

Correspondence

World Wide Web access to the British Universities Human Embryo Database

The British Universities Human Embryo Database has been created by merging information from the Walmsley Collection of Human Embryos at the School of Biological and Medical Sciences, University of St Andrews and from the Boyd Collection of Human Embryos at the Department of Anatomy, University of Cambridge. The database has been made available electronically on the Internet and World Wide Web browsers can be used to implement interactive access to the information stored in the British Universities Human Embryo Database. The database can, therefore, be accessed and searched from remote sites and specific embryos can be identified in terms of their location, age, developmental stage, plane of section, staining technique, and other parameters. It is intended to add information from other similar collections in the UK as it becomes available.

Normal human embryonic development was studied extensively during the first half of the 20th century; this early work was largely descriptive and involved careful observation of sectioned material using traditional microscopical techniques. These basic studies raised questions about the control of developmental processes which were investigated by experimental manipulation of nonhuman embryonic tissues. More recently, however, the techniques of molecular biology have been applied to developing embryos to gain an understanding of how gene action is linked to the control of the developmental process.

Consequently, molecular biologists are now finding it essential that they have access to detailed anatomical information in order to fully interpret their results. In particular, the application of techniques such as *in situ* hybridisation to study gene expression in abnormal embryos has created an urgent need for reference to normal embryos; this is particularly acute for early human material. The use of human embryos for research is a sensitive issue and consequently these resources are both rare and difficult to access. However, there are collections of sectioned human material in various academic institutions throughout the UK and elsewhere, which include the earliest pre-embryonic and embryonic stages. Often these embryos were collected and sectioned as part of the original descriptive studies.

Our own renewed interest in the development of the embryonic human heart (McLachlan *et al.*, unpublished observations) has focused our attention on a significant collection of over 50 sectioned human embryos in the School of Biological and Medical Sciences at the University of St Andrews. The collection, dating from the first half of the century and now known as the Walmsley Collection of Human Embryos, has been renovated and catalogued with the aid of a grant from the Anatomical Society of Great Britain and Ireland. As part of this project, a computer database has been created which is compatible with the database for the Boyd Collection of Human Embryos in the Department of Anatomy at the University of Cambridge

Table. *Useful Web addresses and addresses of embryo resources*

General information	Product/Service/Information	Uniform Resource Locator (URL)
Starnine	Webstar server software	http://www.starnine.com/webstar.html
Netscape	Netscape Navigator software	http://home.netscape.com/
Qualcomm	Eudora e-mail software	http://www.qualcomm.com/quest
RFOM	FilemakerPro CGI (for Applescript)	http://rowen.astro.washington.edu/
Frontier	Frontier software (AppleScript alternative)	http://www.hotwired.com/userland/yabbdabba/nativefrontierpublicbe-390.html
Claris	FileMaker Pro software	http://www.claris.com/
Webcrawler	Web search engine	http://metacrawler.cs.washington.edu/mi
Altavista	Alta Vista Web Search Engine	http://www.altavista.digital.com/
Microsoft	Microsoft Internet Navigator	http://www.microsoft.com/windows/ie/msie.htm
MedWeb	Listing of most medical subject areas	http://www.cc.emory.edu/WHSC/medweb.html
Embryo resources		
	British Universities Human Embryo Database	http://embryos.st-andrews.ac.uk/
	Visible Embryo Project	http://visembryo.ucsf.edu/
	Embryo Development	http://www.med.upenn.edu/embryo-project/embryo.html
	Mouse Atlas Project	http://genex.hgu.mrc.ac.uk/

