

# Students' Perspectives on Learning Basic Histology

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## Abstract

**Background:** Histology plays a crucial role in shaping future physicians by providing a microscopic perspective on the human body. Despite its significance, both students and educators often perceive histology as a challenging and abstract subject. Limited research exists on students' perspectives regarding the difficulties encountered in this area of health science undergraduate programs.

**Objectives:** Characterize students' perspectives and experiences when learning basic histology as part of the medical program at the Universidad Tecnológica de Pereira, Colombia.

**Methods:** Ninety-five undergraduate medical students participated in a survey to gather their viewpoints on the basic histology curriculum. The responses address key issues from the student perspective, such as specific difficulties in their learning, identification of the most challenging theoretical and practical topics, struggles in image identification, and suggestions for course improvement.

**Results:** Hematopoiesis was identified as the most challenging topic in the curriculum (32.5%). Difficulties in image identification were expressed, citing similarities in histological tissues (25.6%), the aged and damaged condition of microscope slides (21.5%), and confusion in tissue orientation and sectioning (13.9%). Recommendations to improve the course included replacement of laboratory materials/instruments (14.9%), incorporation of prior anatomy knowledge (13.5%), increased hours with student monitors (13%), and integration of more dynamic activities (12.1%).

**Conclusion:** This study provides valuable insights into students' opinions and needs regarding basic histology, prompting a critical evaluation of the curriculum and teaching methodologies. Understanding these perspectives is essential for refining histology education, fostering a more effective, engaging learning environment for future healthcare professionals.

**Keywords:** Histology; Learning; Medical Education; Medical Student; Undergraduate Medical Education

## Background

Histology, a fundamental branch of biology, involves the microscopic examination of the intricate structures comprising cells and tissues within the human body. Its significance extends to medical education, providing students with an in-depth understanding of diverse cell types, tissues, structures and organs. Traditional instructional approaches typically involve theoretical classes, elucidating the morphological and functional organization of cells. Complementary to this, educators utilize light microscopy photographs. Practical training further reinforces comprehension in laboratory settings

where students employ optical microscopes to observe, identify, and interpret theoretical concepts (1).

Globally acknowledged as one of the most challenging courses in the health science curriculum (2), histology often becomes overlooked in the basic sciences as students progress into clinical subjects (3). Insights from educational contexts in Turkey, Canada, Iran, and Saudi Arabia emphasize the significant impact of the learning environment on students' perceptions, influencing their training, attitudes toward the curriculum, and future professional practice (4-9). Notably, obstacles to learning have been recognized as

factors that can negatively influence student motivation and academic achievements (10).

To enhance teaching quality and facilitate knowledge acquisition, it is imperative for educators to identify topics commonly found to be challenging within a subject. Understanding how students perceive the teaching methodologies can provide valuable insights into effective learning approaches (5, 6, 11). Students' perceptions influence both "hard" (academic achievement) and "soft" (satisfaction and development of key skills) learning outcomes, both directly and mediated through their approaches to study (9). As students' approaches to learning and the quality of their learning outcomes are strongly influenced by students' perceptions of the educational environment, it is vital and appropriate to study these perceptions (8). To achieve this goal, Learning Environments Research has established various instruments, such as questionnaires, for curriculum developers and educators to explore the psychosocial environment of the classroom from students' perspectives (6).

Despite over 4,000 medical schools around the world, there are few studies conducted in developing countries that focus on medical sciences pedagogy. To date, limited research has been conducted into students' perceptions of their difficulties in learning histology specifically and, to our knowledge, no such study has been conducted in Colombia, nor the American continent.

### Objectives

This study aimed to characterize the students' perspectives and experiences of learning basic histology under the current curriculum taught in the medical program at the Universidad Tecnológica de Pereira, Colombia.

