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A visible human online reference for medical education and research: the detailed, free of charge www-atlas of human cross sections of the Workshop Anatomy for the Internet

Dr. med. Holger Jastrow, Department of Anatomy, Histology, Johannes Gutenberg-University, Becherweg 13, 55128 Mainz, Germany
Email: jastrow@mail.uni-mainz.de; <http://www.uni-mainz.de/~jastrow/>

Introduction

In the present 'information society' with high-speed computers and increasing network connections throughout the whole world, medical education and particularly anatomy cannot do without the new media. In this context the internet seems to be the best place to offer easily accessible, interactive teaching modules for acquisition of a three-dimensional functional picture of the human body. The detailed, free of charge www-atlas of human cross sections of the [Workshop Anatomy for the Internet](#) is a valuable contribution to world-wide anatomy learning and teaching.

Methods

The atlas is based on digitised sections of the Visible Human male and female as, at present, the most important international source for free high quality images of human gross anatomy including CT and MRI [1,2]. In regions of special clinical interest like the head and with many small details more sections were selected than in others with less evident changes between the slices (Table 1). Further, corresponding axial radiological images were included. Image data were obtained from the [NLM](#) or its [mirror sites](#). Decompression and conversion into JPG files were necessary to put the images at disposal in the internet. Thereby the original resolution was maintained. 12-Bit greyscale CT- and MR images were reduced to 8-Bits of grey.

The JPG compression resulted in a strong reduction of the file size without naked-eye detectable loss of colour contrast (Figure 1). The converted pictures were oriented according to radiological standard, trimmed and prepared to appear on a black background (Figure 2). For labelling black margins were added in order not to cover the pictures by the letters (Figure 3). Labelling was performed mostly by instructed students attending the workshop according to the

Region	original	labelled	data source
Head 1	39	39	male
Head 2	30	13	male
Neck	30	21	male
Shoulder	22	19	male
Thorax	24	17	male
Abdomen	24	7	male
Pelvis	10	4	male
Thigh	20	8	male
Knee	26	17	male
Shank	20	8	male
Feet	29	6	male
=	274	159	male
upper pelvis	35	14	female
lower pelvis	29	11	female
=	64	25	female
Total:	338	184	male + female

Table 1. Original and labelled sections included in the atlas on 5 Oct 2000.

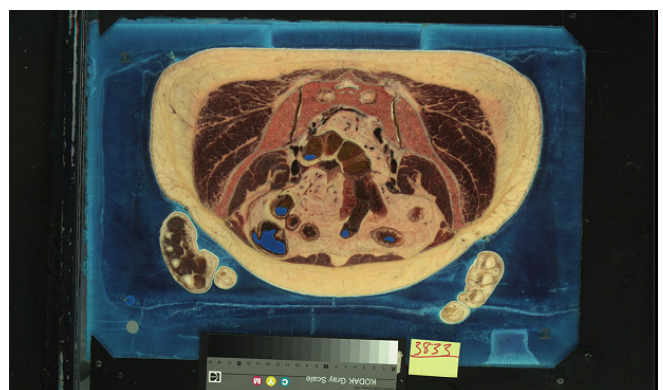


Figure 1. Original section from the VH-female dataset (vhf 1775a) after conversion into JPG.



Figure 2. Section vhf 1775a after orienting and trimming on a black background.

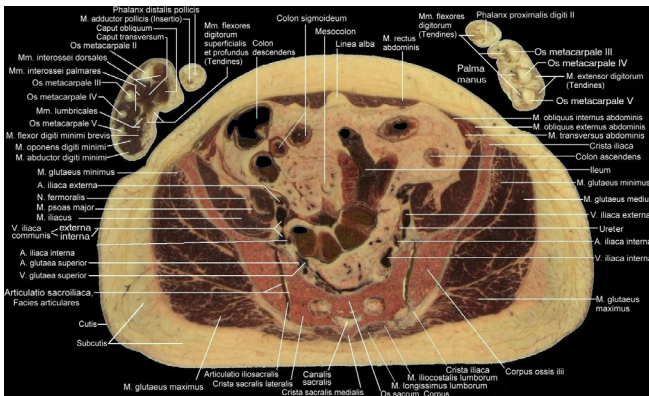


Figure 3. Section vhf 1775a labelled ([www 1](#)).