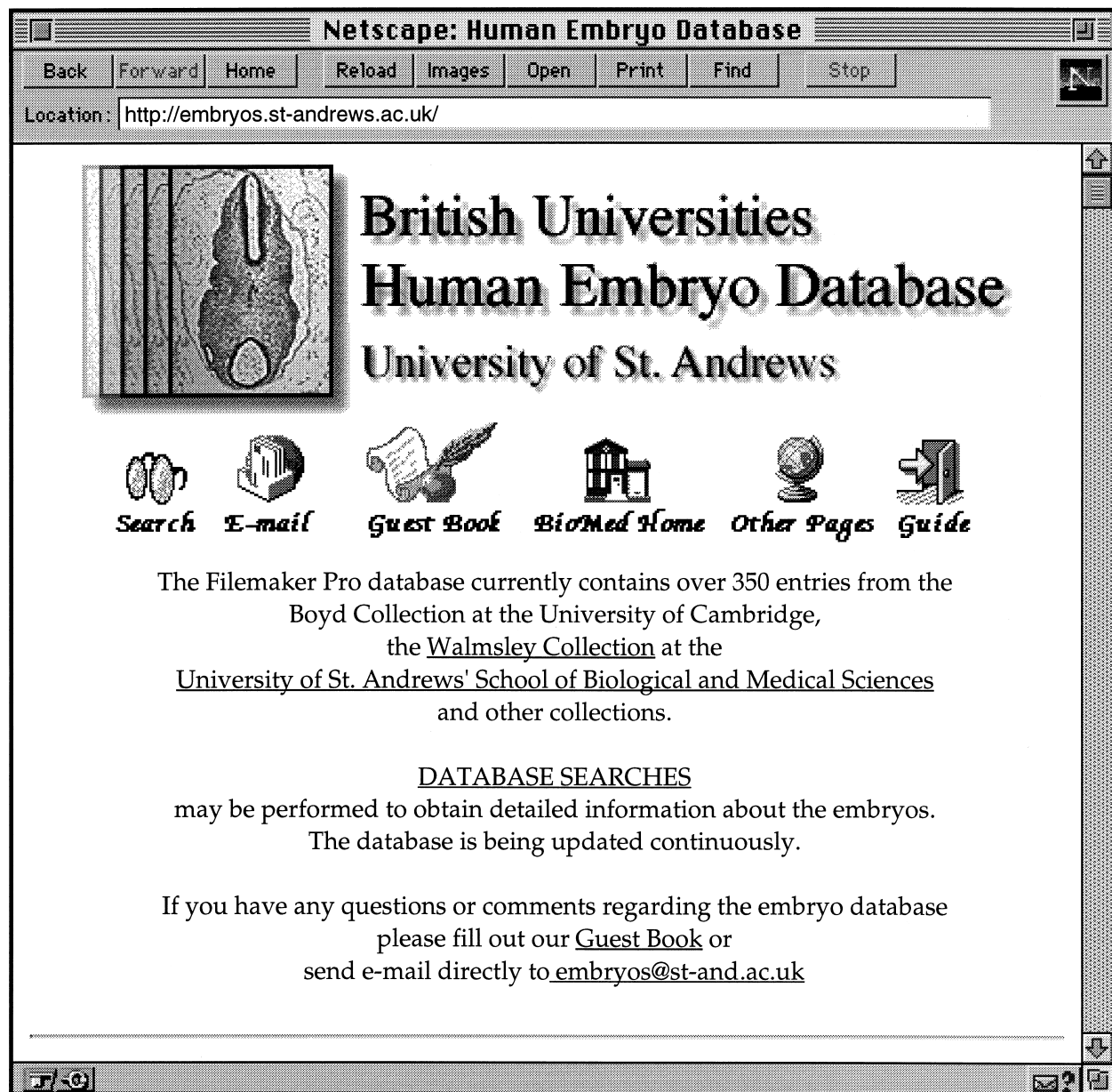


Fig. 1. Introductory screen for the British Universities Human Embryo Database. The Location field contains the address (URL) of the server which runs the database; <http://embryos.st-and.ac.uk/> Text which is underlined links to other pages on the server and to servers at other sites. Clicking on DATABASE SEARCHES opens the page which allows users to interrogate the database.

(also funded by the Anatomical Society). These databases have been merged to form the British Universities Human Embryo Database which is administered from the School of Biological and Medical Sciences at the University of St Andrews. We intend that information from other similar collections in the UK will be added to the database as it becomes available. Ownership of the original material is, of course, unaffected by the inclusion in the database. Instead, the Human Embryo Database catalogues electronically, information already available in paper copy.

It is now possible to access computerised databases via the Internet which links computer networks throughout the world. The World Wide Web (WWW) provides a system


which allows direct access to information stored on those computers set up as WWW servers on the Internet. We have therefore used the WWW to implement interactive access to the British Universities Human Embryo Database. This means, in effect, that the database can be accessed and searched from computers at remote sites. It allows researchers to identify specific embryos in terms of their location, age, developmental stage, plane of section, staining technique, and other parameters.







We describe here how this was achieved and also provide a guide for users. Holders of similar collections of embryos are invited to contact us, with a view to adding information about their collections to the master database.

Netscape: Search the Human Embryo Database

Back Forward Home Reload Images Open Print Find Stop

Location:

 **Search the Human Embryo Database**

 **Embryo Home**  **E-mail**  **Guest Book**  **BioMed Home**  **Other Pages**  **Guide**

SEARCH THE WHOLE DATABASE

Any fields left blank will assume that all values for the field will be returned (for example, if "Embryo Length [mm]" is left blank it will assume that all embryo lengths are wanted)

Embryo length [mm]:

Region Sectioned:

Plane of Section: All Coronal Longitudinal Sagittal Transverse

Nature of Embryo: All Sectioned Whole Mount

Age in days:

Carnegie Stage:

Location:

Sex: All Female Male

Sort by:

Records per page:

http://www.st-andrews.ac.uk/cgi-bin/imagemap/~www_sbms/macforms/embryoindsearchg

Fig. 2. The search page of the Human Embryo Database. Up to 8 fields can be used to enter search criteria. Additional instructions for using this page can be accessed by selecting [Instructions for searching](#). Carnegie Stages are given according to the criteria of O'Rahilly & Muller (1987).

