

# HISTOLOGY RESOURCES FOR PROMOTING BLENDED LEARNING

A. Peña-Fernández<sup>1</sup>, I. Ramos<sup>1</sup>, C. Young<sup>1</sup>, D. Gray<sup>1</sup>, M.D. Evans<sup>1</sup>, M. Randles<sup>1</sup>,  
L. Zhu<sup>1</sup>, M.C. Lobo-Bedmar<sup>2</sup>

<sup>1</sup>*De Montfort University, Faculty of Health and Life Sciences (UNITED KINGDOM)*

<sup>2</sup>*IMIDRA, Departamento de Investigación Agroambiental (SPAIN)*

## Abstract

Human health courses at universities are facing different challenges to provide students with real laboratory experiences due to the combination of large course cohorts with a shortage of academic staff, resources and time. Future health professionals are encouraged to have a complete understanding of human anatomy and histology as well as to have some pathology and diagnostic skills including the necessary skills to use a microscope. However, students often find learning histology challenging as they usually need to learn how to use a microscope in a limited time during a practical timetabled with several peers, in which they are also required to undertake other activities such as tissue embedding, cutting and staining. To address these factors, different web-based resources have been made available to enhance learning of anatomy and histology, however they are directed to medical students so their use by non-medical students (e.g. pharmacy, biomedical science, nursing, etc.) is limited due to their complexity. As a result, De Montfort University (DMU, UK) is leading an international project to develop an on-line package for teaching and learning biology, named *DMU e-Biology*, which will cover not only the foundation but also the latest scientific knowledge on human biology. This novel resource is also equipped with a Virtual Microscope and a Virtual Laboratory. The Virtual Laboratory will present different subsections with a range of units regarding biomedical techniques and equipment, which will be developed following previous successful experience from the team. Units will be highly engaging and will contain short videos of academics and/or technicians working hands-on with equipment and/or techniques to bring the laboratory to the student's house. Videos will be enhanced with audio and subtitles in English and the user will be able to complete a series of voluntary self-assessments throughout each unit to enhance engagement and provide the user with tools to evaluate their acquisition of knowledge. A subsection will cover all the elements to perform routine histological techniques in a biomedical laboratory, including the use and practicalities of the microtome, how to perform paraffin embedding and tissue sampling, and common staining techniques such as haematoxylin & eosin (H&E) and periodic acid–Schiff stain (PAS). The histology section will be publicly available from the DMU website in late 2018 here [http://parasitology.dmu.ac.uk/ebiology/biologyLaboratory\\_units.htm](http://parasitology.dmu.ac.uk/ebiology/biologyLaboratory_units.htm).

Additionally, this resource is supported by a virtual microscope in which the user will be able to explore a library of virtual histological slides from different human tissues and organs; the virtual microscope will transfer the practicalities of a microscope to study human histology. These resources will be tested with first year BSc Biomedical Science and BMedSci Medical Science students enrolled in the module Basic Anatomy and Physiology at DMU by implementing blended learning, *i.e.* a pedagogy that integrates e-learning resources and materials with formal teaching (lectures, workshops and practicals), as different studies have pointed out that this pedagogy can enhance self-learning and facilitate acquisition of knowledge and long-term retention of information. This paper will provide a description of these novel resources and explore their practicalities with non-medical science students.

Keywords: Histology, blended learning, virtual microscope, virtual resources.

## 1 INTRODUCTION

Medical histology is a basic science course in any health care programme to appropriately learn other subjects such as cell biology, anatomy and physiology and to understand pathology. However, the teaching of this science has significantly changed in the latest decades due to the anthropogenic technical and scientific progress. Thus, the teaching of histology was impacted with the appearance of the transmission and scanning electron microscopes during the second half of the 20<sup>th</sup> century and currently, histology is undergoing significant modifications to incorporate emerging technologies including the Internet and the use of web-enabled devices such as tablets, mobiles and lap-tops [1-2].