### Methods

*Design and Setting:* The Histoembriology I course and its curriculum aimed to acquaint students with the fundamentals of medical histology, focusing on basic microscopy, cell, and tissue identification. A first semester course for medical students, the basic histology curriculum spanned a total of 108 hours, comprising 36 hours of theoretical lectures and 72 hours of practical exercises in the laboratory. The theoretical lectures underscored the structural and identification aspects of tissues at the cellular level, incorporating cellular and functional correlations. Each week, students had a total of six hours contact time comprising a two-hour

theoretical lecture and a four-hour practical class in the laboratory, covering basic human histology. The course content covered surface epithelia, exocrine glands, connective tissue, adipose tissue, skin, blood tissue, cartilage tissue, bone tissue, muscular tissue, bone marrow, hematopoiesis, lymphoid tissue, and female and male genitalia.

The study design was a descriptive observational cross-sectional study adapted from a survey conducted by García et al. 2018 which investigated challenges faced by undergraduate biology students in learning basic histology at the University of Alicante, Spain (12). The survey was translated into Spanish, students' native language, and the multiple-choice answer options were adapted for the current basic human histology curriculum of the Universidad Tecnológica de Pereira. The content validity of the instrument was measured based on the feedback of three experts, all experienced histology tutors. The experts' recommendations were incorporated to ensure an accurate Spanish translation, and correct word order for items pertaining to the curriculum. The multiple-choice response options in the third part of the original questionnaire were removed based on their suggestions. Reliability coefficient, Cronbach's alpha, produced an acceptable reliability score for the questionnaire ( $\alpha=0.90$ ).

Ethical clearance for the study was obtained from the Investigation Ethics Committee at the same University, code 129-201123. The participants were fully informed of the study's objective. Participation in the study was entirely voluntary and anonymous. No personal data or data that could characterize the population were collected.

*Participants and sampling:* Participants consisted of undergraduate medical students at the Universidad Tecnológica de Pereira. The inclusion criteria were students who were in the first and second semester in the medicine program and who had completed the Histoembriology I course between June 2022 and November 2023. The exclusion criteria were students who dropped out of the course or those who did not sign an informed consent form to participate in the study.

The sample size was calculated using the formula  $n = N / (1 + N * e^2)$  where:  $n$  = the sample size to be determined;  $N$  = the total population size, and  $e$  = the margin of error. Using the formula with a population of 125 students with a 95% confidence interval and a 5% margin of error, resulted in a sample size of 95 students.

### Tools/Instruments

At the beginning of the survey, participants indicated which histology course cohort they were part of: June to October 2022, November 2022 to May 2023, or July to November 2023. The questionnaire comprised six questions. In the first question, students were asked to select the topics they found most difficult from a list of 15 predefined topics from the basic histology curriculum. Multiple choice question. Question 1: Which of the following curriculum topics did you find most difficult to learn? [Participants may select more than one answer] Answer options: Surface epithelia, exocrine glands, cytoskeleton and extracellular matrix, embryonic connective tissue, adult connective tissue, skin, blood tissue, cartilage tissue, bone tissue, muscular tissue, bone marrow, hematopoiesis, lymphoid tissue, female genitalia, and male genitalia.

The second question sought reasons for difficulties across 15 topics, presenting seven reasons or the option of indicating non-difficulty. Question 2: If you had difficulty learning the following topics, please select a reason by checking the box. If you didn't have any learning difficulties, select the "No difficulty" box. Topics: Surface epithelia, exocrine glands, cytoskeleton and extracellular matrix, embryonic connective tissue, adult connective tissue, skin, blood tissue, cartilage tissue, bone tissue, muscular tissue, bone marrow, hematopoiesis, lymphoid tissue, female genitalia, and male genitalia. Answer options: complex topic, many specific terms, requires a lot of memory, little time to learn, insufficient practice, abstract topic, I didn't go to class/I didn't pay attention, and no difficulty.

