Godschalk M. 1999. General plan anatomy objectives of the teaching of anatomy/embryology in medical curricula in the Netherlands. *Eur J Morphol* 37:228–325.
- Kerby J, Shukur ZN, Shalhoub J. 2011. The relationships between learning outcomes and methods of teaching anatomy as perceived by medical students. *Clin Anat* 24:489–497.
- Leonard RJ, Acland RD, Agur A, Blevins CE, Cahill DR, Collins JD, Dalley AF II, Dolph J, Hagedoorn JP, Hoos PC, Jones DG, Mathers LH, McFee R, Mennin SP, Negulesco JA, Nelson ML, Olson TR, Page DW, Pawlina W, Petterborg LJ, Price JM, Spielman JE, Younoszai R. 1996.

- A clinical anatomy curriculum for the medical student in the 21st century: gross anatomy. *Clin Anat* 9:71–99.
- Leonard RJ, Hoos PC, Agur A, Gilroy AM, Lozanoff S, Nelson ML, Newman LM, Petterborg LJ, Rosenheimer J. 2000. A clinical anatomy curriculum for the medical student in the 21st century: developmental anatomy. *Clin Anat* 13:17–35.
- McBride JM, Drake RL. 2018. National survey on anatomical science in medical education. *Anat Sci Educ* 11:7–14.
- McHanwell S, Atkinson M, Davies DC, Dyball R, Morris J, Ockleford C, Parkin I, Standing S, Whiten S, Wilton J. 2007. A core syllabus in anatomy—adding common sense to need to know. *Eur J Anat* 11: S3–S18.
- Moxham BJ, Hennon H, Lignier B, Plaisant O. 2016. An assessment of the anatomical knowledge of laypersons and their attitudes towards the clinical importance of gross anatomy in medicine. *Ann Anat* 208:194–203.
- Moxham BJ, McHanwell S, Berkovitz B. 2018. The development of a core syllabus for the teaching of oral anatomy, histology and embryology to dental students via an international “Delphi Panel”. *Clin Anat* 31:231–249.
- Moxham BJ, McHanwell S, Plaisant O, Pais D. 2015. A core syllabus for the teaching of neuroanatomy to medical students. *Clin Anat* 28:706–716.
- Moxham BJ, Moxham SA. 2007. The relationships between attitudes, course aims and teaching methods for the teaching of gross anatomy in the medical curriculum. *Eur J Anat* 11: 19–30.
- Moxham BJ, Pais D. 2016. How optional should regional anatomy be in a medical course? An opinion piece. *Clin Anat* 29: 702–710.
- Moxham BJ, Plaisant O. 2006. Perception of medical students towards the clinical relevance of anatomy. *Clin Anat* 20:560–564.
- Moxham BJ, Plaisant O, Smith CF, Pawlina W, McHanwell S. 2014. An approach toward the development of core syllabuses for the anatomical sciences. *Anat Sci Educ* 7:302–311.
- Orsbon CP, Kaiser RS, Ross CE. 2014. Physician opinions about an anatomy core curriculum: a case for medical imaging and vertical integration. *Anat Sci Educ* 7:251–261.
- Pabst R. 2009. Anatomy curriculum for medical students: what can be learned for future curricula from evaluations and questionnaires completed by students, anatomists and clinicians in different countries? *Ann Anat* 191:541–546.
- Patel KM, Moxham BJ. 2006. Attitudes of professional anatomists to curricular change. *Clin Anat* 19:132–141.
- Patel KM, Moxham BJ. 2008. The relationships between learning outcomes and methods of teaching anatomy as perceived by professional anatomists. *Clin Anat* 21:182–189.
- Smith CF, Finn GM, Stewart J, Atkinson MA, Davies DC, Dyball R, Morris J, Ockleford C, Parkin I, Standing S, Whiten S, Wilton J, McHanwell S. 2016b. The Anatomical Society core regional anatomy syllabus for undergraduate medicine. *J Anat* 228:15–23.
- Smith CF, Finn GM, Stewart J, McHanwell S. 2016a. Anatomical Society core regional anatomy syllabus for undergraduate medicine: the Delphi process. *J Anat* 228:2–14.
- Tubbs RS, Paulk PB. 2015. Essential anatomy of the head and neck: the complete Delphi panel list. *Clin Anat* 28:423.
- Tubbs RS, Sorenson EP, Sharma A, Benninger B, Norton N, Loukas M, Moxham BJ. 2014. The development of a core syllabus for the teaching of head and neck anatomy to medical students. *Clin Anat* 27:321–330.
- Webb AL, Green RA, Woodley SJ. 2018. The development of a core syllabus for teaching musculoskeletal anatomy of the vertebral column and limbs to medical students. *Clin Anat*. 32:974–1007 <https://doi.org/10.1002/c.23319>.