Anatomical Science International (2024) 99:387–399
https://doi.org/10.1007/s12565-024-00759-5

ORIGINAL ARTICLE

Convergence and Divergence of Anatomical Terminology

Towards a *Terminologia Anatomica Humana*

Hans J. ten Donkelaar[1,2,3] · **Robert Baud**[4,5,6] · **David Kachlik**[7,8]

Received: 26 December 2023 / Accepted: 3 February 2024 / Published online: 16 March 2024

Abstract

Unfortunately, the long-awaited revision of the official anatomical nomenclature, the *Terminologia Anatomica 2* (TA2), which was issued in 2019 and after a referendum among the Member Societies officially approved by the General Assembly of the International Federation of Associations of Anatomists in 2020, is built on a new version of the Regular Anatomical Terminology (RAT) rules. This breaks with many traditional views of terminology. These changes in the *Terminologia Anatomica* of 1998 (TA98) met great resistance within many European Anatomical Societies and their members are not willing to use terms following the RAT rules. European anatomy teachers and scientists using traditional Latin in their teaching, textbooks and atlases will keep using the TA98. The German Anatomical Society (Anatomische Gesellschaft) recently announced the usage of the TA2023AG in curricular anatomical media such as textbooks and atlases, based on the TA98 and the *Terminologia Neuroanatomica* (TNA). We are preparing a more extensive improvement of the TA98, called *Terminologia Anatomica Humana* (TAH). This project is fully based on the noncontroversial terms of TA98, incorporating the recent digital version (2022) of the TNA from 2017. Further, it is completed with many new terms, including those in TA2, along with their definitions and relevant references, clinical terms, and correcting inconsistencies in the TA98. The TAH is still in process, but many chapters are already freely available at the IFAA Website in Fribourg (https://ifaa.unifr.ch) as is the digital version of the TNA.

Keywords Anatomical nomenclature · Anatomical terminology · Terminologia Anatomica · Terminologia Neuroanatomica

✉ David Kachlik
david.kachlik@lfmotol.cuni.cz

1 FIPAT Working Group Neuroanatomy, Nijmegen, The Netherlands

2 Department of Neurology, Radboud University Medical School, Nijmegen, The Netherlands

3 Donders Institute of Brain, Cognition and Evolution, Nijmegen, The Netherlands

4 Webmaster IFAA Website Fribourg, University of Fribourg, Fribourg, Switzerland

5 Anatomy, Section of Medicine, Faculty of Science and Medicine, University of Fribourg, Fribourg, Switzerland

6 SIB Data Mining, Swiss Institute of Bioinformatics, Geneva, Switzerland

7 Department of Anatomy, Second Faculty of Medicine, Charles University, V Úvalu 84, 150 06 Prague 5, Czech Republic

8 Centre for Endoscopic, Surgical and Clinical Anatomy, Second Faculty of Medicine, Charles University, Prague 5, Czech Republic

Text

Introduction

The history of modern anatomical terminology starts with the *Basler Nomina Anatomica* (BNA), published in Latin by the Anatomische Gesellschaft (Society of German-speaking anatomists) under the leadership of Wilhelm His (His 1895). It was not accepted worldwide, in particular not in France and Great Britain. In 1903, the International Federation of Associations of Anatomists (IFAA) was founded and started to work on a revision of the BNA from 1905 onwards. Since this work took so much time, the Anatomical Society of Great Britain and Ireland (1933) published its own modification as *Birmingham Revision* (BR). In 1935, the Anatomische Gesellschaft approved an extensive modification of the BNA, the *Jenaer Nomina Anatomica* (JNA), published in 1936 (Stieve 1936). The JNA was focused on veterinary anatomy as well, preferred the horizontal position of the body, and included many language corrections.

In 1936, the IFAA established the International Anatomical Nomenclature Committee (IANC) to revise the BR and the JNA, but due to World War II, it began to operate not before 1952. Its main task was to create an anatomical nomenclature in Latin, which could be accepted worldwide. The IANC took the BNA as its starting point and strictly refused to accept the JNA changes. In 1955, at the sixth IFAA Congress in Paris, the IANC proposal was discussed and accepted as the *Paris Nomina Anatomica* (PNA 1955). Various revisions were approved and published from 1961 to 1983 as the *Nomina Anatomica* (NA) that is why the PNA is also known as NA1. The fourth edition (NA4 1977) included the first histological and embryological nomenclatures in Latin, the *Nomina Histologica* and the *Nomina Embryologica.* A fifth edition (NA5) appeared in 1983. In 1989, the IANC published a sixth edition (NA6) without the approval of the IFAA. Then, at its meeting in Rio de Janeiro in 1989, the IFAA decided to appoint a new commission, Federative Committee on Anatomical Terminology (FCAT). FCAT took the NA5 as its starting point (Kachlik et al. 2008).

Eight years later, the IFAA approved the *Terminologia Anatomica* (TA) in São Paulo. It was published in 1998 in Latin and English (TA 1998). The Chairman of FCAT, Ian Whitmore, explained the intentions of the committee (Whitmore 1999). Apart from continuing the elaboration of histological, cytological, embryological, odontological, and anthropological terminology, FCAT proposed to produce a dictionary of anatomical terms, an illustrated terminology, and an electronic version of the whole series. Later, it changed name to Federative International Committee on Anatomical Terminology (FICAT) and published the *Terminologia Histologica* (TH) in 2008.

This brief overview of the history of anatomical terminology clearly shows that to reach a worldwide accepted anatomical nomenclature, many hurdles have to be taken. After FICAT, the IFAA founded a new programme for anatomical terminology, Federative International Programme for Anatomical Terminology (FIPAT) with new sections on Anthropology, Odontology and Neuroanatomy, aiming at electronic, online versions. It issued the *Terminologia Embryologica* (TE) in 2013 and already in 2017, the second edition of the *Terminologia Embryologica* (TE2) and also the *Terminologia Neuroanatomica* (TNA) went online at FIPAT's Dalhousie's website (https://fipat.library.dal.ca/). A full version of TNA was finally made available in December 2021 (https://ifaa.unifr.ch). The second edition of the *Terminologia Anatomica* (TA2) went online not before 2019, among others due to the inclusion of the Regular Anatomical Terms (RAT) rules (Neumann et al. 2017). FIPAT suggested to use the RAT in the synonym column, but its Gross Anatomy Working Group decided otherwise, after which the IFAA suggested a Referendum among its Member Associations. At the Referendum on Regular Anatomical Terms versus traditional, standard Latin for the TA2, in Autumn 2020, the final vote was: 40 votes for RAT and 30 votes for standard Latin. Forty associations took part in the referendum, 20 voted for RAT and 18 voted for standard Latin. Two societies' votes were considered spoilt ballots. It appeared that Societies in parts of America and the Far East, not using Latin in their teaching, voted for RAT, while Societies in parts of Europe, using Latin in their teaching, voted to maintain standard Latin. Fortunately, while RAT became the primary set of terms used in the terminologies, it is still permissible to use the Latin terminology, as standard Latin became the first synonym (Table 1).

Some notes on the regular anatomical terms

As to the implementation of the human anatomy nomenclature rules for the computer age (Neumann et al. 2017), there may be some truth in these, but the Anatomical Societies using proper Latin in their teaching, textbooks, and atlases will hardly follow these rules. It is good that generic rules for the word order are set up, but especially Rules 10 and 11 met great resistance within European Anatomical Societies in particular, and no one of their members is willing to use terms following such rules. For the TA 1998 and earlier versions, the word order followed a general rule for adjectives: the more general term should be first and the more specific term should be second, e.g., fossa cranii anterior and not fossa anterior cranii, arteria cerebri media and not arteria media cerebri, and flexura coli sinistra and not flexura sinistra coli. The *nonconcordant adjective* must be stated *first*, followed by a concordant positional adjective (Kachlik et al. 2015). This was applied in the TNA for the TA terms Venae superficiales cerebri and comparable terms (TNA 2017b; ten Donkelaar et al. 2017, 2018). Otherwise, the terms will produce confusion. This way seems the most reasonable from linguistic, rational, and traditional points of view. A more widespread discussion on the preferred word order would be advisable to come up with regular rules that also seem intuitive, before implementing these rules that change such a vast amount of the terminology. Major changes in anatomical nomenclature on the basis of logic and intuitiveness should have broad support. There can be a beautiful list of seemingly logic terminology but if the majority of anatomists do not support it, the majority will not use it. This would downgrade the status of the TA.