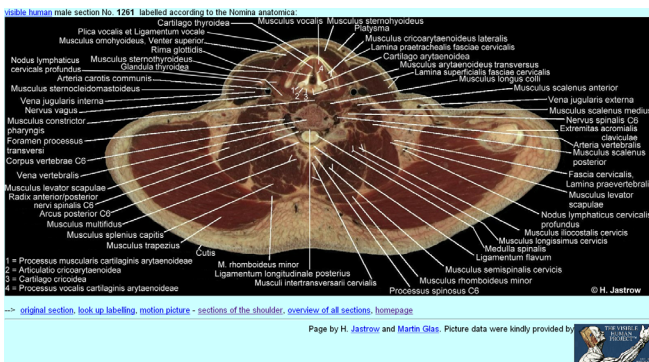


Figure 4. Internet page showing a labelled section of the VH-male ([www 2](#)).

present international terminology, Terminologia Anatomica, by using different anatomical atlases and books, e.g. [3]. After thorough checks, revision, correction and trimming, internet pages (Figure 4) were composed. As many structures as possible and reasonable were labelled on the pages with marked sections. When a structure was not labelled, it was either not clearly visible or there was not sufficient space available. In that case, the structure was labelled on the neighbouring sections. There is no strict uniformity in the layout, thus all labelled images reflect the individuality of the involved student whose name is given below the

Workshop Anatomy for the Internet: [visible human male section 1107](#)

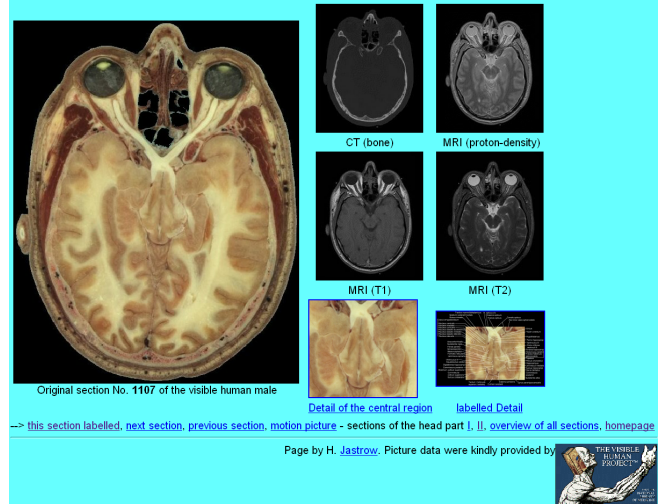


Figure 5. An atlas page of the head region with radiological images & a regional detail ([www 3](#)).

Workshop Anatomy for the Internet: [visible human male section 1455](#)

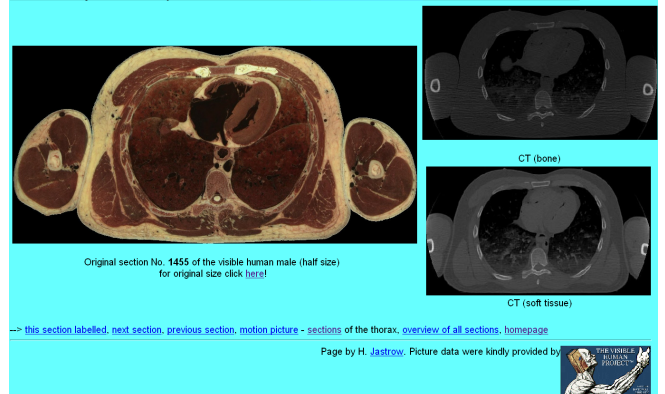


Figure 6. Atlas page with a section from the thorax with corresponding CT-images ([www 4](#)).

picture. Images are presented in full original pixel resolution in all pages of original sections in the head, neck and lower limb regions. Prepared sections, available corresponding CT and MR-images, and in some cases icons of details enlarged on linked pages (Figure 5) were arranged with further links using the Netscape Composer™. The images of pages with sections of the thoracic, abdominal and pelvic regions were reduced to half size with a link to the full-sized picture in order not to push the CT scans out of the screen (Figure 6). CT-Scans are shown below the original sections for optimal space management in web pages with sections of the lower limb (Figure 7).

