



## BRIEF REPORT

# Experience of Biology Degree students in the recognition of tissue alterations in human histopathological samples

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**KEYWORDS**

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Survey

**Abstract**

**Introduction:** The analysis of histological images plays a fundamental role in studying pathological alterations associated with human diseases, especially in the context of practical teaching. However, in the Biology Degree programme there is a lack of practical activities based on the study of human histological preparations.

**Material and methods:** A collaboration with an Anatomical Pathology department was established for this project, which aimed to carry out an innovative practice based on the study of human biopsies in the subject of Cell Biology and Cellular Pathology of the Biology Degree programme. Face-to-face and non-face-to-face activities were performed, involving group work, image search and selection for the preparation of digital material.

**Results:** This activity allowed for the identification of morphological changes caused by the deregulation of cellular processes in various diseases.

**Conclusions:** Our results indicate that students find this practice very useful for their training, so this activity could be applied to other similar subjects taught in other degree programmes.

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## PALABRAS CLAVE

Anatomía patológica;  
Biología;  
Educación médica;  
Histología;  
Encuesta

## Experiencia de los estudiantes del Grado en Biología en el reconocimiento de alteraciones tisulares en muestras histopatológicas humanas

### Resumen

**Introducción:** El análisis de imágenes histológicas juega un papel fundamental para estudiar alteraciones patológicas asociadas a enfermedades humanas, especialmente en el ámbito de la docencia práctica. Sin embargo, en el Grado en Biología existe una carencia de actividades prácticas basadas en el estudio de preparaciones histológicas humanas.

**Material y métodos:** Mediante una colaboración con un Servicio de Anatomía Patológica, en este trabajo se planteó realizar una práctica innovadora basada en un estudio de biopsias humanas en la asignatura de Biología y Patología Celular del Grado en Biología. Se realizaron actividades presenciales y no presenciales, basadas en trabajos en grupo, con búsqueda y selección de imágenes para la elaboración de material digital.

**Resultados:** Esta actividad permitió identificar los cambios morfológicos producidos por desregulación de procesos celulares en diferentes enfermedades.

**Conclusiones:** Nuestros resultados indican que los alumnos consideran esta práctica muy útil para su formación, por lo que esta actividad se podría extrapolar a otras asignaturas similares que se imparten en otros grados.

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## Introduction

The introduction of new technologies into teaching has led to a shift in students' autonomy, enhancing their abilities and independence in seeking information and using digital resources.<sup>1</sup> Teaching staff have transitioned to a role of guiding and encouraging the use of information and communication technologies (ICTs), resulting in improved and diversified content and learning activities.<sup>2</sup>

A significant percentage of students in the Biology Degree demonstrate a strong interest in Biomedicine.<sup>5</sup> Nevertheless, there is a lack of practical content focused on the study of the pathophysiology of the most prevalent diseases.<sup>6</sup> The use of human biopsies could be very useful in this regard, as it would help reinforce and expand theoretical knowledge about cell organisation and physiology, as well as the cellular foundations of various diseases. Additionally, the use of these types of samples could serve as a motivational tool for students.<sup>3,4</sup> Unfortunately, there is limited access to histopathological samples from patients, which has hindered the practical and applied demonstration of morphological and structural alterations in tissues and organs. Considering the interest of Biology students in subjects related to cellular pathology and the scarcity of existing practical content, it is surprising that collaborations have not been established with Departments of Anatomical Pathology to obtain this type of material.