As a possible solution and to increase the acceptance of the TA2, following earlier suggestions by FIPAT, we propose to have *two equivalent columns* in the six-column format, one with the traditional Latin terms as in TA98, the other with the Regular Anatomical Terms. In the current form, the long-standing presently used terms have to be looked for under synonyms and other columns, even in

Table 1 Abbreviations used for terminologies

Abbreviation	Explanation	Year of publishing and publisher
BNA	Basler Nomina Anatomica	1895 by His as Supplement to Arch Entwgesch Suppl 1–180
BR	Birmingham Revision	1933 by Anatomical Society of Great Britain and Ireland at Robert Maclehose and Co, Ltd, University Press, Glasgow
FMA	Foundation Model of Anatomy	2003 by Rosse and Mejino in J Biomed Inform 36:478–500
JNA	Jenaer Nomina Anatomica	1936 published by Stieve at Fischer, Jena
NA2	Nomina Anatomica, 2nd ed.	1961 published by Excerpta Medica, Amsterdam
NA3	Nomina Anatomica, 3rd ed.	1963, reprint of NA2 by Excerpta Medica, Amsterdam
NA4	Nomina Anatomica, 4th ed.; includes Nomina Embryologica and Nomina Histologica	1977 published by Excerpta Medica, Amsterdam-Oxford
NA5	Nomina Anatomica, 5th ed.; also includes Nomina Embryologica and Nomina Histologica	1983 published by Excerpta Medica, Amsterdam-Oxford
PNA = NA1	Paris Nomina Anatomica	1955 by Spottiswoode, Ballantyne and Co, London
TA98	Terminologia Anatomica, FCAT (Federative Committee for Anatomical Terminology)	1998 by Thieme, Stuttgart-New York
TA98	Terminologia Anatomica, FCAT	2013 by FIPAT, online version at http://ifaa.unifr.ch
TA2	Terminologia Anatomica, 2nd ed.	2019 by FIPAT at http://FIPAT.library.dal.ca
TAH	Terminologia Anatomica Humana	From 2021 onwards at http://ifaa.unifr.ch
TE	Terminologia Embryologica, FIPAT (Federative International Programme for Anatomical Terminology)	2013 by Thieme, Stuttgart-New York
TE2	Terminologia Embryologica, 2nd ed., FIPAT (Federative International Programme for Anatomical Terminology)	2017 by FIPAT at http://FIPAT.library.dal.ca
TH	Terminologia Histologica, FICAT (Federative International Committee for Anatomical Terminology)	2008 by Lippincott, Wolters-Kluwer, Philadelphia
TNA	Terminologia Neuroanatomica, FIPAT (Federative International Programme for Anatomical Terminology)	2017 by FIPAT at http://FIPAT.library.dal.ca
TNA 2021	Terminologia Neuroanatomica, digital version	2021 available at http://ifaa.unifr.ch

the column "Other". Given the not too major differences between the UK-English and the US-English columns, these may be combined again to one as in TA98. The RAT should remain "considered alternatives" until the recommended wider discussion of the RAT rules has taken place. As will be shown below, the automatic generation of Latin terms by the *Terminologia Anatomica Humana* (TAH; see below) is done in a standard way. It is obvious that the generated terms may have two variants: the traditional term and an RAT compliant term.

Notes on other changes in the TA2

In the TA2, many other changes are apparent:

1. The use of full terms, not the short terms as usual (TA98). Extending the terms to complete (stand-alone) terms, so not anymore needing to extend terms with part of parent terms such as in TA98, which led to uncertainty about the stand-alone term, is a major and very welcomed improvement.
2. Grouping together bony and cartilaginous structures, joints, and muscles. This certainly has its advantages.
3. A large number of adjectives have been changed as compared to the earlier version sent to the Member Societies (November 2016). Most of these are not explained and seem to be unnecessary: why Os sphenoideum instead of Os sphenoidale, why Articulatio radiocarpea instead of Articulatio radiocarpalis; this applies to all terms involved (…-carpalis or …-tarsalis). We are not impressed by all these unnecessary corrections in Latin terms. The traditional terms better resemble the terms in various vernacular languages. To quote the late Roger Warwick in his introduction to the NA4 (1977): "The more the Latin term can be made to resemble its vernacular language, the easier it is to guess the significance of the Latin term".
4. Neither is the reintroduction of diphthongs as in thyreoid… and all the "prae's" explained. Diphthongs were deleted since the PNA, by now also from the second edition of the *Terminologia Embryologica* (TE2 2017a). Such diphthongs would better be presented in the column "Other" or as historical terms.
5. Given the fact that the TNA 2017, available on the FIPAT website since February 23, 2017, and accepted by the General Assembly as the official terminology for the nervous system and the sense organs at the 19th

IFAA World Congress (August 9–11, 2019, London), the TNA should be the basis for Capita XIV and XV of TA2. In the TA2, several entities in neuroanatomy received different TA2 terms besides the yet accepted TNA terms. This is counter to FIPAT's core goal of anatomical nomenclature unification and hence, if ratified, would seriously undermine FIPAT's credibility. Moreover, the TA2 apparently does not accept modern views on the subdivision of the central nervous system applied in the TE2 and the TNA. The TNA is increasingly accepted, for instance in the TA2023AG of the Anatomische Gesellschaft (see below).

6. TA98 used plural and singular terms, seemingly random (Gobée et al. 2011). TA2 appears to have made improvements in this respect. We recommend all terms to be made singular.

The current situation

Several Anatomical Societies, using standard Latin in their teaching, will continue using the TA98 as well as the TNA 2021, officially accepted at IFAA's 19th World Congress in London, August 9, 2019. Since the TA2 often contains more Latin synonyms than one, and the first official terms are often replaced without apparent reasoning, it is difficult to see which entity in TA2 is new and which entity is deleted. Therefore, these Anatomical Societies prefer TA98. Recently, the Anatomische Gesellschaft announced the usage of the TA2023AG, based on the TA98 and incorporating the TNA. The TA2023AG is a descriptive nomenclature following the evolution of anatomical knowledge and language in the scientific literature and in current practice rather than introducing linguistic modifications (Anatomische Gesellschaft 2023).

It might be useful to go back to the first FIPAT Meeting in Beijing (August 7, 2014), where an internal document '*Anatomical Terminologies for Tomorrow'* by Robert Baud, Tom Gest, Paul Neumann, and Pierre Sprumont was discussed. In its introduction, FIPAT's goals for the revision of the TA98 were mentioned:

1. To merge the TA98 and the TH 2008 to form a single terminology for adult human anatomy, provisionally abbreviated TAH for *Terminologia Anatomica Humana.*
2. To conservatively revise the terminology to ensure uniqueness and clarity of terms: (a) to improve compliance of the Latin terms to the traditional rules; (b) to improve the precision of the terminology; (c) to adopt and apply new naming rules (Regular Anatomical Terminology); and (d) to use terms in the singular throughout.
3. To make the hierarchical relationships between terms explicit.
4. To develop definitions of terms.
5. To encourage the use of the preferred terms in Latin and equivalent terms in other languages.

The *Terminologia Anatomica Humana*

The TAH is a nomenclature based on scientific criteria, which are commonly accepted in biological domains such as in the Foundation Model of Anatomy (FMA; Rosse and Mejino 2003). Both the FMA and the TAH are compatible with the essentials of database development in life sciences as recommended by the OBO Foundry (Smith et al. 2007), and we adopt the basic principles of the Basic Formal Ontology 2.0 (Smith et al. 2015). The size of the terminology, which amounts to more than a hundred thousand terms, and the complexity of interlanguage concordance and coordination, makes such a scientific background strictly necessary. The support of dedicated computer applications for the implementation of the terminology is, therefore, a must.

The following specifications are mandatory for the TAH:

1. The terminology is based in two hierarchies, partonomy and taxonomy, with permanent bridges between the two.
2. The terminology is language-independent, which means that no language can impose whatever rules or concepts that are specific or local. A special position is given to Latin, considered as a reference model for all vernacular languages.
3. The terminology must be formally multilingual with guidance rules for the translation in any language. This means that the translation is computer-generated.
4. The inter-entities relations must be made explicit using pointers, not by linguistic clues.
5. All terms are defined as singular and plural forms when necessary are exclusively computer-generated.
6. The terminology is publicly available in three forms: web pages, PDFs, and tables. The PDF files replace the published book.
7. Definitions must be included in the terminology.
8. The new version of the terminology must be traced back to earlier versions, including the TA98. Links must be provided between corresponding identifiers in each version.
9. The management of the terminology must be documented.

These specifications need the following explanations:

1. In the TA98, a general partonomy of the human body was used with taxonomic aspects under *Nomina gen-*

eralia (*General terms)*, but it lacks an explicit taxonomy. The FMA has a complete coverage of the TA98 and supplies the missing taxonomy. From then on, new versions of the nomenclature must contain both hierarchies with permanent connections between the two.

2. A terminology dominated by a preferred language is not acceptable at an international level, not even Latin. Therefore, a language-independent reference is necessary to make the terminology shared by all countries. A universal representation is the recipient of what is common to everyone: each entry of the terminology is formulated as a sequence of abstract words, each one having a defined representation in all languages. From the universal formulas, an automated process generates the terminology in any language, including Latin. However, each language must be in the position to save its specificity and its traditional aspects. To do that, every universal term is accepted by a given language or is replaced by a typical term at will of the native speakers of this language. This process must be performed without restriction. The experience with five languages in the TNA (Latin, English, French, Spanish, and Russian) shows that 95% of the universal terms are accepted as they are. This means that the universal representation is clearly the skeleton for the terminology of the future.
3. Once it has been defined by universal terms or their language exceptions, the terminology must be translated in any language by automatic translation. In fact, the language of anatomy is a simplified subset of the human languages. The automatic translation is fully mastered today for at least the five languages mentioned above and may be extended at the cost of a manageable availability of manpower.
4. Most entities in the terminology are in the form A of B or equivalent, for instance *tunica mucosa gastris*, where A stands for *tunica mucosa* and B for *gaster*. This means several thousands of relations that must be made explicit. The generation of the term for such an entity is realized using a pointer to *gaster*, without duplicating this term.