The third question involved selecting the five most challenging theoretical histological topics from a list of 24. Multiple choice question. Question 3: Select according to your criteria which were the 5 most difficult theoretical topics of the course. [Participants select five topics] Answer options: Epithelium and its morphological classification, apical specializations of the cell surface, cell junctions, cytoskeleton and extracellular matrix, basement membrane, exocrine glands and their classification, embryonic connective tissues, connective tissue cells, classification of connective tissue, epidermis, dermis, blood cells, cartilage tissue cells, isogenic group and cartilage matrix, chondrogenesis, bone tissue cells, osteogenesis, muscle tissue, erythropoiesis, granulopoiesis, lymphopoiesis, lymphoid organs, ovarian cycle/fallopian tube/uterus, and testicular cells/sperm ducts.

Question four explored reasons for challenges in image identification, offering eight predefined reasons and a blank space for additional responses. Multiple choice question. Question 4: Why is it difficult to identify an image under a microscope? Answer options: Lack of anatomical knowledge, difficulty defining cell boundary, tissue orientation or sectioning, histological staining (coloring), difficulty using the microscope, old/scratched/broken slides, microscope with poor light or low resolution, and similarity between tissues.

In the fifth question, students were required to identify the five most challenging practical histological topics from a list of 20. Multiple choice question. Question 5: Select according to your criteria which were the five most difficult practical topics of the course. [Participants select five topics] Answer options: Epithelium and its morphological classification, apical specializations of the cell surface, exocrine glands and their classification, embryonic connective tissues, connective tissue cells, classification of connective tissue, epidermis, dermis, blood cells, cartilage tissue cells, isogenic group and cartilage matrix, chondrogenesis, bone tissue cells, osteogenesis, muscle tissue, erythropoiesis, granulopoiesis, lymphoid organs, ovarian cycle/fallopian tube/uterus, and testicular cells/sperm ducts.

The final question invited students to suggest improvements to the histology course through a blank space or by choosing from 13 possible options. Multiple choice question. Question 6: Which of the following options would you consider could improve the learning of histology? Answer options: Carry out dynamic activities related to the topics, change the grading methodology, more student/teacher interaction, eliminate subject content, more time to study between exams, improve the teaching style of teachers, increase the course theoretical time, increase the course practical time, greater number of monitors with the monitor in charge, greater number of teachers consultations, replace the material and instruments that the laboratory has, improve the laboratory facilities, and have previous knowledge of anatomy.

*Data collection methods:* Employing a combination of quantitative and qualitative questions, the study aimed to ascertain students' perspectives on the difficulties encountered when learning basic histology. Questionnaires were distributed via email during the final practical laboratory session and completed using

Google Forms (Google, California, USA). All responses were anonymous, and informed consent was secured.

**Data analysis:** The data obtained were analyzed using descriptive statistics and analyzed using Microsoft Excel® (2205 edition). For questions one, three, five and six, percentages were obtained. For the second question the mode was acquired. Results were expressed in percentages. Open-ended questions one, four and six were categorized and analyzed thematically.

## Results

### Question one: Students' perspectives on the most difficult topics to learn on the basic histology curriculum.

Hematopoiesis emerged as the most challenging topic in the curriculum, selected by 80% of the students surveyed (76 out of 95 students). Exocrine glands followed with 34 answers, blood tissue and female genitalia were both selected by 20 students, and embryonic connective tissue with 19 responses (Figure 1 for full results). In response to this multiple-choice question, no student cited adult connective tissue and skin as difficult topics on the curriculum. Most students selected two or three topics for this question.

### Question two: Students' reasons for difficulties in learning the basic histology curriculum.

Of the students who responded that they had found one or more topics difficult, 40% cited hematopoiesis as the most complex subject. For other topics, the predominant response was that they weren't inherently difficult to understand. However, the breakdown of responses to the second question revealed that glandular epithelia was considered complex by 13.68%, blood tissue was seen as abstract by 12.63%, female genitalia was considered complex by 9.47%, and embryonic connective tissue was viewed as complex with lots of specific terms by 11.57% (Table 1 for full results).