Creating the accessible database

The World Wide Web. This is now the fastest growing international electronic communication system, with an estimated 70 million users (as of June 1996). The key philosophy which underlies access to the Web is that of *universal readership* which ensures that information stored on one computer can be accessed from any other computer, using a simple interface. Underpinning the infrastructure

and operation of the Web are the concepts of hypertext, hyperlinks and hypermedia. A hypertext document is a document with links (hyperlinks) to text in another document. Hyperlinks allow readers to access relevant, accessory documents which have been linked by the authors to the main body of information; these may be contained in the same archive or may be in remote archives. Hypermedia documents not only have links to text, but can also have links to other types of digital information such as images, sounds, animations and video segments.

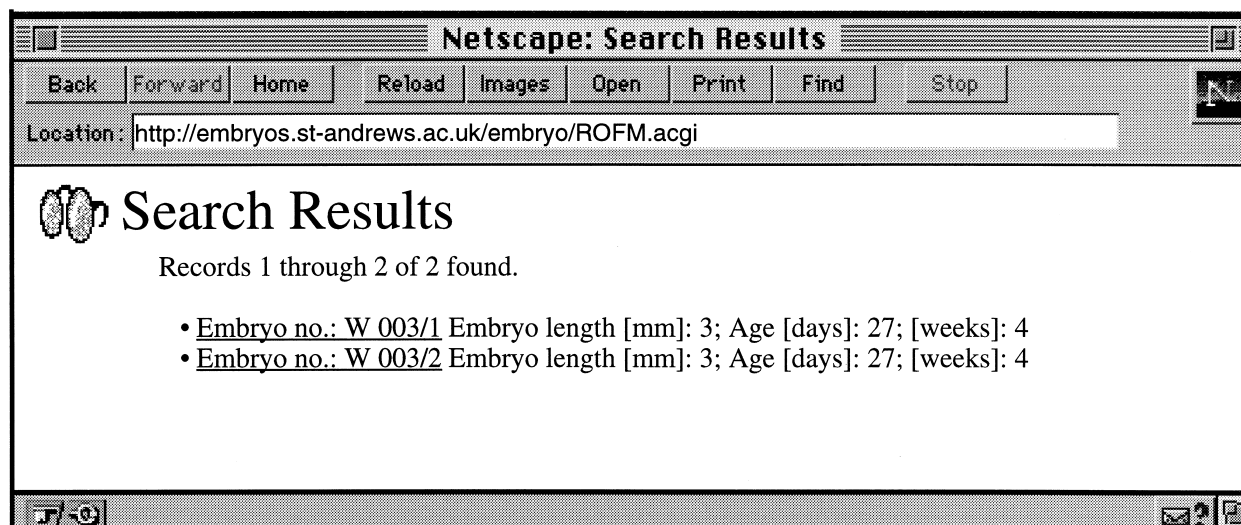


Fig. 3. The results of a search for all 3 mm embryos (see Fig. 2). In this case, 2 records were found and these are returned in an abbreviated format. Selecting a record will return the detailed information, held on file, in the database (see Fig. 4).

The Web has no central coordination. Any computer, acting as a *server*, can be an information-provider and publish data on the Internet. This information can be accessed by any *client* whose computer is running the appropriate software. The transfer protocols which operate on the Web are designed to facilitate the communication between clients and servers. Initiation of a hypermedia link by the client sends a request to the server software running on a remote computer system. The server retrieves the appropriate file and sends it back to the client via the Internet. On receipt of the file, the client computer displays the information or passes the file to an external viewer for platform-specific file translation. The rapid expansion of the Web is, to a large extent, founded on the flexibility of this client-server architecture where information is made available 'on demand' in a format which is independent of the operating system used by the client (Mac OS, Windows, UNIX, etc.)

Web client software. Among the most popular client software (also known as browser software) are Netscape Navigator and Microsoft Internet Explorer which are free to the academic community. Versions of all the major browsers are available for a variety of computer platforms and operating systems including Apple Macintosh, IBM - PC clones, Windows, Sun, X-Windows, etc. New features are constantly being developed and added to browser software to enhance the capabilities and facilities offered by the Web (e.g. interactive viewing of 3 dimensional objects).

The British Universities Human Embryo Database and Web Server. The database was created using Claris FileMaker Pro (currently version 3.0 is available for both Macintosh and IBM-compatible systems). The Web server which holds and serves the embryo database is a PowerMac 9500 running WebSTAR (version 1.3) as the Web server software. WebStat, a software package summarises WebSTAR transmission statistics and provides detailed statistics on access and usage.