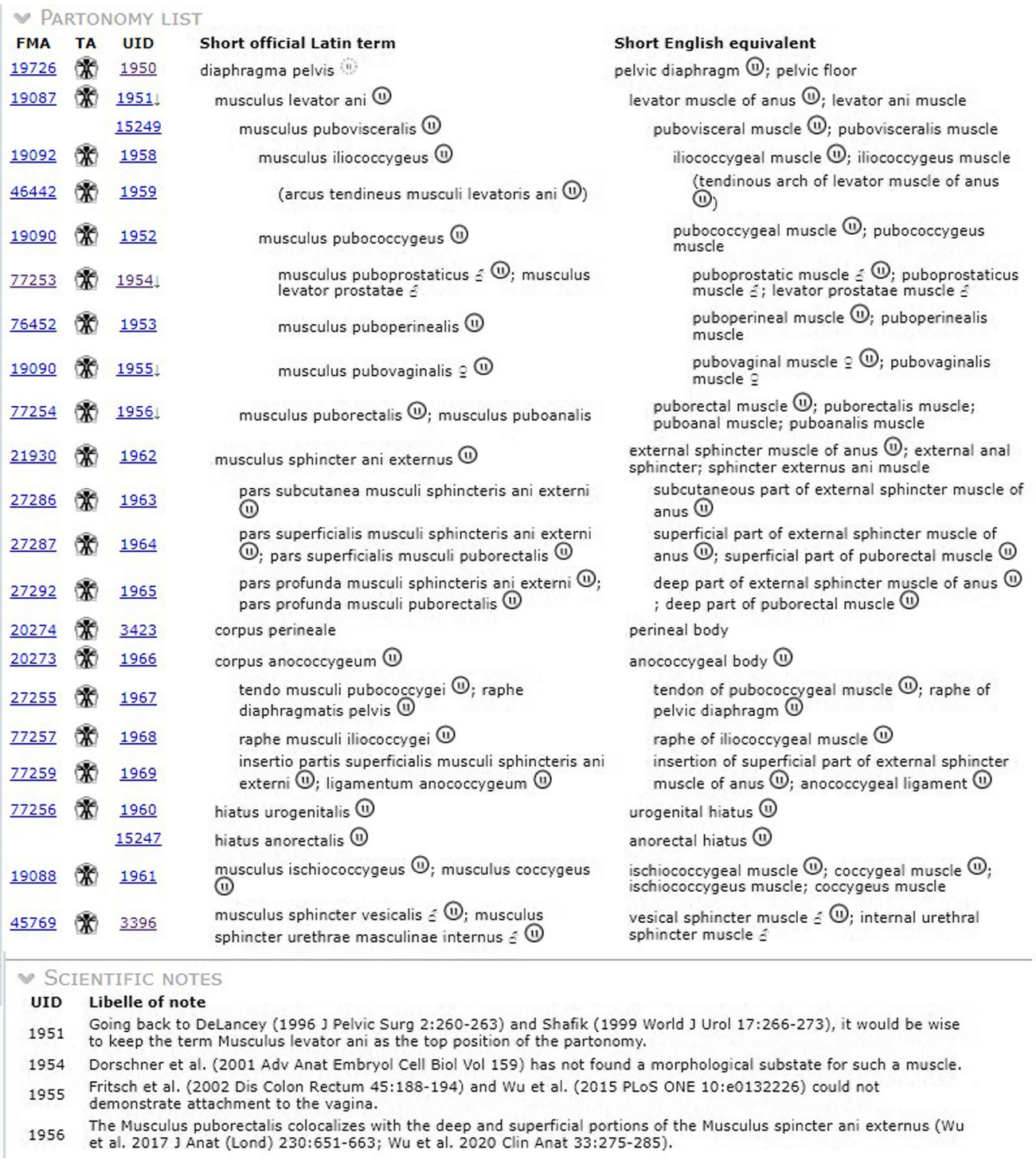
PARTONOMY LIST

FMA	TA	UID	Short official Latin term	Short English equivalent
76866		1761↓	fascia cervicalis Ⓤ	cervical fascia Ⓤ
57805		1762	fascia cervicalis superficialis Ⓤ; lamina superficialis; fascia investiens superficialis colli	superficial cervical fascia Ⓤ; superficial layer; superficial investing cervical fascia
46447		1763	spatium suprasternale Ⓤ	suprasternal space Ⓤ
		15242↓	fascia cervicalis media Ⓤ	middle cervical fascia Ⓤ
46559		1764↓	fascia cervicalis visceralis Ⓤ; lamina pretrachealis	visceral cervical fascia Ⓤ; pretracheal layer
57793		1765	ligamentum suspensorium glandulae thyroideae Ⓤ	suspensory ligament of thyroid gland Ⓤ
46561		1767	vagina carotica (par) Ⓤ	carotid sheath (pair) Ⓤ
21791		15245	fascia cervicalis profunda Ⓤ	deep cervical fascia Ⓤ
		15246↓	fascia intercarotica Ⓤ; lamina superficialis	intercarotid fascia Ⓤ; superficial layer
46560		1766	lamina profunda Ⓤ; lamina prevertebralis Ⓤ	deep layer Ⓤ; prevertebral layer Ⓤ
		15243	fascia scalena Ⓤ	scalene fascia Ⓤ
		15244↓	septum sagittale cervicale Ⓤ; fascia alaris	cervical sagittal septum Ⓤ; alar fascia
76867		1787	fascia nuchae (par)	nuchal fascia (pair) Ⓤ

SCIENTIFIC NOTES

UID	Libelle of note
1761	In a recent study based on a large series embalmed with Thiel's method (Thiel 1992 Ann Anat 174:185-195), Feigl et al. (2020 J Anat (Lond) 237:197-207) clarified aspects of the sometimes confusing terminology for the fascia cervicalis. Their proposal largely follows Hafferl's approach (Hafferl A 1969 Lehrbuch der topographischen Anatomie. Springer, Berlin, pp 227-235).
1764	The term fascia cervicalis visceralis replaces the TA98 term lamina pretrachealis. In TA2, fascia visceralis colli is used.
15242	The fascia cervicalis media (TA2: fascia musculorum infrahyoideum) is formed by the fascia of the infrahyoid muscles.
15244	The septum sagittale cervicale or fascia alaris (TA98, TA2) forms a sagittal septum in the neck, described as 'cloisons sagittales' by Charpy (1912 in: Poirier P, ed Traité d'anatomie humaine. Masson, Paris, pp 258-260).
15246	The lamina superficialis of the fascia cervicalis profunda or fascia intercarotica was named fascia alaris by Grodinsky and Holyoke (1938 Am J Anat 63:367-408; see also Gavid et al. 2018 Surg Radiol Anat 40:917-922), but in TA98 and TA2 this term is reserved for the septum sagittale cervicale/cervical sagittal septum.

Fig. 1 *Fascia cervicalis*. In this and the other tables, a partonomic list is presented with reference to the FMA, the TA98, and the TAH. UID means Unit identifier in the TAH



PARTONOMY LIST

FMA	TA	UID	Short official Latin term	Short English equivalent
19726		1950	diaphragma pelvis	pelvic diaphragm; pelvic floor
19087		1951↓	musculus levator ani	levator muscle of anus; levator ani muscle
		15249	musculus puboviscerali s	pubovisceral muscle; puboviscerali s muscle
19092		1958	musculus iliococcygeus	iliococcygeal muscle; iliococcygeus muscle
46442		1959	(arcus tendineus musculi levatoris ani)	(tendinous arch of levator muscle of anus)
19090		1952	musculus pubococcygeus	pubococcygeal muscle; pubococcygeus muscle
77253		1954↓	musculus puboprostaticus ♂; musculus levator prostatae ♂	puboprostatic muscle ♂; puboprostaticus muscle ♂; levator prostatae muscle ♂
76452		1953	musculus puboperinealis	puboperineal muscle; puboperinealis muscle
19090		1955↓	musculus pubovaginalis ♀	pubovaginal muscle ♀; pubovaginalis muscle ♀
77254		1956↓	musculus puborectalis; musculus puboanalis	puborectal muscle; puborectalis muscle; puboanal muscle; puboanalis muscle
21930		1962	musculus sphincter ani externus	external sphincter muscle of anus; external anal sphincter; sphincter externus ani muscle
27286		1963	pars subcutanea musculi sphincteris ani externi	subcutaneous part of external sphincter muscle of anus
27287		1964	pars superficialis musculi sphincteris ani externi; pars superficialis musculi puborectalis	superficial part of external sphincter muscle of anus; superficial part of puborectal muscle
27292		1965	pars profunda musculi sphincteris ani externi; pars profunda musculi puborectalis	deep part of external sphincter muscle of anus ; deep part of puborectal muscle
20274		3423	corpus perineale	perineal body
20273		1966	corpus anococcygeum	anococcygeal body
27255		1967	tendo musculi pubococcygei; raphe diaphragmatis pelvis	tendon of pubococcygeal muscle; raphe of pelvic diaphragm
77257		1968	raphe musculi iliococcygei	raphe of iliococcygeal muscle
77259		1969	insertio partis superficialis musculi sphincteris ani externi; ligamentum anococcygeum	insertion of superficial part of external sphincter muscle of anus; anococcygeal ligament
77256		1960	hiatus urogenitalis	urogenital hiatus
		15247	hiatus anorectalis	anorectal hiatus
19088		1961	musculus ischiococcygeus; musculus coccygeus	ischiococcygeal muscle; coccygeal muscle; ischiococcygeus muscle; coccygeus muscle
45769		3396	musculus sphincter vesicalis ♂; musculus sphincter urethrae masculinae internus ♂	vesical sphincter muscle ♂; internal urethral sphincter muscle ♂