### Question three and five: Students' perspectives on the theoretical and practical topics they considered the most difficult to learn.

According to the students surveyed, the most challenging theoretical and practical topics in the basic histology curriculum were associated with hematopoiesis, while the easiest were associated with skin, and cartilage cells (Table 2 for details).

### Question four: Students' perspectives on the reasons why image identification was difficult

Concerning image identification using a microscope, 57 students cited difficulties due to

histological tissues appearing very similar, 48 students cited microscope slides being old and damaged, and 31 students cited confusion arising from tissue orientation and section. In the open-ended response section, three students mentioned that structures, tissues, and cells were perceived as abstract, and one student stated the challenge of integrating all the topics by the end of the course (Figure 2 for details).

### Question six: Students' suggestions for improving basic histology learning

Thirty-two students recommended replacing materials and/or instruments in the laboratory, while 29 proposed having prior knowledge of anatomy, 28 students desired more hours with student monitors, and 26 subjects advocated for more dynamic activities related to the topics. The sole suggestion given by one student in the blank space was for more autonomous time in the laboratory to study practical subjects (Figure 3 for details).

## Discussion

### Globally shared challenges

Worldwide, histology experts have defined the essential topics necessary for a foundational understanding of this field of knowledge. In Cui & Moxham's study (2021) on the most difficult topics in a basic histology medical curriculum, they consulted an expert teaching panel to share their recommendations on which topics should comprise the core curriculum. The expert panel suggested the following core topics related to hematopoiesis: hematopoietic stem cells, bone marrow, megakaryocytes, progenitor cells and precursor cells such as proerythroblasts, reticulocytes, megakaryoblasts, myeloblasts, myelocytes (neutrophilic, eosinophilic and basophilic), stab (band) cells (neutrophilic, eosinophilic, & basophilic).

Core topics in reference to glands were: exocrine versus endocrine glands, unicellular and multicellular glands, cell types, intralobular ducts versus interlobular ducts, and exocrine glands classified by product, by mechanisms and by morphology. For blood tissue, the panel suggested that the core subjects were: blood composition, blood plasma, the percentage of each element on the tissue, complete blood count values and blood cell count, blood smear and stain, duration in circulation, life span of blood cells, and structure and function of blood cells such as erythrocytes, platelets/thrombocytes, lymphocytes, monocytes, neutrophils, eosinophils and basophils. Finally, concerning embryonic connective tissue (mesenchyme and mucous connective tissue) experts recommended that it be taught,

but not as part of the core of the curriculum (13). These recommended core topics are all included in the Colombian medical students' basic histology curriculum at the Universidad Tecnológica de Pereira.

Similar results from our questionnaire can be observed in the 2019 study by García et al. in Spain. When students were asked about the most difficult subject on the histology curriculum, glands emerged as the hardest topic, named by 38.36% of respondents (12), a far higher number than in our results of 14.5%. The Spanish animal histology curriculum for biology students consisted of: surface epithelia, glandular epithelia, connective tissue, adipose tissue, bone tissue, muscular tissue, and nervous tissue (12). The Spanish curriculum inclusion of animal histology is very similar to the Colombian curriculum and may explain why results between the Colombian students and the Spanish students were similar regarding glands.

With regard to the reasons for difficulty in learning the basic histology curriculum, Eng-Tat et al. (2023) suggest that their Singaporean students face difficulties because of the nature and the nomenclatures of histology, and its main complaints were about insufficient learning time and the lack of clinical context (14). Tauber et al. in 2021, reported that the most common problems cited by their Czech students included limited study time for histology due to other time-demanding subjects such as anatomy, and problems with the correct recognition of structures (15). When García et al. in 2019 asked their Spanish students about the reasons why the topic identified – glands - was difficult, the most common responses were: I do not study the subject regularly (13.86%); It is very abstract (12.87%); and, there are not enough practical cases (11.88%) (12). Colombian students' perceptions on the reasons for difficulty were primarily that the topics were complex, required a lot of memory, and used many specific terms. These answers matched more closely those of Singaporean medical students which may be due to their curricular similarities.