In the majority of Higher Education Institutions (HEIs), the teaching of histology consists of learning how to use a light microscope for visualising microscope slides and/or using micrographs. Moreover, in exceptional circumstances (mostly in postgraduate programmes) students are using an electron microscope. However, current HEIs are transitioning to also using virtual microscopy systems, to overcome different barriers such as increasing numbers of students enrolled in health care programmes, reduction of the teaching-led hours due to different factors including higher education harmonization and significant increment of knowledge.

To enhance the current teaching status in our clinical science programmes at De Montfort University (DMU, Leicester, UK), *i.e.* BSc Biomedical Science (BMS) and BMedSci Medical Science (BMedSci), we are leading an international innovation teaching project started to develop a complete package for teaching and learning biology, named DMU e-Biology. This project started in the summer of 2017, and a preliminary description of the methods and scaffolding used has been previously described by our team in Peña-Fernández et al. (2017) [3]. Here, briefly, DMU e-Biology is designed to enhance learning and underpin the fundamental concepts of biology and related sciences, by covering the specifications for AS and A level (AQA, 2017 [4]) as well as the basic biology concepts delivered in our clinical science programmes. The final novel package will be available from the DMU website in early 2020 (<http://parasitology.dmu.ac.uk/ebiology/index.htm>), when comprehensive feedback from students collected during 2018/19 has been addressed following previous successful experiences from our team.

DMU e-Biology will be provided with similar tools and resources as those that we are creating for the DMU e-Parasitology package, *i.e.* four modules as follows:

- a) **A theoretical module** with e-learning units that cover the study of cover the basic Biology and related concepts delivered across our programmes. An initial table of content was provided in Table 1.

*Table 1. Core content of the theoretical units of the future DMU e-Biology (adapted from Peña-Fernández et al., 2017 [3]).*

Core content
Brief introduction to biology
Chemistry
Cells
Cellular respiration
Human anatomy and physiology
Genetics
Basic microbiology

- b) **A virtual biomedical laboratory module** for the study/research of different biomedical techniques, which includes a complete sub-section for the study of histology and common staining techniques for human tissues and organs.
- c) **A virtual microscope**, which will present a collection of virtual histology slides for the study of anatomy and histology. Digitised virtual slides will allow the student to view any part of the specimen at any magnification, which in turn will enable them to learn the structure and composition of normal and pathogenic tissues.
- d) **A virtual case studies module** with different degrees of difficulty is being created for students and users with different backgrounds in biology. Case studies will promote active learning and increasing engagement and are aimed to provide the user with problem-solving skills and basic clinical skills.

The main aim of this paper is to provide a first insight to the development of a complete section for the study of histology in the DMU e-Biology Virtual Laboratory module.

## 2 DMU E-BIOLOGY HISTOLOGY SUB-SECTION

The teaching of medical histology in our clinical science programmes is spread across different modules but specifically in our shared (BMS & BMedSci) modules of Basic Anatomy and Physiology (level 4), Organ Systems Physiology (level 5), and the BMS final module of Histopathology and Cytopathology. A complete description of the core components of both programmes is available at the DMU website. As a result of the teaching of medical histology in different modules and levels, we are developing a complete subsection in histology ([http://parasitology.dmu.ac.uk/ebiology/biologyLaboratory\\_units.htm](http://parasitology.dmu.ac.uk/ebiology/biologyLaboratory_units.htm)), which will be equipped with a series of units to cover all the different aspects of histology delivered in these modules plus additional information. Thus, this section could be used in any human health science degree. Units developed so far includes the following:

- 1 **Histological technique.** A generic e-learning unit that covers what histology is and the key steps required to obtain paraffin-embedded tissue samples, *i.e.* fixation, dehydration, clearing, infiltration, tissue embedding and appropriate orientations and how to cut with the microtome (Figure 1). E-learning units are designed to provide the user with the necessary information and are equipped with photos, graphic designs and short videos of an academic performing the technique step-by-step.