The motion pictures (Figures 8,9) of the web atlas were created from stacks of trimmed, aligned, cleaned and equally sized images of all the anatomical or radiological sections mainly of the VH-male provided by the NLM.

Workshop Anatomy for the Internet: [visible human male section 2823](#)



Figure 7. An internet page of the foot region ([www5](#)).



Figure 8. Motion picture of the thorax (17 MB on [www6](#)).

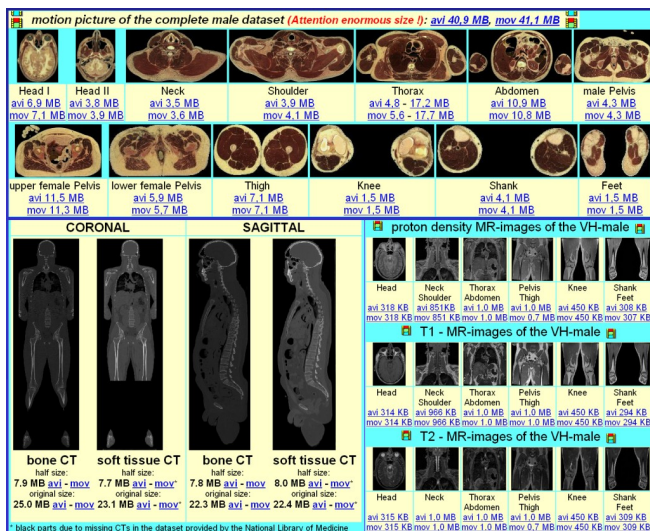


Figure 9. Overview of different available motion pictures ([www7](#)).

They were produced using [Ulead Media Studio™](#) or [MainActor™](#) software in either AVI™ or Quicktime™ format, both in Cinepack Radius™ compression. Only some of the motion pictures of the original sections are reduced in size due to the enormous amount of data involved. One motion picture even runs through the scaled down total of

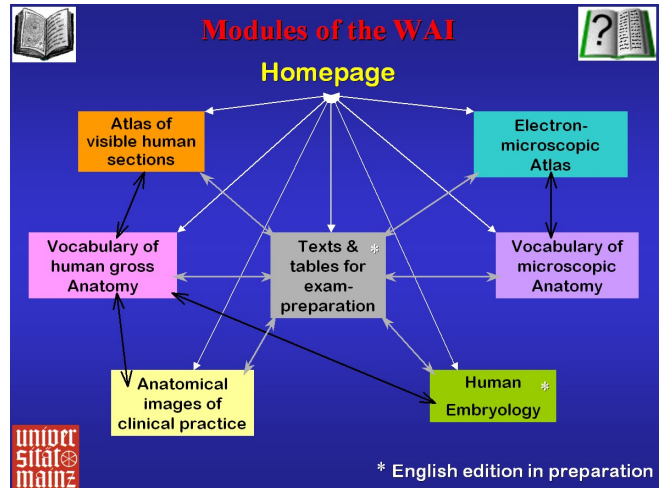


Figure 10. The links between the different modules of the Workshop Anatomy for the Internet (WAI).