The difficulties in image identification reported by our students are in line with global trends. Similar challenges, such as difficulty in focusing and identifying histological slides, were reported by medical students in India (16) and the Czech Republic (15). However, there are some notable differences between our results and those of García et al. (2019) in Spain. The difficulties with image identification reported by Spanish biology students were due to a lack of anatomical knowledge

(77.23%) in contrast with our study of just 9.21%; difficulties in cell delimitation (72.28%) compared to our result of just 8.33%; a lack of histological section orientation (61.39%), again significantly higher than our results of 13.9%, challenges with staining techniques (30.69%) in contrast with our study's 8.33%, and difficulties in using a microscope at just 2.97% (12), a similar result to that of our study (2.19%). The significant contrasts above could suggest that the objectives of the Spanish and Colombian curricula are different while the basic histology curricula for medical students in India and Czech Republic are more similar to Colombia's, given the greater consistency in results between the studies.

With respect to the practical topics that students reported the greatest difficulty in learning, Teshome's survey of 184 medical students in Ethiopia in 2022 found that 65.76% reported finding practical histology more difficult than theory. More than one-third of the Ethiopian medical students recommended that practical histology needed more lab sessions and these same students felt that they needed to put more effort into the subject (39.13%) (17). At the Universidad Tecnológica de Pereira, the recommendation is that the number of practical hours included in the basic histology curriculum be double that of theoretical/lecture hours. Examining our results against those of García et al. (2019), we find that the hardest practical and specific topics were: isogenic groups at 27.72% for the Spanish students versus our study result of just 2.46%; direct and indirect bone formation for 24.75% of Spanish respondents against just 3.45% of respondents in our study, and chondrogenesis for 24.75% of Spanish students in contrast with our study results of just 1.48% (12). These significant differences may be due to the different objectives of the course compared to our academic program or a result of different teaching methods employed by Colombian teachers.

In studies where students were asked for suggestions to improve the teaching of basic histology, Rituparna & Tapati in 2023 report that 16.5% of their Indian students suggested offering students doubt-clearing or Q&A sessions, and 2.35% suggested a greater emphasis on applied histology (16). Eng-Tat et al. in 2023 reported that 89% of their Singaporean student respondents strongly agreed that collaborative teaching with a pathologist was effective in their learning of histology (14). Taş in 2022 asked his Turkish students' opinions on using innovative approaches such as technology-

adapted auxiliary course tools (education sets, mobile applications, and smart and digital devices) in histology education and 81% had positive opinions about such approaches, 7.5% were negative, and 11.5% reported that they were undecided. Curiously, these same students were asked about the necessity and utility of the histology course for clinical applications and, despite not yet having begun their clinical practice as first year students, 42% considered the course very necessary (18). In a survey of Chinese medical students by Ruan et al (2022), students suggested a prerequisite or foundational course in histology before taking the regular program would improve their learning and understanding of the basic histology course (19). Gribbin et al. in 2022 disclosed that their American students considered that staying up-to-date with histology lectures and laboratory work were both important for achieving a high level of competency in this discipline (20). In this same matter, Tauber et al. in 2021, in their survey of Czech medical students, found that students reported that using virtual microscopy alone or in combination with traditional glass slides was the most effective means of learning histology. When these students were asked what would help to facilitate the study of histology, the responses were: recommend just one main study source; introduce practical tests to self-evaluate their knowledge, and open the possibility of viewing more similar specimens from the same area (15). These student perceptions, and the similarities in the teaching methodologies they suggest, reinforce the importance of offering a histology course to undergraduate medical students.