Building on a formal collaboration with an Anatomical Pathology Department, this study aims to enhance the practices conducted in the Cell Biology and Cellular Pathology module, which is taught in the 4th year of the Biology Degree programme. To address this, we developed a new practical session focused on capturing images of human histopathological preparations to describe, recognise, and interpret

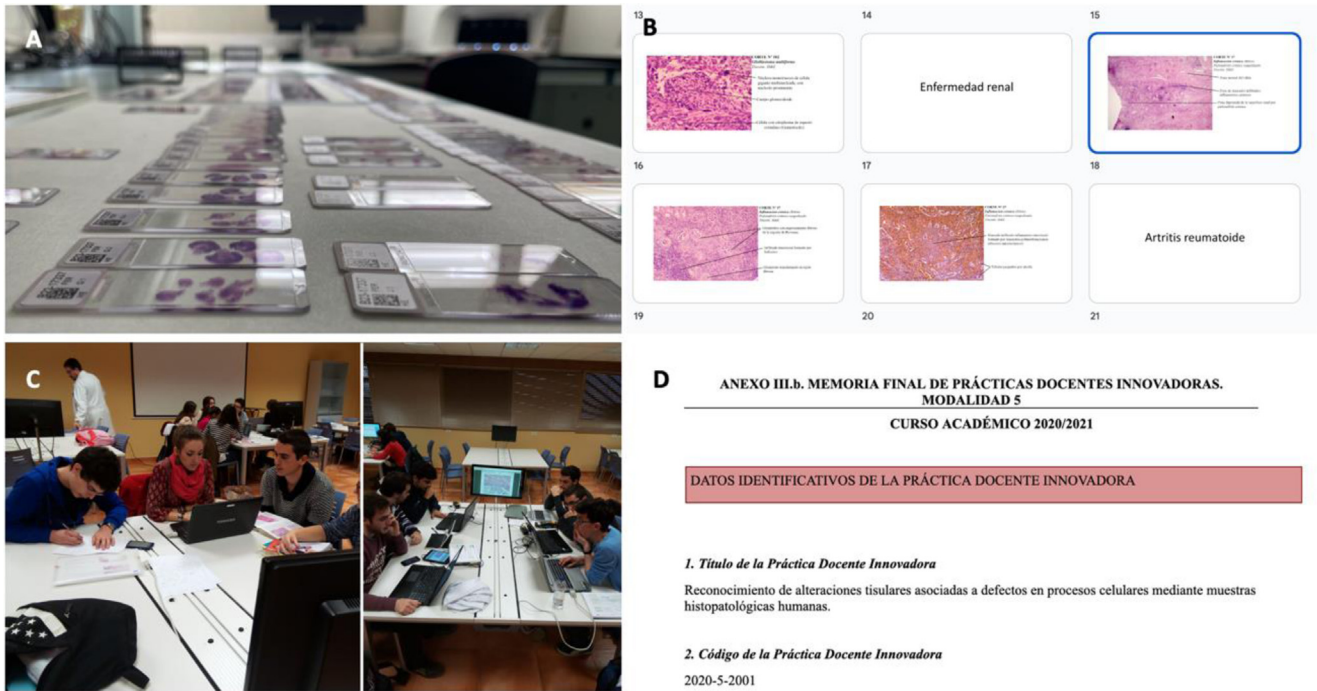
pathological microscopic images. This approach aims to demonstrate the relevance of studying cellular changes as the origin of human diseases and their manifestation in histological morphology and structure. This innovative activity, which applied theoretical learning to practical scenarios, involved collaborative work among the students. Additionally, the students assessed the quality of the practical sessions through a directed survey. We believe that the inclusion of this type of learning content in this subject is of great interest, as there is no other module in the Biology Degree curriculum dedicated to histopathology.

## Material and methods

The teaching activity was conducted with students from the Cell Biology and Cellular Pathology module in the fourth year of the Biology Degree programme at the University of Córdoba. The educational activity was delivered to a total of 48 students who took the subject during the 2020–2021 academic year and included the following phases.

### Preparation and design of the activity by the teaching staff

Histological sections from human biopsies of various diseases were selected from the Anatomical Pathology Department of the University Hospital Reina Sofía of Córdoba, with prior approval from the Research Ethics Committee of the Province of Córdoba. The histological sections were stained with haematoxylin–eosin, Masson's trichrome, PAS, etc., to provide a histopathological description consistent with a suspected diagnosis based on each patient's clinical presentation. Subsequently, the histological sections were digitised



**Figure 1** Chronological representation of the activity. (A) Samples selected. (B) Selection of images and disease by the students. (C) Example of activity development in a multifunctional classroom. (D) Report on the Teaching Innovation Project of the University of Córdoba.

using a Leica® Aperio AT2 scanner, with a numerical code assigned to each image to ensure the anonymisation of each sample.