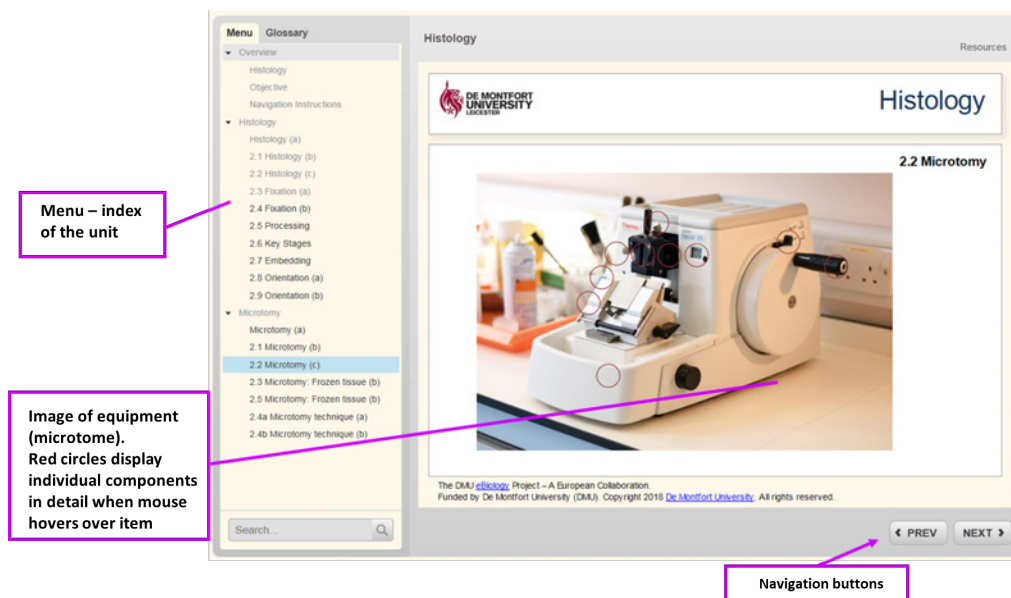


Figure 1. Overview of the DMU e-Biology Histology Technique unit (Image courtesy of DMU). Available at: [http://parasitology.dmu.ac.uk/ebiology/units/Histology/story\\_html5.html](http://parasitology.dmu.ac.uk/ebiology/units/Histology/story_html5.html)

- 2 **Staining methods.** This e-learning unit is mostly informative and provides an overview of the different stains used in histology and their application. Additionally, it provides a description of the differences between stain and dye.
- 3 **Haematoxylin-eosin (H&E) stain.** A complete e-learning unit describing step-by-step how to perform H&E in a biomedical laboratory. The unit is presented with a video of a histopathology technician performing all the steps of this technique; videos are also enhanced with subtitles containing relevant information for the student as displayed in Fig. 2. Videos are aimed not only at providing students with a complete experience of the technique in the laboratory but also to facilitate the implementation of blended learning (the combination of academic-led teaching with web-based resources such as e-learning) in any programme. Blended learning has been reported to enhance science education [5], and we consider that it will benefit our students because they come from different educational backgrounds and they live in different areas so accessing learning resources will have an impact on their learning and engagement.
- 4 **Periodic acid-Schiff (PAS) stain.** Following the same methods and structure as with the H&E stain unit, we have completed unit to cover PAS staining