Finally, Cui & Moxham in 2021 cited statistics from The International Federation of Associations of Anatomists showing that students on medical education programs in the United States received 22 hours  $\pm$  17SD hours devoted to laboratory practices in histology (13). Taş in 2022, within the scope of his study, asked Turkish medical students whether they considered the intensity of the theoretical histology course to be adequate at two hours per week. The length of the course – one semester – was found to be sufficient by 57.5% of students and insufficient by 24.1%. Additionally, the students were asked for their opinion on the necessity of practical histology courses. Practical histology education was considered necessary by almost three-quarters of respondents (73%), and unnecessary by almost a fifth (19.5%) (18). These students complete just half the

number of practical hours that Colombian students receive.

**Suggestions for pedagogical intervention:** The limitations of the present study include the use of data from only one institution and a single undergraduate program. Another limitation is that it provides a one-sided perspective from students only, without any reflection or feedback from teachers. A further limitation is that the survey did not include data to characterize the surveyed population such as gender, academic term, or prior academic performance which reduces the analytical depth of the study. Recommendations for future research include incorporating teachers' opinions alongside those of students. Additionally, the absence of nervous tissue as a topic in our basic histology course, acknowledged as a curriculum limitation, prompts future investigations into its impact on students' comprehensive histological understanding. Finally, further research could explore the consequences of such omissions on students' competence in an advanced histology course and their ability to integrate knowledge across disciplines.

## Conclusion

The results of the present study characterize the perceptions of medical students regarding the curriculum of basic histology. This course is considered by undergraduate students to contain complex and abstract topics with a lot of specialist terms. Furthermore, students often have difficulty connecting the histology theoretical foundation with the laboratory practice, and they also acknowledge that similarities between different tissue types make some topics difficult to understand. Students made it clear that prior anatomical knowledge is important to deepen understanding on the course and that increasing the number of hours of practical sessions in the lab with better materials or instruments would significantly improve their learning.

Regarding the current basic histology curriculum, hematopoiesis and exocrine glands were highlighted as the topics students reported most difficulty in learning. This provides useful feedback and invites teachers to reconsider how these specific topics are taught within the course, the depth of their teaching, and the didactics of lectures and laboratory sessions. On the other hand, students perceived cartilage, muscle, and skin as easy to learn topics. These findings will be used to inform a targeted revision of the histology curriculum at our institution, focusing on the most challenging topics as

identified by students so that more time can be allocated to those lectures during the course and more engaging teaching methods can be proposed.

Research in this field is lacking and students' opinions may be a useful point of departure to design more robust and detailed surveys that could lead to improved methods of evaluation for basic histology curricula. Surveying student perceptions enables teachers to evaluate the effectiveness of their teaching methods, as well as prompting students to reflect on their own learning process. To improve and facilitate student learning, more active learning strategies should be placed in the curriculum. Finally, as teachers, students should be motivated to consider the basic histology course and its curriculum as a science for the acquisition of skills for their future as physicians.

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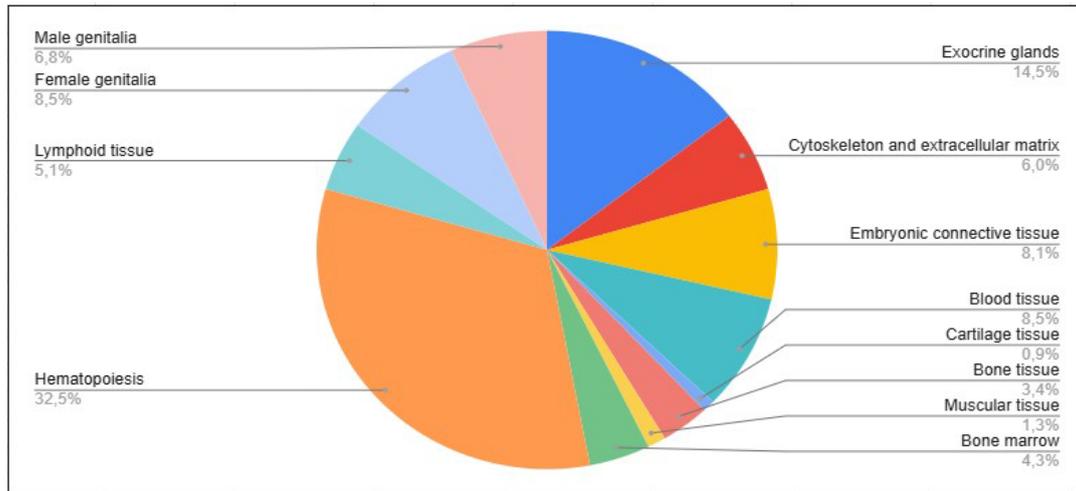