### Organisation and assignment of tasks for students

After scanning and anonymising the images, they were sent to the students via the University of Cordoba's digital teaching platform (UCOMoodle). This part of the activity was conducted online and organised into groups of two students. Each group was assigned images of biopsies from a disease they had previously chosen (in order of request), based on a pre-prepared list organised according to cellular alterations and the corresponding disease. This list was added to the UCOMoodle platform to make it available to all students.

### Personal and supervised student work

The students labelled the images and created summaries with explanatory texts to aid their understanding of the concepts under study. For each test image, the students identified the tissue/organ, described the "residual" histological elements or structures and their alterations, and identified all the structures to label them on the digital image. Additionally, the students conducted literature searches to correlate normal structures with pathological ones.

Students were required to deliver a remote presentation comparing normal and pathological images from a histological perspective. This part of the practical activity was designed with instructions from the professor, who provided specific guidelines on how to prepare the presentation. To

address problems and clarify doubts, virtual tutoring was conducted with each student group. This tutoring, carried out via the Moodle platform, assisted them in preparing their presentations and provided them with specific guidance on locating documentation related to each disease.

### Presentation of the students' work

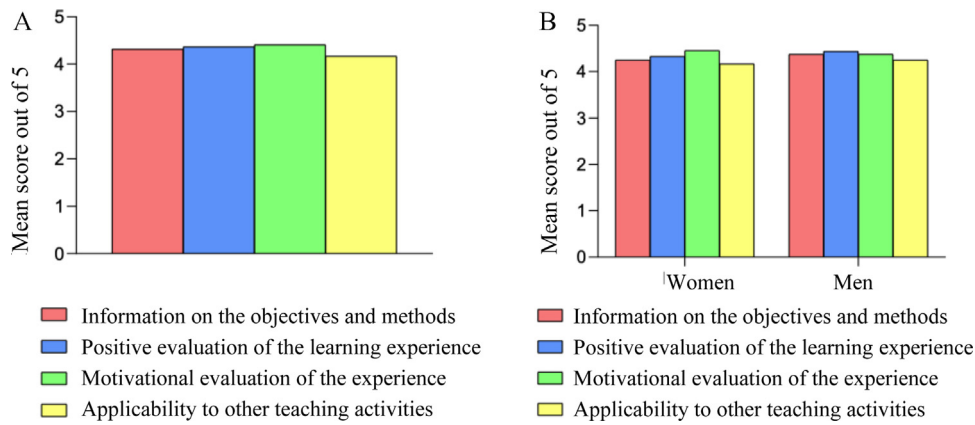
The presentations were delivered and defended publicly. To facilitate this, 6 in-person sessions were organised (4–5 groups per day), each featuring a 15-min presentation where students described the characteristics of the histological images and their relationship to the development of the disease. The audiovisual resources available in the classroom were used. After each presentation, a question-and-answer session was held to address content-related queries and resolve any doubts.