SCIENTIFIC NOTES

UID	Libelle of note
1951	Going back to DeLancey (1996 J Pelvic Surg 2:260-263) and Shafik (1999 World J Urol 17:266-273), it would be wise to keep the term Musculus levator ani as the top position of the partonomy.
1954	Dorschner et al. (2001 Adv Anat Embryol Cell Biol Vol 159) has not found a morphological substate for such a muscle.
1955	Fritsch et al. (2002 Dis Colon Rectum 45:188-194) and Wu et al. (2015 PLoS ONE 10:e0132226) could not demonstrate attachment to the vagina.
1956	The Musculus puborectalis colocalizes with the deep and superficial portions of the Musculus spincter ani externus (Wu et al. 2017 J Anat (Lond) 230:651-663; Wu et al. 2020 Clin Anat 33:275-285).

Fig. 2 Diaphragma pelvis

5. This rule follows the decision of the IFAA General Assembly in Beijing. By definition, the terms of the taxonomy are always singular. Presenting sets at plural is possible in the partonomy and the corresponding terms are computer-generated from the singular form.
6. The minimal presentation of the terminology has three forms in parallel. Web pages allow the presentation on the Internet, the PDF format allows anyone to make a personal copy, whereas the table form is an invitation

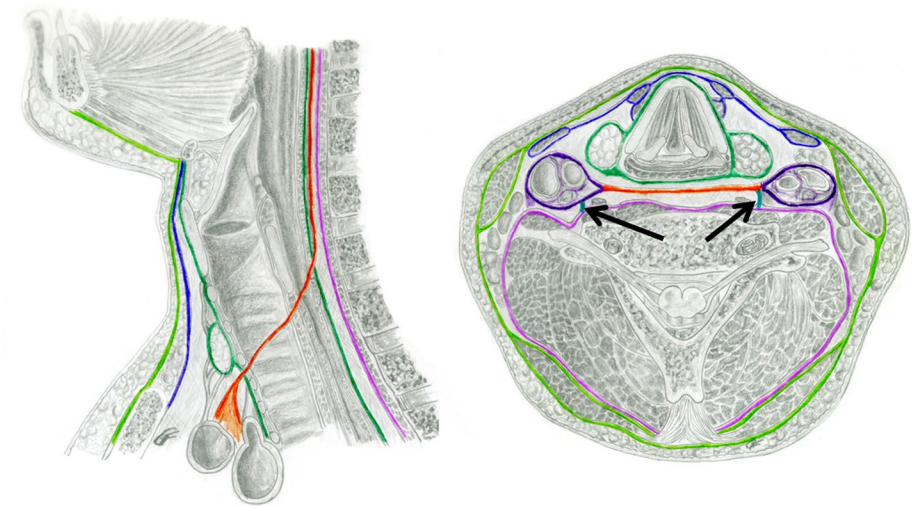


Fig. 3 Overview of the *Fascia cervicalis*: drawings of a median (mediosagittal) and transverse cross-section: *fascia cervicalis superficialis* (light green), *fascia cervicalis media* (blue), *fascia buccopharyngea* (green), *fascia intercarotica* (orange), *fascia prevertebralis* (pink), and *fascia alaris* (turkoise). The *fascia alaris* is marked by arrows as well (Feigl et al. 2020)

to any casual user to experiment with the terminology, building his/her proper database and new applications.

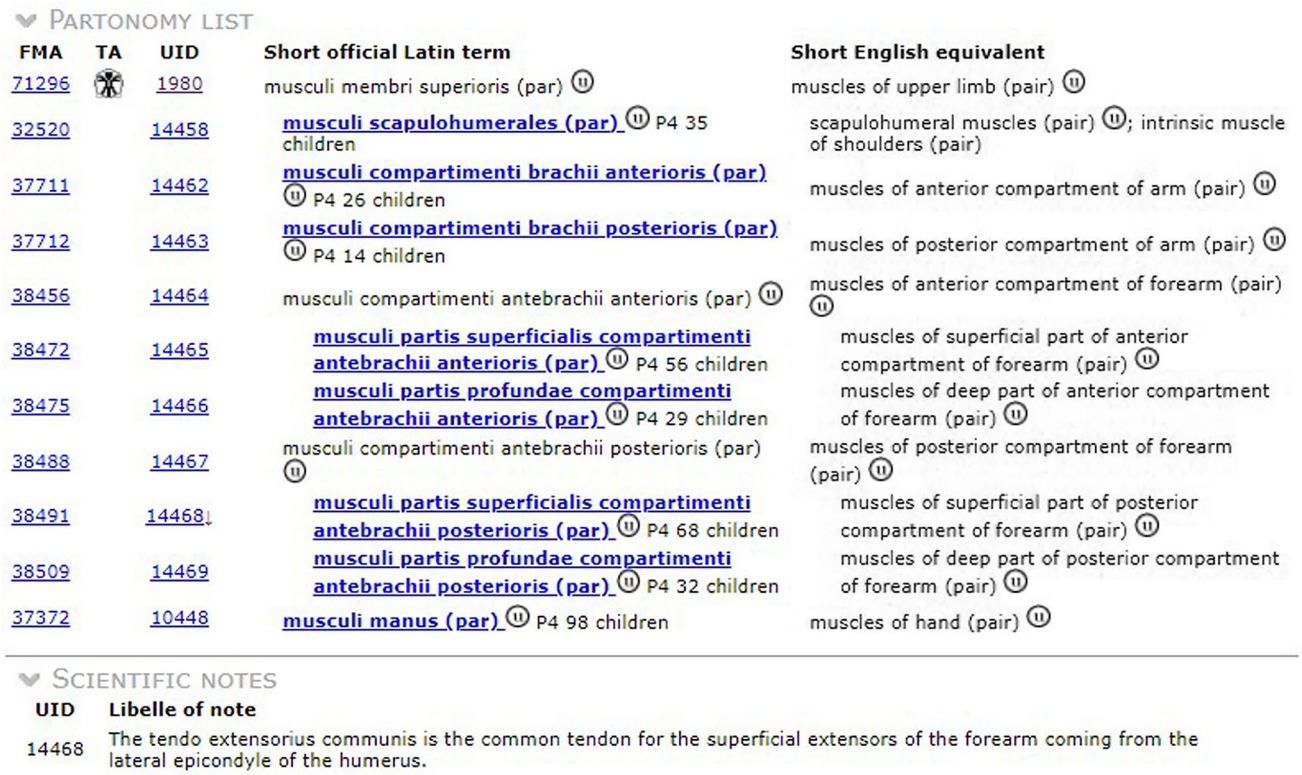
7. Definitions are the core of the terminology. Many controversial entities must be explicitly defined to clear what we are talking about. Due to the immense task of building definitions for the entire terminology, a partial automation is necessary. The website AnatomicalTerms.Info (https://www.anatomicalterms.info) provides a good beginning for definitions. The TAH has developed the taxonomic definitions which are a disciplined approach of this task without the comfortable feeling of encyclopaedic definitions, but with a significant degree of automatic generation. Some 2000 definitions are present, considered today as an experimental trial.
8. Tracing the terminology from TA98 to any successor is essential. Often, users of the terminology are used to previous versions and hesitate to move to a new version. Therefore, tracing of the terms in successive versions must be a basic service.
9. Documentation, help systems, and guidance within the terminology are keys to the success. As a general point of view, users of the terminology are mostly not specialists in ontology, linguistic, or other scientific domains. Therefore, a didactic approach is welcome. The value of the terminology relies on the capability to transfer the whole application from one actor to another.