Figure 1. Students' perspective on the most difficult topics to learn on the basic histology curriculum

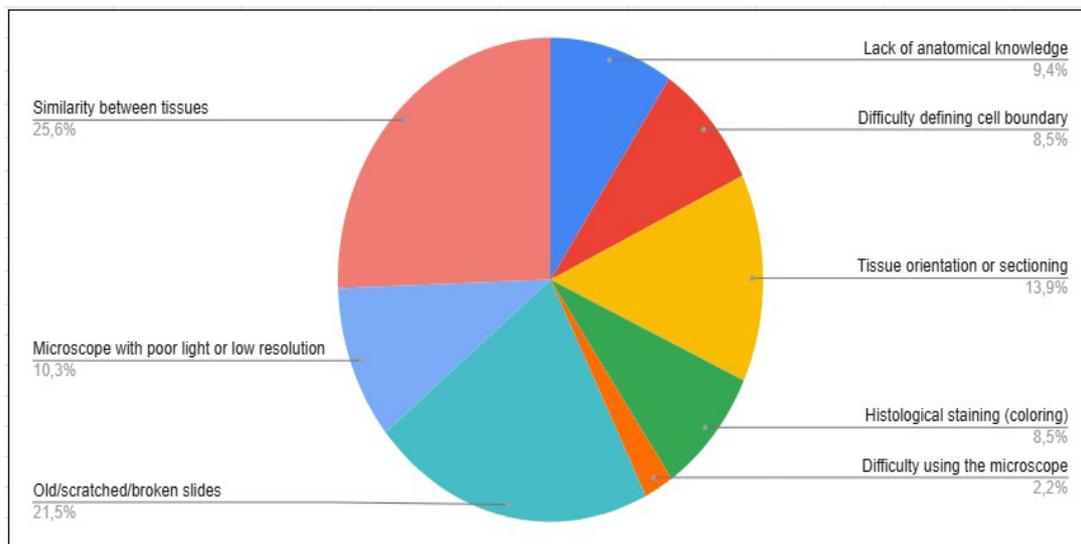


Figure 2. Students' perspectives on the reasons why image identification was difficult