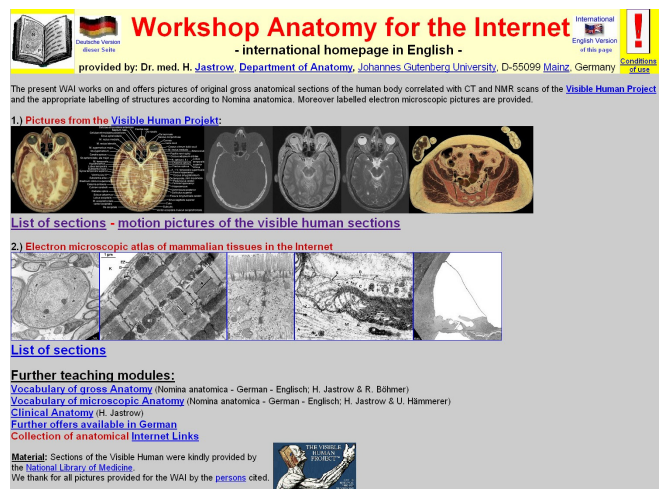


Figure 11. English homepage of the Workshop Anatomy for the Internet ([www8](#)).

the complete sections of the VH-male. Figure 9 shows links to the motion pictures on three of five pages providing a total of over 120 movies ready for download that were mainly produced from the VH-male data set.

Results

The atlas of visible human sections is one of some anatomy web-teaching modules of the [Workshop Anatomy for the Internet](#) of the Johannes Gutenberg-University of Mainz, Germany. These modules are linked to each other as shown in Figure 10. Those already available in English are accessible from the [English homepage of the workshop](#), which is shown in Figure 11. Apart from the [extensive electron microscopic atlas](#) ([www9](#)) and the other teaching modules it leads to the [atlas of visible human sections in the internet](#) which is presented here. When choosing the upper "List of sections", the index page of

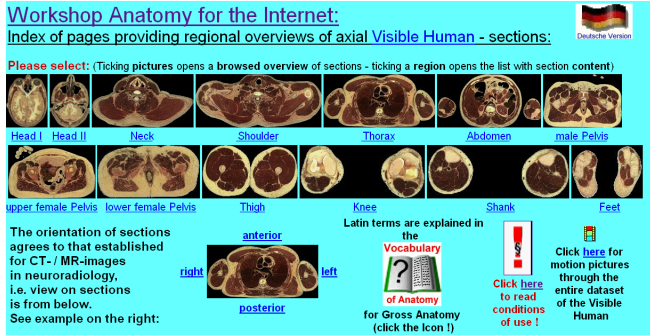


Figure 12. Index page of the atlas of axial visible human sections ([www10](#)).

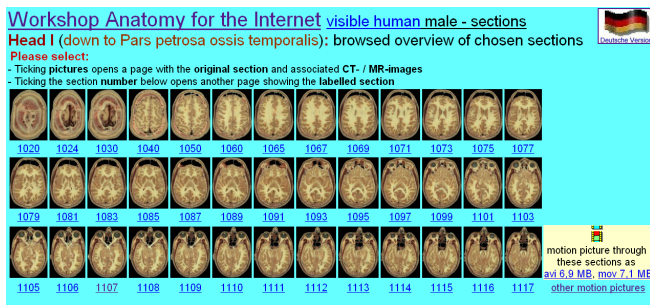


Figure 13. The page with the first region overview of the head ([www11](#)).

this atlas is loaded (Figure 12). This index page provides miniaturised transverse overview sections for each region of the body, linked to pages with browsed overviews of the chosen sections. Further one section is labelled with terms of orientation providing a link to an appropriate page of a vocabulary. Additional icons provide links to this [vocabulary of gross anatomy](#) ([www12](#)), [motion pictures](#) ([www7](#)), language selection and [conditions of use](#) ([www13](#)). When clicking the head 1 icon the [first region overview of the head](#) (Figure 13) providing small icons of all sections chosen here comes forth. When an icon of an image is selected the page with the full sized section and its corresponding radiological images, in the head region MRI and bone CT come up. A tick on the section number below opens the page with this section labelled. Further down the beginning of the list of the most important structures of the sections is shown.

The linked [vocabulary of gross anatomy](#) (Figure 14) provides over 850 Latin anatomical terms and their corresponding expressions in English and German. The terms are arranged according to subject as well as alphabetically. Thus unclear labelling can be looked up easily.