Progress on the TAH so far

As to the first of FIPAT's goals in Beijing, merging of TA98 and TH2008, so far this has only been accomplished in the TNA, of which an illustrated version with definitions was published (ten Donkelaar et al. 2018). In December 2021, a digital version of the TNA was prepared in five languages (Latin, English, French, Spanish, and Russian) and became available at the IFAA's Fribourg website (https://ifaa.unifr.ch). This digital version may be viewed as the first part of the TAH as suggested in 2014 and will form Chapters 14 (The Central and Peripheral nervous system) and 15 (The Senses) of the TAH. The TAH has 16 Chapters as in TA98 and TA2. It contains unique, computer-generated identifiers. For the changes made, see '*About the Terminologia Neuroanatomica*: *Past*, *Presence and Future'* (ten Donkelaar and Baud 2021). In the digital version of the TNA, the following major changes were made in its presentation: (1) presenting the terms in a top-down approach, i.e., from telencephalon to spinal cord, to make terms compatible with the FMA and other parts of the TA98; (2) a new view on the presentation of tracts was implemented (Baud et al. 2018); and (3) the universal model for terms was applied. Because of its clinical and functional significance, the TNA includes the blood supply to the brain and spinal cord (*Vasa sanguinea encephali* and *Vasa sanguinea medullae spinalis*). Clinically relevant subdivisions of the large vessels to the brain are included. The document is divided into three Chapters: (1) Chapter 1 (Central Nervous System); (2) Chapter 2 (Peripheral Nervous System), and (3) Chapter 3 (The Senses).

Following the digitalization of the TNA, we started an initiative to prepare a digital version of the other Chapters of an updated TA98, in which improvements and new items of the TA2 and from the literature have been included, and inconsistencies in the TA98 have been corrected. First, the *Systema musculare* (*Muscular system*) has been updated and included as part of the TAH (its Chapter 4). Like in the TA98 and TA2, the following parts are discussed in a partonomic hierarchy:

1. Pars capitis systematis muscularis;
2. Pars cervicalis systematis muscularis;



PARTONOMY LIST

FMA	TA	UID	Short official Latin term	Short English equivalent
71296		1980	musculi membri superioris (par)	muscles of upper limb (pair)
32520		14458	musculi scapulohumerales (par) P4 35 children	scapulohumeral muscles (pair); intrinsic muscle of shoulders (pair)
37711		14462	musculi compartimenti brachii anterioris (par) P4 26 children	muscles of anterior compartment of arm (pair)
37712		14463	musculi compartimenti brachii posterioris (par) P4 14 children	muscles of posterior compartment of arm (pair)
38456		14464	musculi compartimenti antebrachii anterioris (par)	muscles of anterior compartment of forearm (pair)
38472		14465	musculi partis superficialis compartimenti antebrachii anterioris (par) P4 56 children	muscles of superficial part of anterior compartment of forearm (pair)
38475		14466	musculi partis profundae compartimenti antebrachii anterioris (par) P4 29 children	muscles of deep part of anterior compartment of forearm (pair)
38488		14467	musculi compartimenti antebrachii posterioris (par)	muscles of posterior compartment of forearm (pair)
38491		14468	musculi partis superficialis compartimenti antebrachii posterioris (par) P4 68 children	muscles of superficial part of posterior compartment of forearm (pair)
38509		14469	musculi partis profundae compartimenti antebrachii posterioris (par) P4 32 children	muscles of deep part of posterior compartment of forearm (pair)
37372		10448	musculi manus (par) P4 98 children	muscles of hand (pair)

SCIENTIFIC NOTES

UID	Libelle of note
14468	The tendo extensorius communis is the common tendon for the superficial extensors of the forearm coming from the lateral epicondyle of the humerus.

Fig. 4 Musculi membri superioris

3. Pars dorsalis systematis muscularis;
4. Pars thoracica systematis muscularis;
5. Pars abdominalis systematis muscularis;
6. Pars pelvica systematis muscularis;
7. Systema musculare membri superioris;
8. Systema musculare membri inferioris.

All parts comprise *Musculi*, *Fasciae*, *Bursae* and *Vaginae tendinum*, where appropriate. For the limbs a section *Compartimenta* is included. Compartments for hand and foot were added. For all terms, unlike TA2, comparison with the Foundation Model of Anatomy (FMA) and TA98 is given. New terms from TA2 and some from the literature (Kachlik et al. 2015, 2016) were added with explanatory notes, particularly for the *Fascia capitis* (Stecco et al. 2011, 2013; Herlin et al. 2015), the *Fascia cervicalis* (Fig. 1), the *Fascia pelvis* (Fritsch et al. 2004), and the *Diaphragma pelvis* (Fig. 2). In a recent study on a large series embalmed with Thiel's method (Thiel 1992), Feigl et al. (2020) clarified aspects of the sometimes confusing terminology for the *Fascia cervicalis*. Their proposal largely follows Hafferl's approach (Hafferl 1969). In brief (Figs. 1 and 3), the term *Fascia cervicalis superficialis* stands for the TA98 term *Lamina superficialis fasciae cervicalis*; the term *Fascia buccopharyngea (fascia cervicalis visceralis)* replaces the TA98 term *Lamina pretrachealis fasciae cervicalis*. In TA2, *Fascia visceralis colli* is used. The *Fascia cervicalis media* (TA2: *Fascia musculorum infrahyoideum*) is formed by the fascia of the infrahyoid muscles. The *Fascia cervicalis profunda* is subdivided into three layers: (a) the *Lamina superficialis* or *Fascia intercarotica*; (b) the *Lamina profunda* or *Fascia prevertebralis* (former *Lamina prevertebralis fasciae cervicalis*); and (c) the *Septum sagittale cervicale* or *Fascia alaris* (TA98 and TA2). This septum forms a sagittal membrane in the neck, described as 'cloisons sagittales' by Charpy (1912).

For the *Diaphragma pelvis*, new terms are available for the *Musculus levator ani* going back to DeLancey (1996) and Shafik (1999), but it would be wise to keep the term *Musculus levator ani* as the primary term with the following subdivision (Fig. 2): (a) *Musculus puboviscerali*s, consisting of the *Musculus iliococcygeus*, the *Musculus pubococcygeus* with the *Musculus puboprostaticus* in males, the *Musculus pubovaginalis* in females, and the *Musculus puboperitonealis*; (b) the *Musculus puborectalis* seu *puboanalis* (TA2), subdivided into a *Pars profunda* and a *Pars superficialis*. It should be emphasized that (a) the *Musculus puboprostaticus* and the attachment of the *Musculus pubovaginalis* to the vagina could not be demonstrated (Dorschner et al. 2001; Fritsch et al. 2002; Wu et al. 2015) and (b) that the *Musculus puborectalis* colocalizes with

Partonomy list

FMA	TA	UID	Short official Latin term	Short English equivalent
		15491↓	anastomoses portocavales	portocaval anastomoses
		15492↓	anastomosis portocavalis gastrooesophagea	gastrooesophageal portocaval anastomosis
15399		4824	vena gastrica sinistra	left gastric vein
62829		4491	venae oesophageales; venae oesophageae	oesophageal ▲
		15843↓	anastomosis portocavalis mesentericorectalis	mesentericorectal portocaval anastomosis
15391		4841	vena mesenterica inferior	inferior mesenteric vein
70913		4766	venae rectales inferiores; venae anorectales inferiores	inferior rectal veins; inferior anorectal veins; inferior hemorrhoidal veins
		15496↓	anastomosis portocavalis rectalis	rectal portocaval anastomosis
15393		4844	vena rectalis superior; vena anorectalis superior	superior rectal vein; superior anorectal vein; superior haemorrhoidal vein
70912		4762	venae rectales mediae; venae anorectales mediae	middle rectal veins; middle anorectal veins; middle hemorrhoidal veins
		15497↓	anastomosis portocavalis subcutanea	subcutaneous portocaval anastomosis
71591		4822	venae paraumbilicales	paraumbilical veins
44318		4780	vena epigastrica superficialis	superficial epigastric vein
		15498↓	anastomosis portocavalis muscularis	muscular portocaval anastomosis
71591		4822	venae paraumbilicales	paraumbilical veins
21162		4772	vena epigastrica inferior	inferior epigastric vein
		15499↓	anastomosis portocavalis preperitonealis	preperitoneal portocaval anastomosis
71591		4822	venae paraumbilicales	paraumbilical veins
18934		4755	plexus venosus vesicalis	vesical venous plexus
		15500↓	anastomosis portocavalis retroperitonealis	retroperitoneal portocaval anastomosis
14331		4837	vena splenica; vena lienalis	splenic vein
		14688↓	venae retroperitoneales anteriores	anterior retroperitoneal veins
		15501↓	anastomosis portocavalis hepatica	hepatic portocaval anastomosis
		2712	capsula fibrosa perivascularis	perivascular fibrous capsule
14480		2665	area nuda faciei diaphragmaticae hepatis	nude area of diaphragmatic face of liver

Scientific notes

UID	Libelle of note
14688	Fine veins emptying into the ventral aspect of the inferior vena cava and its tributaries (Turyna et al. 2013 J Anat 223:69-73).
15491	Under pathological conditions, venovenous 'bypasses' open to decrease hypertension in the portal vein system. These are enlarged existing venovenous anastomoses: Portocaval anastomoses. The following major routes can be distinguished (Luzsa G 1972 Röntgenanatomie des Gefäßsystems. Akadémiai Kiadó, Budapest; Kachlik et al. 2021 Bosn J Basic Med Sci 21:208-220).
15492	Between tributaries of the left gastric vein and the oesophageal veins.
15496	Between tributaries of the superior rectal vein and the middle and inferior rectal veins.
15497	Between the paraumbilical veins and tributaries of the superficial eipgastric and thoracoepigastric veins.
15498	Between the paraumbilical veins and tributaties of the inferior and superior epigastric veins within both rectus abdominis muscles.
15499	Between the paraumbilical veins and tributaries of the vesical venous plexus running in the midline along the median umbilical ligament.
15500	Between veins of the spleen and retroperitoneal veins and veins of the posterior abdominal wall.
15501	Between veins of the hepatic capsule and veins of the diaphragm at the area nuda hepatis.
15843	Between the inferior mesenteric vein and the middle and inferior rectal veins.