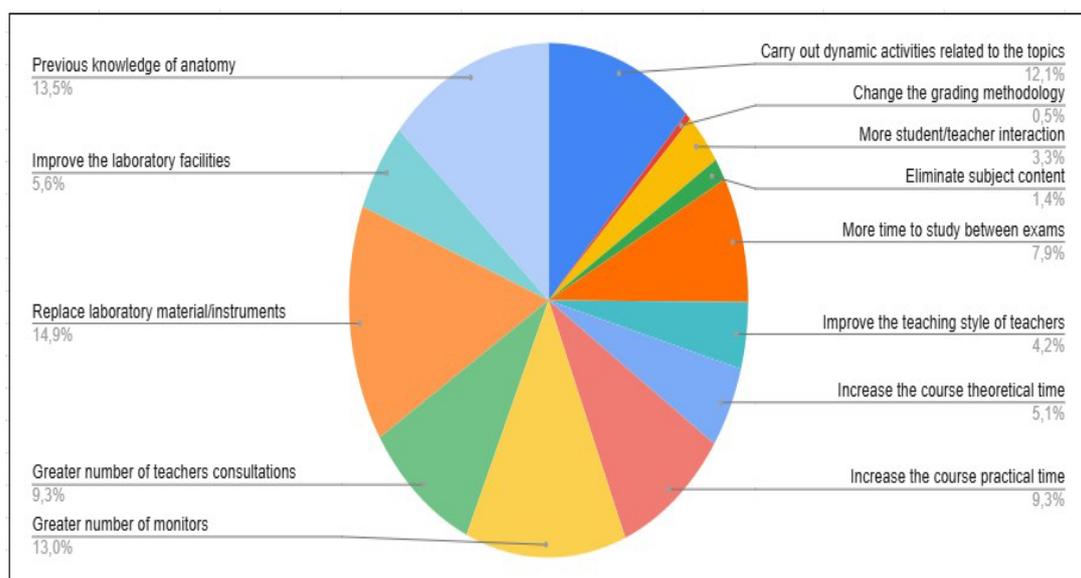


Figure 3. Students' suggestions for improving basic histology learning

**Table 1.** Students' reasons for difficulties in learning histology topics

Topics	Number of respondents (n=95)							
	Complex topic	Many specific terms	Requires a lot of memory	Little time to learn	Insufficient practice	Abstract topic	I didn't go to class/ I didn't pay attention	No difficulty
Surface epithelia	2	2	3	5	0	5	1	77
Exocrine glands	13	3	8	6	3	11	2	49
Embryonic connective tissues	11	11	10	4	1	5	2	51
Adult connective tissue	2	4	8	2	1	1	1	76
Cytoskeleton and extracellular matrix	4	11	6	3	1	4	2	64
Skin	1	3	5	1	0	3	2	80
Blood tissue	9	9	10	3	2	12	0	50
Cartilage tissue	1	3	6	3	0	3	1	78
Bone tissue	5	6	5	5	0	4	1	69
Muscle tissue	2	3	8	0	0	3	3	76
Bone marrow	14	5	5	4	1	7	1	58
Hematopoiesis	38	12	21	3	3	8	1	9
Lymphoid tissue	4	11	8	3	6	5	5	53
Female genitalia	9	8	8	4	0	2	2	62
Male genitalia	10	7	9	1	1	2	4	61

**Table 2.** Comparison of the mean knowledge and skill scores of the students under study in the two control and intervention groups

Topics	Theoretical topics		Practical topics	
	Percentage of respondents (%)	Number of respondents (n=95)	Percentage of respondents (%)	Number of respondents (n=95)
Epithelium and its morphological classification	7.4	7	9.5	9
Apical specializations of the cell surface	4.2	4	7.4	7
Cell junctions	18.9	18	-	-
Cytoskeleton and extracellular matrix	18.9	18	-	-
Basement membrane	1.1	1	-	-
Exocrine glands and their classification	24.2	23	38.9	37
Embryonic connective tissues	45.3	43	20	19
Connective tissue cells	0	0	7.4	7
Classification of adult connective tissue	3.2	3	11.4	11
Epidermis	0	0	3.2	3
Dermis	0	0	1.1	1
Blood cells	29.5	28	48.4	46
Cartilage tissue cells	0	0	2.1	2
Isogenic group and cartilage matrix	11.6	11	10.5	10
Chondrogenesis	6.3	6	6.3	6
Bone tissue cells	6.3	6	6.3	6
Osteogenesis	8.4	8	14.7	14
Muscle tissue	6.3	6	6.3	6
Erythropoiesis	62.1	59	85.3	81
Granulopoiesis	56.8	54	75.8	72
Lymphopoiesis	54.7	52	-	-
Lymphoid organs	14.7	14	24.2	23
Ovarian cycle/fallopian tube/uterus	46.3	44	29.5	28
Testicular cells/sperm ducts	24.2	23	17.9	17