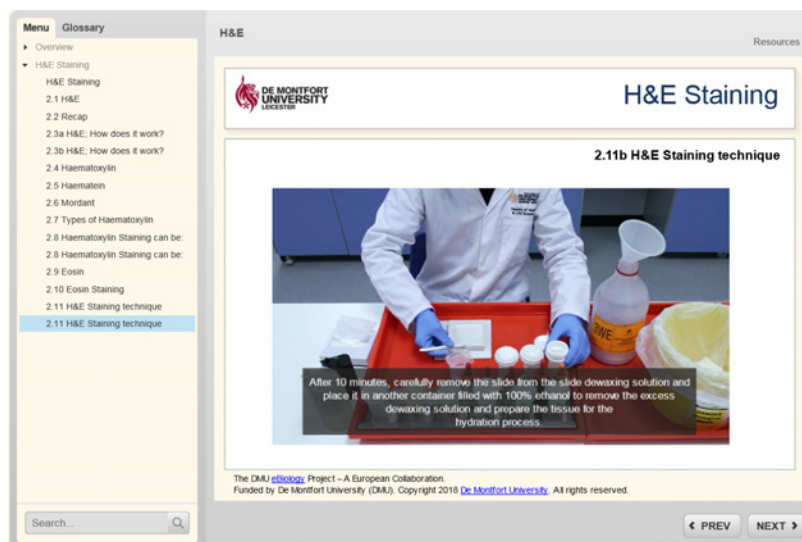


Figure 2. Overview of the DMU e-Biology H&E Stain unit (Image courtesy of DMU). Available at: [http://parasitology.dmu.ac.uk/ebiology/units/H&E/story\\_html5.html](http://parasitology.dmu.ac.uk/ebiology/units/H&E/story_html5.html)

### 3 DMU E-BIOLOGY MICROSCOPE

Additionally, the DMU e-Biology package is supported by a virtual microscope in which the user will be able to explore a library of virtual histological slides from different human and mammalian tissues and organs. Each virtual slide will be provided with the practicalities of a microscope so students will be able to study histology from virtually any place as long as they have a web-enabled device and access to the Internet. Slides will also be provided with explanatory information so the student will be able to familiarise themselves with the characteristics of the specimens to study human histology.

### 4 FUTURE WORK & CONCLUSIONS

DMU e-Biology histological resources will be tested with first year BMS and BMedSci students enrolled in the 30 credit module of Basic Anatomy and Physiology at DMU in 2018/19 by using blended learning. Students will be provided in advance with the appropriate links to the different units described above prior to them attending the respective practicals. Comprehensive feedback will be collected to study whether the created units facilitated students' acquisition of knowledge and skills to perform the different techniques described in the e-learning units. Moreover, we hope that our students welcome this initiative and help to enhance retention in our programmes by enhancing and promoting self-learning and critical analysis, and specifically for promoting their satisfaction and their desire to learn.

### ACKNOWLEDGEMENTS

The authors would like to express their sincere appreciation to Marek Kowalic (DMU frontrunner 2017/18) for his designs and videos; and DMU sandwich placement student Maksymilian Szymulewicz for production of histology units (2018). Finally, authors would like to thank the DMU e-Parasitology project team [Teaching Innovation Project Fund at De Montfort University (scheme 2015-16); project lead Dr Peña-Fernández] as we are partly using these resources to develop DMU e-Biology.

### REFERENCES

- [1] Blake CA., Lavoie HA., Millette CF. Teaching medical histology at the University of South Carolina School of Medicine: Transition to virtual slides and virtual microscopes. *Anat Rec B New Anat* 2003; 275(1):196-206.
- [2] Vainer B., Mortensen NW., Poulsen SS., Sørensen AH., Olsen J., Saxild HH., Johansen FF. Turning Microscopy in the Medical Curriculum Digital: Experiences from The Faculty of Health and Medical Sciences at University of Copenhagen. *J Pathol Inform* 2017; 8:11.

- [3] Peña-Fernández A., Sgamma T., Young C., Randles MJ., Del Águila C., Hurtado C., Evans MD., Potiwat N., Izquierdo F., Peña MA., Coope J., Armstrong M., Bhambra A. Building a DMU e-Biology resource for health sciences' students. ICERI2017 Proceedings 2017; 1582-1587. ISBN: 978-84-697-6957-7.
- [4] AQA. AS and A-level Biology Specifications. Available at: <http://www.aqa.org.uk/subjects/science/as-and-a-level/biology-7401-7402> [accessed 24/09/2018]
- [5] Stockwell BR., Stockwell MS., Cennamo M., Jiang E. Blended learning improves science education. *Cell* 2015; 162(5):933e936.