Fig. 5 Anastomoses portocavales

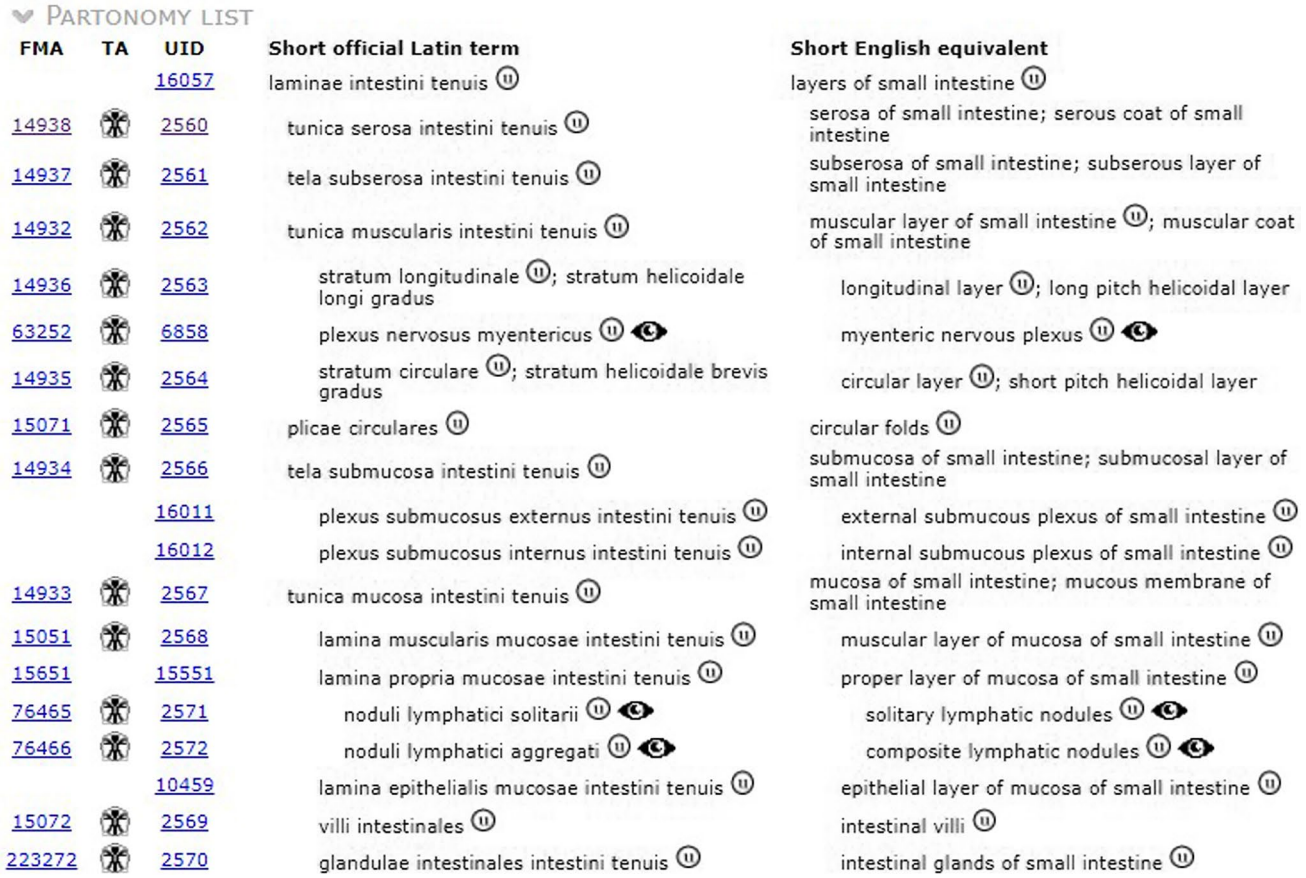


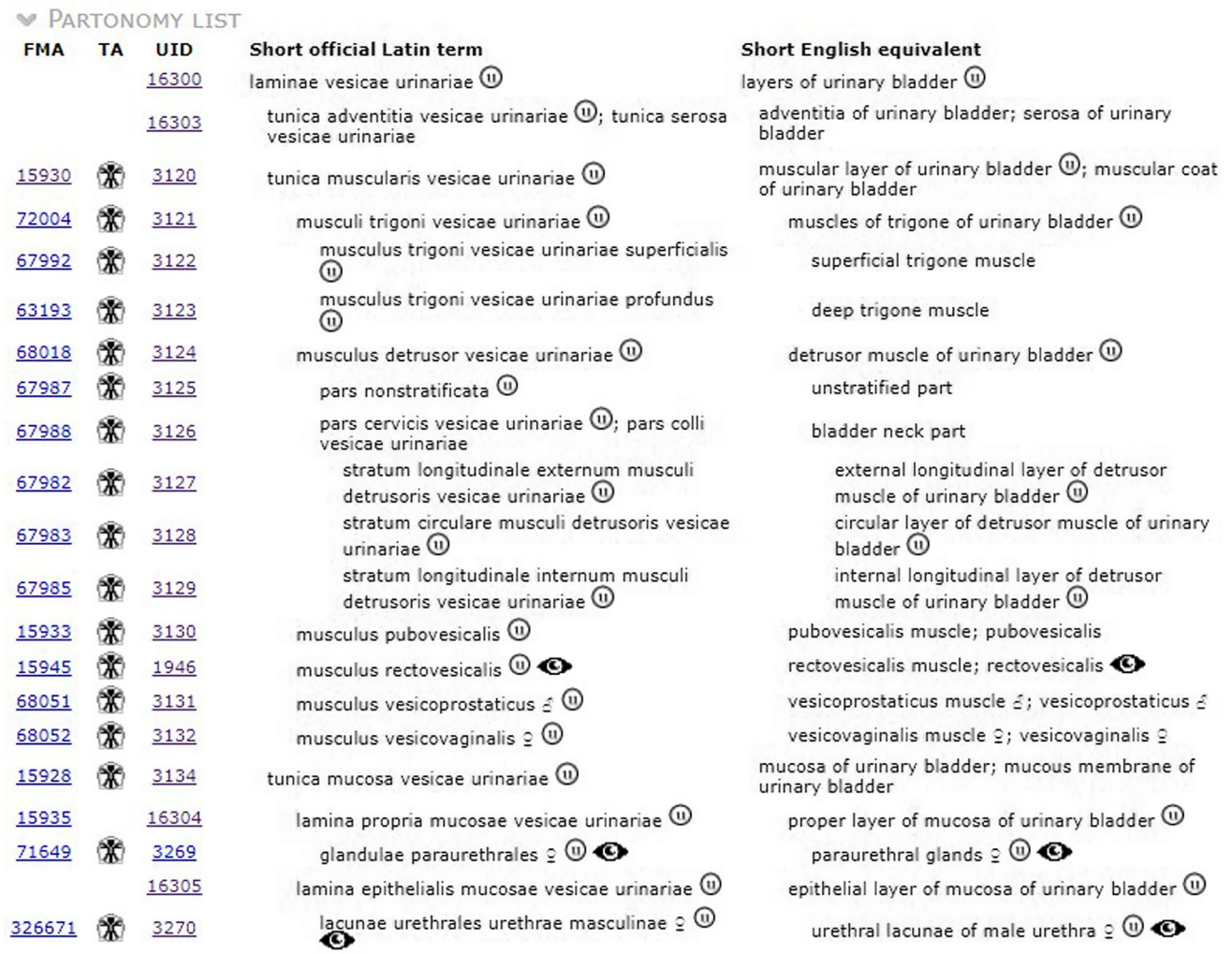
Fig. 6 Laminae intestini tenuis

the *Pars profunda* and *Pars superficialis* of the *Musculus sphincter ani externus* (Wu et al. 2017, 2020).

The presentation of *Musculi* largely follows the subdivision as found in most atlases and textbooks as exemplified in Fig. 4 for the muscles of the upper limb, but is different from TA98, in which most terms were grouped as a single section. The discrepancy between the use of English and half English/half Latin terms was solved by presenting an English term with the English term from TA98 as synonym. For example: long flexor muscle of great toe versus flexor hallucis longus muscle. We kept the use of the term muscle in all muscles as accepted at the 2nd FIPAT Meeting in Istanbul (August 31/September 1, 2015). Anglicizing of terms such as Spinotransversales muscles into Spinotransversal muscles as in Transversospinal muscles has been done. The same holds for Interspinales and Intertransversarii muscles, for the muscles of the tongue and the palate. The revised terminology for the muscular system can be viewed on the Fribourg website (https://ifaa.unifr.ch).