### Academic assessment of learning

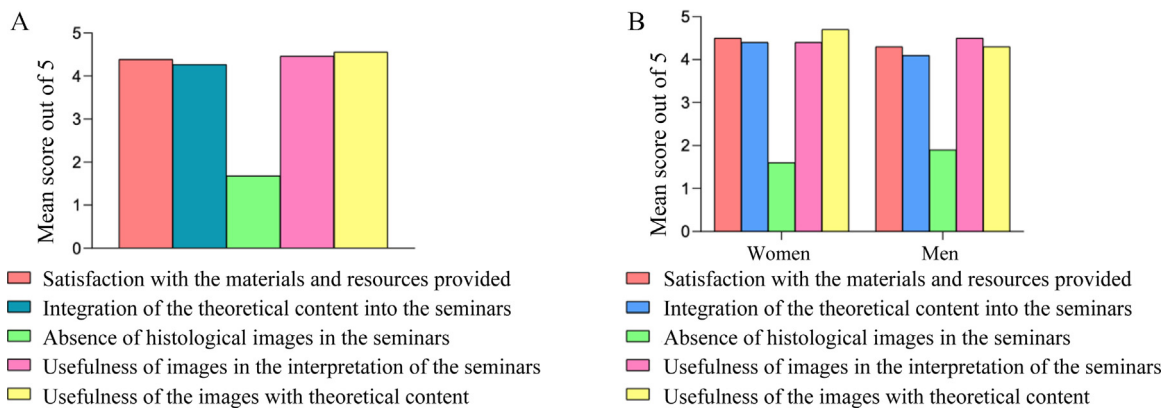
The teaching staff evaluated and commented on the information provided by the students, clarifying concepts and correcting any possible errors. The material produced after this activity was shared through the course's UCOMoodle platform to make it available to the rest of the students (Fig. 1).

### Assessment of the experience by the students

After the practical session was completed, it was assessed via an anonymous and voluntary survey. A Google® Form link



**Figure 2** (A) Evaluation of the method used. (B) Evaluation of the method used, broken down by sex.



**Figure 3** (A) Usefulness of the implemented educational activity. (B) Usefulness of the implemented teaching activity, broken down by sex.

was provided. The survey included 12 items covering general questions (2 items), objectives, methods, and motivation (4 items), evaluation of the innovative teaching practice (4 items), and overall evaluation of the course (2 items). Each item was assessed on a Likert scale from 0 (not at all) to 5 (a great deal), except for the last two items, which were grouped into: excellent, acceptable, fair, and poor. The results were compared between the final grade for the course and the seminar grade using a Spearman regression analysis (non-parametric variables).

## Results

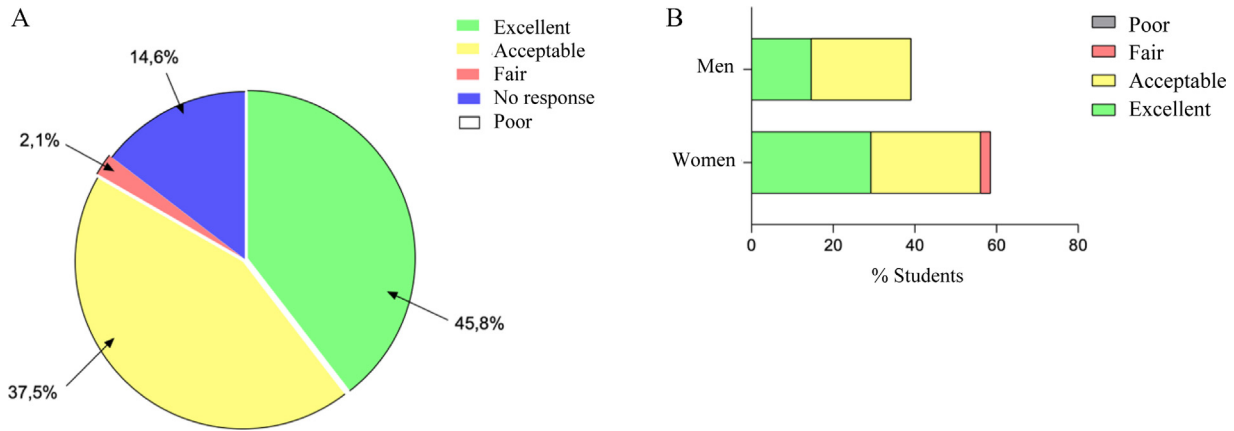
The survey was completed by 41 out of 48 students enrolled in the course (85.48%), of whom 24 were women (58.5%). The responses were grouped into four blocks: (1) evaluation of the methods used, (2) usefulness of the activity, (3) overall satisfaction with the innovative teaching practice, and (4) ratings of the seminar presentation. In the block concerning the methods used, an average score of 4.31 was obtained for the question about whether the objectives were clear and whether applying this new method to other courses would be beneficial (Fig. 2A). The average score was 4.41 for the question regarding the motivation for this type of seminars

compared to others attended by the students. Fig. 2B shows the scores by sex.