1.	Directions of cutting and planes, terms of direction and position, action of muscles and joints
2.	Basic structures (choice)
3.	Main parts and regions of the body
4.	Organs
5.	Bones
6.	Arteries
7.	Veins
8.	Nerves
9.	Muscles (German version - English version in preparation)
10.	Important abbreviations
11.	Enlarged list of words in alphabetical order A - Z Translation: Nomina anatomica (gr. / lat.) >>> German + English A brief dictionary of anatomical technical terms
12.	How to learn and understand anatomy: Useful tips and tricks for the preparation course

Figure 14. Features of the vocabulary ([www12](#)).

Discussion

The atlas intends to be a useful online reference for medical education and research by a hierarchic structure of pages and links, overviews providing scaled down images, motion pictures through all sections, original sections in high resolution and quality, a selection of sections regarding clinical relevance, detailed labelling according to the international terminology, including corresponding CT / MRI next to all sections, a structured vocabulary to look up terms, offering interactive choice of interesting features and the possibility of printing images and pages. The users gain a realistic picture of the whole human body from head to feet and are able to make a visual journey through the whole body showing all relevant structures of gross anatomy. In so far the atlas contributes to a three-dimensional understanding of topographic relationships. All important structures of gross anatomy are labelled using the official terminology to make the atlas ideal for use throughout the world. By giving representative views of all relevant structures of all body regions next to corresponding radiological images a valuable reference for correlation of radiological and anatomical structures has been created.

The present atlas is published the internet as the most important medium of today and future times to retrieve and present knowledge. Namely, the web offers possibilities that partly even CDs cannot provide and that are of great advantage in comparison to printed media. These advantages are prompt and easy world-wide

access for everyone, interactive choice of interesting subjects, possibility of printing and downloading only material of personal interest, integration of motion pictures, sound and interactive 3D-models, performance and automatic evaluation of self-assessment tests, possibility of quick correction, update and extension, web-wide linking, easy user feedback by E-mail, possibility to check what is most interesting for the users by web counters, nothing has to be carried or to be installed on a PC but a web browser and there is 'unlimited' space. Further the web is environmentally friendly. Due to world-wide efforts network connections will improve significantly in the nearer future so that download time will be less and less a problem. Since it is the aim to offer entirely correct labelling, the users of the atlas are requested to inform the author of imperfections via E-mail, as, in contrast to a book, publication in the internet offers the possibility of quick and easy correction.

Many people can benefit from the internet atlas since the offered material can be used for teaching as well as learning gross anatomy in general: medical students, doctors and staff; university teachers of anatomy and related subjects; specialists in anatomy; dissection courses; anatomical museum collections; teachers and students of health care subjects; schools for nurses, physiotherapists, medical technicians and health related professions; teachers and attendants of biology lessons in high schools and colleges and everybody interested in gaining insight into the own body. In brief, the spectrum reaches from university, health care related schools and colleges to lay people. The students who help to create teaching material for others by labelling the images in the workshop benefit in many ways: they markedly improve their knowledge in anatomy which is most important for their later work as medical doctors, learn how to handle PCs, gather experience how to deal with the internet and acquire skills in digital image processing. Further they are named below the images they worked on and receive a certificate of attendance useful when seeking positions.

The offered material is suitable for study and instruction of anatomy in general. Printouts of the non-labelled sections can be used in

examinations due to their high quality and resolution and for self assessment of anatomical knowledge in combination with the labelled images. Printouts of the labelled sections can help as reference for scientific purposes. In dissection courses medical and dental students already use them to identify structures in many places, especially when studying other original body sections. Further such printouts serve students for preparation of examinations; are used for anatomy teaching in general, e.g. in biology lessons in colleges or high schools and serve radiologist to recognize structures on similarly oriented CT- or MRI of patients. In addition, the provided material is an online supplement of anatomical museum collections. Interesting sections as well as motion pictures for topographical instruction can be projected on a screen directly from the www during dissection courses if a video beamer is available. The vocabulary can be used to understand the labelling and to get a structured overview of human organs and systems. The motion pictures help to gain a 3D picture of structures allowing to follow them through the sections to elucidate topographical relationships. In the training of medical students and doctors it is essential to correlate anatomical structures of the human body with radiological images. For this reason sections are presented next to corresponding radiological images that also can serve radiologists as a reference or in clinical anatomy instruction. In brief, the atlas is a source of images and information for medical education and research. Its pictures can be integrated in lectures, seminars and practical studies. Either direct internet access or printouts of the images are applicable.