The key factor in setting up and creating the accessible database is the interface between the Web client (Netscape Navigator, Microsoft Internet Explorer, etc.) and the Web server (WebSTAR). This interface makes it possible to

perform a remote search of the FileMaker Pro database from any Internet-linked computer which has the appropriate Web browser software installed. The results of the search are returned to the client within a matter of seconds. The server address for the Human Embryo Database is:

<http://embryos.st-andrews.ac.uk/>

Further useful addresses are contained in the Table.

Accessing the Database via the WWW

Computer access to the Web requires a computer with a direct link to the Internet and the appropriate client software (see Table). Opening the location <http://embryos.st-andrews.ac.uk/> gives direct access to the introductory page describing the database (Fig. 1) and clicking on 'DATABASE SEARCHES' leads directly to the searchable database (Fig. 2).

Using the Database

Comprehensive instructions for searching the database can be requested from the search page if necessary and successful searches return abbreviated records of those embryos which meet the search criteria (Fig. 3). Each embryo is represented by a complete *record* (Fig. 4) which can be displayed by clicking on the brief version. Each record consists of the available information on the embryo presented in a number of categories, each category being known as a *field*. There are currently 22 fields in each record (Fig. 4), and 8 of them can be selected as search categories (see Fig. 2). Both numeric and text fields support standard database enquiry strategies. Further enquires about specific embryos identified from the database search can be made via e-mail at the address, embryos@st-andrews.ac.uk

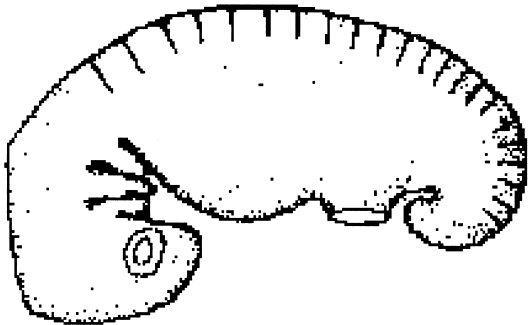
Future developments

Some of the records already contain diagrams of the embryo. It is planned to extend this feature, where possible,

Netscape: Retrieved Record

Back Forward Home Reload Images Open Print Find Stop

Location: http://embryos.st-andrews.ac.uk/embryo/ROFM.acgi?_action=GET&_database



Embryo no.: W 003/2
Embryo length [mm]: 3
Region sectioned: All
Plane of section: Transverse
Sections per slide: 6
Slide nos.: 1 - 283
Stain: See Comments below
Section interval [μ]: 10
Section date:
Nature of embryo: Sectioned
Age in days: 27
Age in weeks: 4
Carnegie Stage: 12
Status: Established
Sex:
Location: St. Andrews
CD available: No
Original Remarks: Slide 28 is blank.
Comments: Earliest embryo. There are two boxes of slides: Box 1 contains slides 1 - 144 and Box 2 contains slides 145 - 283. There are three stains used: Every even numbered slide is stained with Ehrlich's H & E. Every 8th slide from 5 to 157, and from 163 to 211, plus slides 217, 222 and every 8th up to 277 are stained with Mallory's phloxine-Methylene Blue. All remaining odd numbered slides are stained with Iron Haematoxylin and Van Gieson.

Fig. 4. An example of an individual embryo record returned after a Web search. Some records include diagrams showing the appearance of the embryo and the Comments field contains additional relevant information about the staining, state of preservation, and fixation where available.

to provide a graphic illustration of the plane of section. The marked curvature and twisting of embryos during development means that conventional descriptions of section planes are less informative for embryos than for adults.

It would be desirable if researchers could not only identify the location of material of interest through the Web, but could also download images of selected embryos, without

having to visit the home collection. We are exploring the creation of an image bank of this kind, stored in Photo CD format. Photo CDs currently hold up to 100 images, each of which is stored at 5 separate resolutions, enabling detailed examination of sections at high power without loss of image quality on the screen. CD 'juke boxes' which hold multiple CDs can be connected to the server, so that an image set

could be selected without manual intervention. We are currently engaged in seeking funding for this project.

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ACKNOWLEDGEMENTS

We gratefully acknowledge the support of the Anatomical Society, which funded the curation of the Walmsley Collection and the setting up of the Database, and of the Scottish Higher Education

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Funding Council, which funded the purchase of the Web Server through the Metropolitan Area Networks Initiative. We also gratefully acknowledge the help of Professor David Brynmor Thomas (University of St Andrews) in facilitating access to the Walmsley Collection, and Dr Visvan Navaratnam (University of Cambridge), who was responsible for creating the original Boyd Collection Database and who kindly allowed us to incorporate this material into the joint Database.

REFERENCE

O'RAHILLY R, MULLER F (1987) *Developmental Stages in Human Embryos*. Washington DC: Carnegie Institute of Washington Publication 637.