The next part concerns the *Systema cardiovasculare* (*Cardiovascular system*). It forms Chapter 12 of the TAH. Again, the following parts are discussed in a partonomic hierarchy:

1. *Cor*: following the TA2, (a) the importance of an attitudinal appropriate description was emphasized (Anderson and Loukas 2009); (b) we reordered terms so that the atrioventricular valves are considered in the context of a 'valvar complex' (*Complexus valvaris cordis*); (c) the section on fibrous skeleton of heart (*Skeleton fibrosum cordis*) has been extended according to recent studies (Mori et al. 2016; Saremi et al. 2017); and (d) the conducting system of the heart (*Systema conducens cordis*) is listed separately, to which the internodal tracts were added (James 1963, 2001; Seo et al. 2022).
2. *Systema arteriosum commune* following TA98 with some additions from the literature (Kachlik et al. 2015, 2017, 2018, 2021). The intrarenal arteries have also been added.
3. *Systema arteriosum cerebrospinale* (from TNA).
4. *Systema venosum commune* following TA98 with some additions from the literature, in particular the veins of the lower limb (Caggiatti et al. 2002, 2005, 2018, 2021; Kachlik et al. 2010, 2012). Sections on the portocaval anastomoses (*Anastomoses portocavales*) and the cavocaval anastomoses (*Anastomoses cavocavales*) have been added as well as the intrarenal veins.



PARTONOMY LIST

FMA	TA	UID	Short official Latin term	Short English equivalent
		16300	laminae vesicae urinariae	layers of urinary bladder
		16303	tunica adventitia vesicae urinariae; tunica serosa vesicae urinariae	adventitia of urinary bladder; serosa of urinary bladder
15930		3120	tunica muscularis vesicae urinariae	muscular layer of urinary bladder; muscular coat of urinary bladder
72004		3121	musculi trigoni vesicae urinariae	muscles of trigone of urinary bladder
67992		3122	musculus trigoni vesicae urinariae superficialis	superficial trigone muscle
63193		3123	musculus trigoni vesicae urinariae profundus	deep trigone muscle
68018		3124	musculus detrusor vesicae urinariae	detrusor muscle of urinary bladder
67987		3125	pars nonstratificata	unstratified part
67988		3126	pars cervicis vesicae urinariae; pars colli vesicae urinariae	bladder neck part
67982		3127	stratum longitudinale externum musculi detrusoris vesicae urinariae	external longitudinal layer of detrusor muscle of urinary bladder
67983		3128	stratum circulare musculi detrusoris vesicae urinariae	circular layer of detrusor muscle of urinary bladder
67985		3129	stratum longitudinale internum musculi detrusoris vesicae urinariae	internal longitudinal layer of detrusor muscle of urinary bladder
15933		3130	musculus pubovesicalis	pubovesicalis muscle; pubovesicalis
15945		1946	musculus rectovesicalis	rectovesicalis muscle; rectovesicalis
68051		3131	musculus vesicoprostaticus ♂	vesicoprostaticus muscle ♂; vesicoprostaticus ♂
68052		3132	musculus vesicovaginalis ♀	vesicovaginalis muscle ♀; vesicovaginalis ♀
15928		3134	tunica mucosa vesicae urinariae	mucosa of urinary bladder; mucous membrane of urinary bladder
15935		16304	lamina propria mucosae vesicae urinariae	proper layer of mucosa of urinary bladder
71649		3269	glandulae paraurethrales ♀	paraurethral glands ♀
		16305	lamina epithelialis mucosae vesicae urinariae	epithelial layer of mucosa of urinary bladder
326671		3270	lacunae urethrales urethrae masculinae ♀	urethral lacunae of male urethra ♀

Fig. 7 Laminae vesicae urinariae

5. *Systema venosum cerebrospinale* (from TNA).
6. *Vasa lymphatica* following TA98 with superficial and deep trunks for the limbs added (Kachlik et al. 2017, 2018, 2021).

In Fig. 5, the *Anastomoses portocavales* are presented. Under pathological conditions, veno-venous 'bypasses' open to decrease hypertension in the hepatic portal vein system. These are enlarged existing veno-venous anastomoses. The following major routes can be distinguished (Luzsa 1972; Kachlik et al. 2021) between: (a) the left gastric vein and the oesophageal veins; (b) the inferior mesenteric vein (and its superior rectal vein) and the middle and inferior rectal veins; (c) the paraumbilical veins and tributaries of the superficial epigastric and thoracoepigastric veins; (e) the paraumbilical veins and tributaries of the inferior and superior epigastric veins within both rectus abdominis muscles; (f) the paraumbilical veins and tributaries of the vesical venous plexus running in the midline along the median umbilical ligament; (g) the splenic, superior and inferior mesenteric veins and retroperitoneal veins and veins of the posterior abdominal wall; (h) between veins of the hepatic capsule and veins of the diaphragm at the area nuda of the liver.

For the *Systemata visceralia* (Chapters 5–10) of the TAH, we largely followed the TA98. Again, new data from the literature are added (Kachlik et al. 2015; Musil et al. 2019; TA2) and, where appropriate, the layers of the various structures were brought in line with the TH. For Chapter 5 (*Systema digestorium*), we decided to present the Teeth as a separate section *Dentition* (in progress; Chapter 6). The recently published *Oroanatomical Terminology with Russian Equivalents*, which was approved by the Working Group *Terminologia Oroanatomica* (TOA) of FIPAT, will be consulted (Nikityuk 2023). The muscles of the tongue, palate, and pharynx are listed under *Systema musculare* with a reference in this chapter. For all parts of the digestive

system, the presentation of the various layers follows the TH as exemplified for the *Laminae intestini tenuis* in Fig. 6. In Chapter 7 (*Systema respiratorium*), the *Cartilagines laryngis* and *Articulationes laryngis* were kept in this chapter. The laryngeal muscles, however, are listed under *Systema musculare*. The section *Cavitas thoracis* follows TA98, as did TA2, but will be included in a new Chapter 10. In Chapter 8 (*Systema urinarium*), the process of removing microscopic features to the TH as in TA2 is not followed. For all parts, layers are included again as shown for the *Vesica urinaria* in Fig. 7. Chapter 9 (*Systemata genitalia*) in fact consists of two separate sections: *Systema genitale femininum* and *Systema genitale masculinum*. The hotly debated term *Pudendum femininum* was replaced by *Vulva*, although in the BNA Regio pudendalis was used for both sexes. For further discussion, see Moxham and Sprumont (2016) and Kachlik (2021). The terms on the *Perineum* are largely included in the *Systema musculare* (*Fascia pelvis, Diaphragma pelvis*). Remaining terms such as *Fossa ischioanalis* are together with the *Cavitas thoracis* and the *Cavitas abdominopelvica* covered in Chapter 10 (*Systema trunci*).

Remaining short Chapters, including Chapter 11 (*Glandulae endocrinae*), Chapter 13 (*Systema lymphaticum*), and Chapter 16 (*Integumentum commune*) will be included shortly. The large Chapters 2 (*Systema skeletale*) and 3 (*Systema articulare*) will be dealt with in the first half of 2024.

Conclusions

The long-awaited revision of the official anatomical nomenclature, the second edition of the *Terminologia Anatomica* (TA2), issued in 2019, breaks with many traditional views of terminology. These changes in the TA98 met great resistance in many European Anatomical Societies who decided to keep using the TA98. We felt that the TA98 certainly needs updating but especially a digital version. The *Terminologia Anatomica Humana* project incorporates the recent digital version of the *Terminologia Neuroanatomica* from 2017 as its Chapters 14 and 15. The TAH is expanded with many new terms, including those in TA2, along with their definitions, relevant references, and clinical terms as shown in the various tables. Inconsistencies in the TA98 were corrected. Although the TAH is still in progress, many chapters are already available at the IFAA Website in Fribourg (https://ifaa.unifr.ch) as is the digital version of the TNA (2022).

Acknowledgements The authors would like to thank Luis Filgueira and Pierre Sprumont for encouraging us in this project and allowing us to use the IFAA Website in Fribourg. The authors would also like to thank our Anatomical Societies for their support.

Author contributions All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Hans ten Donkelaar, Robert Baud, and David Kachlik. The first draft of the manuscript was written by Hans ten Donkelaar and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding No funds, grants, or other supports was received.

Data availability All data are available freely at IFAA Website in Fribourg (https://ifaa.unifr.ch).