Unfortunately, high quality anatomy software is often not affordable for students, in places with poor library facilities especially in Third World countries. In contrast, the present offer, even though no freeware, allows everybody to benefit from the excellent material offered by the NLM by being easily accessible in the Internet (no registration required) and at no charge for personal use. In so far it contributes to the realisation of the goals of the Visible Human Project providing the data sets to serve as a common public domain reference for the study of human anatomy [4]. A [page with the conditions of](#)

[use](#) informs about legal aspects and explains how to obtain printouts of the images. It is apparent that the present atlas is the most comprehensive one in the internet offering most detailed labelling of sections in the web. Otherwise, comparable detailed labelling, usually in English, is only present in few commercial CDs and books, e.g. [3]. The present contribution surveys other web-anatomy atlas projects since there are no further www offers with a comparable number of full sized VH sections, only some have few motion pictures, there is no similar extensive vocabulary of anatomical terms in www and very few other web pages provide sections with correlated CT/MRI. With its further anatomy teaching offers the [Workshop Anatomy for the Internet](#) represents a unique concept of presenting anatomy to specialists as well as to the general public. The commercial CDs providing more sections (usually unlabelled) or reconstructions are in most cases rather expensive for students. Commercial software offering 3D-reconstructions with detailed labelling of greater amounts of structures and sections is even much more expensive.

Prospect

The present atlas is constantly extended by including further original and labelled sections of the VH male and -female aiming at a maximal intersection distance of 5 millimetres in all regions. Due to presently still considerable download time, especially for the motion pictures, it is planned to offer them on a student affordable CD-ROM with as many sections as possible. Apart from the extension of the vocabulary and its links, it is planned to offer computed coronal and sagittal sections, 3D reconstructions of organs and structures and self assessment tools. Further the clinical anatomy shall be considerably extended and linkage between the different modules of the workshop is planned to be improved significantly. With these goals it is intended to contribute to world-wide improvement of three-dimensional understanding of anatomy in pre-clinical and clinical medicine.

Conclusions

The internet atlas of visible human sections of the [Workshop Anatomy for the Internet](#) provides easy and free access to 338 axial high resolution and quality sections of the visible human male and female shown next to corresponding CT- / MR-images. Presently 184 sections are labelled in detail according to the international Terminologia Anatomica. Over 120 motion pictures and an extensive vocabulary of gross anatomy as well as further anatomical www teaching offers contribute to a structural and functional three-dimensional understanding of the human body. The broad spectrum of usability spans from university instruction of specialists and reference for scientific purposes over education of medical students, doctors and staff, teachings of clinical anatomy to biology lessons in college and high school.

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- [4] Ackerman, M.J., The visible human project. Proceedings of the IEEE, vol. 86(3), pp. 504-511, 1998.

WWW pages of the WAI

[http://www.uni-mainz.de/FB/Medizin/
Anatomie/workshop/...](http://www.uni-mainz.de/FB/Medizin/Anatomie/workshop/...)

- 1 ...[vishuman/FEMALE/EF1775aok.html](#)
- 2 ...[vishuman/E1261ok.html](#)
- 3 ...[vishuman/E1107.html](#)
- 4 ...[vishuman/E1455.html](#)
- 5 ...[vishuman/E2823.html](#)
- 6 ...[vishuman/Film/Thoraxok.avi](#) [17 MB!]
- 7 ...[vishuman/FilmEng.html](#)
- 8 ...[englWelcome.html](#)
- 9 ...[EM/EMAtlas.html](#)
- 10 ...[vishuman/Eready.html](#)
- 11 ...[vishuman/BildKopfE.html](#)
- 12 ...[Vokabular/InhaltE.html](#)
- 13 ...[legal.html](#)

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