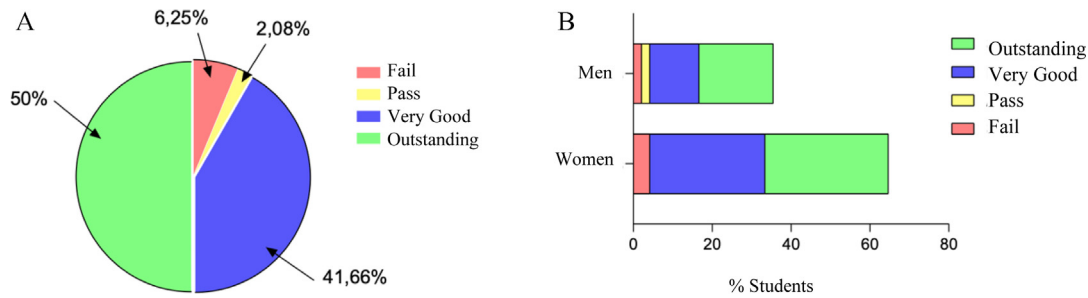
In the group evaluating the seminar content and the usefulness of the practice, the lowest average score was 1.68, as the majority felt that images were essential for the practical seminars (Fig. 3B). The highest average score was 4.56, which corresponded to the question about whether the images facilitated the understanding of the diseases selected for each seminar (Fig. 3A).

The final block refers to the overall satisfaction of students with the innovative teaching practice. In this block, 53.6% (22 students) rated it as excellent, 43.9% (18 students) as acceptable, and 2.1% (1 student) as fair (Fig. 4A). By sex, a higher percentage of women rated their satisfaction with the practice as excellent (25.4%), with only 2.1% of them considering the practice as fair (Fig. 4B).

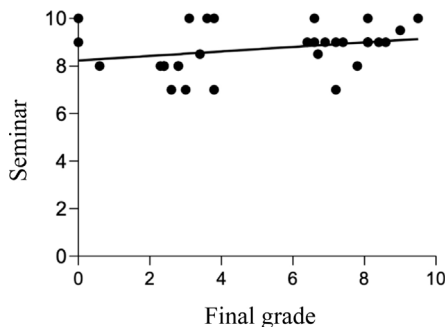
In terms of grades, the average score obtained by the students for the work completed was 8.6 out of 10. Fifty percent of the students received an "outstanding" grade, and 42% were graded as "very good" (Fig. 5A). In the distribution by sex, women achieved higher academic performance based on the grades received, with 26% attaining an "outstanding" grade (Fig. 5B). Additionally, a significance level of  $p < 0.045$  was obtained for the comparison between the final grade awarded to students who partici-



**Figure 4** (A) Overall satisfaction with the innovative teaching practice. (B) Satisfaction with the practice distributed by sex.



**Figure 5** (A) Grades obtained in the seminar presentation. (B) Grades obtained in the seminar presentation, distributed by sex.



**Figure 6** Spearman correlation between the final grade for the module and the seminar grade,  $p < 0.045$ .

ated in the survey and the grade received in the seminar defence (Fig. 6).