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

References

Anatomical Society of Great Britain and Ireland (1933) Final report of the committee appointed by the Anatomical Society of Great Britain and Ireland on June 22nd, 1928 "To consider proposals to the society for the revision of the B.N.A., with the view of bringing the matter before the next meeting of an international congress of anatomists". Robert Maclehose and Co, Ltd, University Press, Glasgow

AnatomicalTerms.Info. https://www.anatomicalterms.info

Anatomische Gesellschaft (2023) Terminologia Anatomica 2023 of the Anatomische Gesellschaft (TA2023AG), Protokolll der Mitgliederversammlumg der Anatomischen Gesellschaft 28-09-2023 Wuerzburg

Anderson RH, Loukas M (2009) The importance of attitudinally appropriate description in cardiac anatomy. Clin Anat 22:47–51

Baud R, Sprumont P, ten Donkelaar HJ (2018) The representation of white matter in the central nervous system. Front Neuroanat 12:102

Caggiatti A, Bergan JJ, Gloviczki P, Jantet G, Wendell-Smith PH, An International Interdisciplinary Consensus Committee on Venous Anatomical Terminology (2002) Nomenclature of the veins of the lower limbs: an international interdisciplinary consensus statement. J Vasc Surg 36:416–422

Caggiatti A, Bergan JJ, Gloviczki P, Eklof B, Allegra C, Partsch H, An International Interdisciplinary Consensus Committee on Venous Anatomical Terminology (2005) Nomenclature of the veins of the lower limb: extensions, refinements, and clinical application. J Vasc Surg 41:719–724

Charpy A (1912) Aponévroses du cou. In: Poirier P (ed) Traité d'anatomie humaine. Masson, Paris, pp 258–260

DeLancey JV (1996) Standing anatomy of the pelvic floor. J Pelvic Surg 2:260–263

Dorschner W, Stolzenburg J-U, Neuhaus J (2001) Structure and function of the bladder neck. Adv Anat Embryol Cell Biol 159:1–113

FCAT (1998) Terminologia Anatomica. International anatomical terminology. Thieme, Stuttgart, New York

Feigl G, Hammer GP, Litz R, Kachlik D (2020) The intercarotid or alar fascia, other cervical fascias, and their adjacent spaces—a plea for clarification of cervical fascia and spaces terminology. J Anat 237:197–207

FICAT (2008) Terminologia Histologica. International histological terminology. Lippincott, Wolters-Kluwer, Philadelphia

FIPAT (2013) Terminologia Embryologica. International embryological terminology. Thieme, Stuttgart, New York

FIPAT (2017a) Terminologia Embryologica, 2nd ed. http://FIPAT.library.dal.ca
FIPAT (2017b) Terminologia Neuroanatomica. http://FIPAT.library.dal.ca
FIPAT (2019) Terminologia Anatomica, 2nd ed. http://FIPAT.library.dal.ca
Fritsch H, Brenner E, Lienemann A, Ludwikowski B (2002) Anal sphincter complex. Dis Colon Rectum 45:188–194
Fritsch H, Lienemann A, Brenner E, Ludwikowski B (2004) Clinical anatomy of the pelvic floor. Adv Anat Embryol Cell Biol 175:1–66
Gobée OP, Jansma D, de Ruiter MC (2011) AnatomicalTerms. Info: heading for an online solution to the anatomical synonym problem: Hurdles in data-reuse from the Terminologia Anatomica and the Foundation Model of Anatomy and potentials for future development. Clin Anat 24:817–830
Hafferl A (1969) Lehrbuch der topographischen Anatomie. Springer, Berlin, pp 227–235
Herlin C, Chica-Rosa A, Subsol G et al (2015) Three-dimensional study of the skin/subcutaneous complex using in vivo whole body 3T MRI: review of the literature and conformation of a generic pattern of organization. Surg Radiol Anat 37:731–741
His W (1895) Die anatomische Nomenklatur. Nomina anatomica. Arch Anat Entwgesch Suppl 1–180
James TN (1963) The connecting pathways between the sinus node and the A-V node and between the right and the left atrium in the human heart. Am Heart J 66:498–508
James TN (2001) The internodal pathways of the human heart. Prog Cardiovasc Dis 43:495–535
Kachlik D (2021) Change of anatomical nomenclature must be deliberate: the female external genitalia. Clin Anat 34:320–323
Kachlik D, Baca V, Bozdechova I, Cech P, Musil V (2008) Anatomical terminology and nomenclature: past, present and highlights. Surg Radiol Anat 30(6):459–466
Kachlik D, Pechacek V, Musil V, Baca V (2010) The venous system of the pelvis: new nomenclature. Phlebology 25:162–172
Kachlik D, Pechacek V, Musil V, Baca V (2012) The deep venous system of the lower extremity: new nomenclature. Phlebology 27:48–58
Kachlik D, Musil V, Baca V (2015) Terminologia Anatomica after 17 years: inconsistencies, mistakes and new proposals. Ann Anat 201:8–16
Kachlik D, Musil V, Baca V (2016) Contribution to the anatomical nomenclature concerning general anatomy and anatomical variations. Surg Radiol Anat 38:757–765
Kachlik D, Musil V, Baca V (2017) Contribution to the anatomical nomenclature concerning upper limb anatomy. Surg Radiol Anat 39:405–417
Kachlik D, Musil V, Baca V (2018) Contribution to the anatomical nomenclature concerning lower limb anatomy. Surg Radiol Anat 40:537–562
Kachlik D, Musil V, Blankova A et al (2021) A plea for extension of the anatomic nomenclature: vessels. Bosn J Basic Med Sci 21:208–220
Luzsa G (1972) Röntgenanatomie des Gefäßsystems. Akadémiai Kiadó, Budapest
Mori S, Fukuzawa K, Takaya T et al (2016) Clinical cardiac structural anatomy reconstructed within the cardiac contour using multidetector-row computer tomography: left ventricular outflow tract. Clin Anat 29:353–363
Moxham BJ, Sprumont P (2016) Anatomical terms: towards development of terminologies (terminogenesis) head to head discussion. Eur J Anat 20:281–285
Musil V, Blankova A, Dvorakova V, Turyna R, Baca V (2019) A plea for an extension of the anatomical terms: organ systems. Bosn J Basic Med Sci 19:1–13
NA4 (1977) Nomina Anatomica with Nomina Histologica and Nomina Embryologica, 4th edn. Excerpta Medica, Amterdam, Oxford
Neumann PE, Baud R, Sprumont P (2017) Human anatomy nomenclature rules for the computer age. Clin Anat 30:300–302
Nikityuk DB (2023) The Oroanatomical terminology with Russian equivalents. Website of the All-Russian Research Society of Anatomists, Histologists, and Embryologists (VNOAGE), May 31, 2023; Plexus, November 2023
PNA/NA1 (1955) Parisiensia Nomina Anatomica. Spottiswoode, Ballantine & Co, London
Rosse C, Mejino JLV Jr (2003) A reference ontology for biomedical informatics: the Foundation Model of Anatomy. J Biomed Inform 36:478–500
Saremi F, Sánchez-Quintana D, Mori S et al (2017) Fibrous skeleton of the heart: anatomic overview and evaluation of pathologic conditions with CT and MR imaging. Radiographics 37:1330–1351
Seo JW, Kim JS, Cha MJ et al (2022) Surgical and electrical anatomy of the inter-nodal and intra-atrial conduction system of the heart. J Chest Surg 55:364–377
Shafik A (1999) Levator ani muscle: new physioanatomic aspects and role in the micturition mechanism. World J Urol 17:266–273
Smith B, Ashburner M, Rosse C et al (2007) The OBO Foundry: coordinated evolution of ontologies to support biomedical data integration. Nat Biotechnol 25:1251
Smith B, Almeida M, Bona J et al (2015) BFO 2.0 specification and user's guide. https://raw.githubusercontent.com/BFO-ontology/BFO/master/docs/bfo2-reference/BFO2-Reference.pdf
Stecco C, Macchi V, Porzionato A, Duparc F, De Caro R (2011) The fascia: the forgotten structure. Ital J Anat Embryol 3:127–138
Stecco C, Tiengo C, Stecco A et al (2013) Fascia redefined: anatomical features and technical relevance in fascial flap surgery. Surg Radil Anat 35:369–376
Stieve H (1936) Jenaer Nomina Anatomica. Fischer, Jena
ten Donkelaar HJ, Baud R (2021) About the Terminologia Neuroanatomica: past, present and future. Plexus, November 2021
ten Donkelaar HJ, Broman J, Neumann PE et al (2017) Towards a Terminologia Neuroanatomica. Clin Anat 30:145–155
ten Donkelaar HJ, Kachlik D, Tubbs RS (2018) An illustrated Terminologia Neuroanatomica: a concise encyclopedia of human neuroanatomy. Springer, Cham
Terminologia Neuroanatomica (2021) https://ifaa.unifr.ch
Thiel W (1992) The preservation of the whole corps with natural color. Ann Anat 174:185–195
Whitmore I (1999) Terminologia Anatomica: a new terminology for the new anatomist. Anat Rec 257:50–53
Wu Y, Dabhoiwala NF, Hagoort J et al (2015) 3D Topography of the young adult anal sphincter complex reconstructed from undeformed serial anatomical section. PLoS ONE 10:e0132226
Wu Y, Dabhoiwala NF, Hagoort J et al (2017) Architectural differences in the anterior and middle compartments of the pelvic floor of young-adult and postmenopausal females. J Anat 230:651–663
Wu Y, Hikspoor JPJM, Mommen G et al (2020) Interactive three-dimensional teaching models of the female and male pelvic floor. Clin Anat 33:275–285