## Discussion

The analysis of histological images plays a crucial role in studying pathological alterations associated with human diseases, especially in the context of practical teaching.<sup>8-10</sup> This study aimed to implement an innovative practice based on the study of histopathological preparations during the Cell Biology and Cellular Pathology course of the Biology Degree. This activity allowed for the identification of morphological changes caused by the dysregulation of cellular processes in various diseases. Our results indicate that stu-

dents consider this practice to be very useful for their training.<sup>9</sup>

In the Biology Degree, there is a shortage of practical activities focused on the cellular bases involved in the development of various diseases.<sup>11</sup> Although the course syllabus includes basic competencies to support professional activities related to biomedicine, no practical sessions using human samples have been conducted to identify morphological and structural alterations in tissues and organs. Until now, the practical sessions in this course related to structural alterations have been conducted using mammalian samples as study models, as they were the only ones available. However, through a new collaboration with the Anatomical Pathology department of the University Hospital Reina Sofía in Córdoba, we have gained access to human-origin histological samples. This has allowed us to demonstrate to the students the relevance of studying cellular alterations as the origin of human diseases. Authors such as Fenderson, Atta or Willians argue that the creation of discussion scenarios focused on morphological content, whether disease-based or not, enables greater development of competencies and skills in students pursuing degrees in biosciences. This is especially true when transitioning towards integrated university teaching models.<sup>2,7,11,12</sup>

The development of this practical activity has led to the inclusion of enhanced content in the course, aimed at stimulating active learning among students, which has consequently improved their competencies. Additionally, we have established a bank of images that will be progressively expanded over time. These images could be useful for developing the theoretical component of the course



and will be available to guide students in completing this practical activity in future academic years. In this regard, our innovative practice stands out from those conducted by other groups, especially Anglo-Saxon ones, which have not used human samples or had no pathologist supervising these samples.<sup>12,13</sup>

Given the results obtained from the student survey, we believe that the practical activity has been conducted effectively. We consider that the students have been able to apply the theoretical knowledge received in the course through the use of human histopathological images. These images directly demonstrate the consequences of the dysregulation of important cellular processes. This approach allows competency-based integrated teaching to empower students with decision-making abilities, aligning with the increasingly prevalent concept of self-regulated learning.<sup>14</sup>

One of the most significant aspects of the study is the collaboration between faculty from different degree programmes (Biology and Medicine), which has fostered synergies that have persisted over time. To our knowledge, such collaborative experiences in these disciplines are unprecedented in our country. However, there are groups in the United States that have implemented collaborative learning between biologists and bioinformaticians, leading to enhanced instruction and the earlier integration of big data analysis into the undergraduate biology curriculum.<sup>15</sup> Indeed, the growing use of educational innovation resources is increasingly appreciated by students, as it helps counteract waning interest in traditional teaching methods and enhances learning capabilities. This is particularly true when using techniques based on cellular or tissue imaging.<sup>16,17</sup>

A fundamental limitation of this study is that it is not multicentric, which reduces reproducibility bias and may diminish the statistical power of the study. However, as a pilot innovative teaching experience to be extended to other universities, it may serve as an interesting model for collaboration between different degree programmes. This approach enhances educational cross-disciplinary integration and aligns with the growing trend towards integrated teaching.<sup>16,18</sup>

### Ethical considerations

The Ethics Committee of the University of Córdoba has been informed about the study, without requiring approval from the Research Ethics Committee of the Province of Córdoba. Students voluntarily respond to the survey and give their consent by participating.

### Final thoughts and conclusions

Students have highly valued the interpretation of histological and histopathological images as an innovative approach to explaining the relevance of certain cellular processes in the development of various diseases. The activity has helped to reinforce the practical learning of the subject, as evidenced by the results of the survey and the academic grades achieved by the students. We believe that teaching strategies such as those implemented by our group should be adopted in other similar degree programmes. This requires effective interaction between healthcare

and non-healthcare professionals as a step towards more interdisciplinary university teaching. Additionally, involving various higher education institutions would allow for a multicentric and multidisciplinary evaluation of the impact of such an activity.

### Informed consent

The ethical considerations relevant to this type of study have been addressed. Informed consent was obtained from participants before they completed the survey, with their agreement to participate required. Participants could choose to withdraw before finishing the survey.

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### Conflict of interest

The author declares no conflict of interest.

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