Integrative seminars: toward teaching and research within the Discipline of Histology

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Microscopy courses are usually based on traditional lectures that intend to exhibit well-established information, presenting many challenges to incorporate research in teaching. The integration between teaching and research stimulate the formation of critical thinking – a cornerstone in science.

The disciplines of histology typically do not stimulate the students to achieve a reasonable knowledge of how interpret images obtained in scientific research. Hence, teachers and researchers face a challenge to clarify the results obtained from the observation of the images. The study of microscopic images brings to the researchers one of their most important tasks in the area of microscopy – teach the students how to deal with unfamiliar and ambiguous images.

The analysis of vascular corrosion replicas by scanning electron microscopy (SEM) is able to exhibit the process of development and degeneration of blood vessels in tumor. The blood vessels are of great importance to tumors keep growing and spreading, becoming a target to anticancer therapies. Morphological analysis of these vessels allows the understanding of microcirculation in tumors. Moreover, these newly formed vessels exhibit similarities in their angioarchitecture among different type of tumors.

The discipline of histology of our University included in its schedule integrative seminars with undergraduate students, postgraduate students and teachers to discuss the interpretation of SEM images. The participants of the seminars were encouraged to analyzed SEM images of corrosion casts of the oral squamous cell carcinoma through active learning methodology. Discussions were based on real questions raised during the development of scientific research in our laboratories.

The method proposed here has been established as routine in our Discipline in order to prepare undergraduate students to do research instead of just understand science. We believe the development of a scientist is a continuous process that begins in undergraduate student and extends throughout the researcher and teaching career.

Keywords: teaching; research; scanning electron microscopy

1. Introduction

Histology courses are usually based on traditional lectures that intend to exhibit well-established information, presenting many challenges to incorporate research in teaching. The integration of research into teaching stimulate the formation of critical thinking – the cornerstone in science [1]. The interpretation of scanning electron microscopy (SEM) images brings for the researcher one of its most important tasks in microscopy: teach their students how to manage unfamiliar and ambiguous results.

Researchers have the responsibility to prepare undergraduate and postgraduate students to do research, rather than just understand science. The development of a scientist is a continuous process that begins during graduation and extends throughout the researcher and teaching career.

Research and teaching can increment each other if new ways of managing this association are considered. Recognition of the conflicts between balancing the time spent on teaching and research can lead to more realistic expectations of staff performance.

The teachers and researches of the discipline of histology from the Federal University of Pelotas (UFPel) created integrative seminars, in order to overcome the barriers of integrating research into teaching. The link between research and teaching has encouraged students to interpret histological images, boosting undergraduate students how to learn and think independently. The lack of computerized tools to perform descriptive analysis of images favors the development of a critical thinking in students.

One line of research developed in our discipline is tumor angiogenesis, in which we have studied the angioarchitecture of newly formed vascular network through vascular replicas by SEM. The study of tumor blood vessels is of great importance to cancer growth and spread, as well as its diagnosis and therapy [2]. The morphological description of the tumor vessels allows the understanding of the tumor's microcirculation, considering that these vascular networks have peculiarities such as increased tortuosity, lack of parallelism, and irregular caliber [3].

In this article, we demonstrate the importance of the active learning method to interpret SEM images by integrative seminars, as well as discuss the interaction of research into teaching.

2. Methodology

Initially, by bringing our research experiences and result into the classroom, a high level of interaction between students and teachers was prompted. The students had indicated in their feedback that this interaction was very accepted and appreciated. Therefore, It was designed a model of elective integrative seminars. A team was composed of undergraduate and postgraduate students in different field of biological sciences, supervised by teachers and researches of our discipline of histology. The members of these seminars participated for a period up to 24 months in a scientific study that was being developed in our labs.

To study the vascularization of tumors we have used a model of chemically induced oral carcinogenesis in Syrian golden hamsters (*Mesocricetus auratus*) [4]. The mucosa of the buccal pouches is similar to human mucosa, being considered as a suitable site to produce squamous cell carcinoma [5].

Briefly, 24 Syrian hamsters were divided into three groups of eight animals each and had submitted their buccal pouches right to tumor induction with dimethylbenzanthracene and carbamide peroxide for 55 days. Following, the animals were maintained without treatment (group I) or receiving sunitinib malate (group II), or cyclophosphamide (group III) for a period of 4 weeks. After the treatment, six animals of each group had casted their vascular networks by Mercox\ resin and qualitatively analyzed by SEM. The remaining two animals of each group had their buccal pouches prepared for qualitative analysis by light microscopy.

Integrative seminars were planned weekly to facilitate the communication among the members of the research team. Students were expected to organize and give a seminar on topic of tumor angiogenesis either proposed by the student or pre-assigned, having the opportunity to present their results, as well as their questions. Seminars were participative and discussion-based, and involve a number of strategic guests. After each seminar, the teachers provided additional materials or search tools to solve the issues raised by the students. The computer-mediated communication facilitated this infrastructure, optimizing the programmatic efficiency and sustaining interdisciplinary research.

3. Results and Discussion

The study of vascular morphology improves the understanding of structures and functions of blood vessels formed during tumor growth [6]. The identification of angiogenesis figures – images of tumor vasculature, may contribute to evaluate the effect of antiangiogenic treatments [7].

The process of how to interpret photomicrographs may be very challenging for teachers, researchers and students due to the wide variety of these figures. Thereby, there is a real need to develop skills in students to enable them to recognize and identify specific features of each type of vascular alteration.

Integrative seminars have been considered a viable and consistent tool to maintain research programs within the discipline of histology in our University. This model has the purpose to align goals of different participants and at the same time ensures a suitable productivity in research labs, because some of the discussions can be directly integrated into our research.

During the analysis of vascular casts of oral squamous cell carcinoma, students observe images of vascular figures repeated among samples. It has been known that these figures are closely related to specific characteristics in each different type of cancer.

Globular outgrowths were seen on the surface of many vessels (Figure 1). These formations indicated early stages of sprouting angiogenesis, representing proliferation of endothelial cell for subsequent development of a functional vessel [8].

Fig, 1 Globular outgrowths identified in the wall of capillaries. The arrows point to the outgrowths and the arrowheads show the sites of possible junctions. SEM - 50μm.

Blind ending vessels were also frequently observed (figure 2). These vessels were oriented radially to the avascular areas of the tumor. However, it was possible to distinguish two types of blind ending vessels: (a) vessels with tapering tips, flat and sharp-pointed with nuclear imprints, and (b) vessels with rounded tips or sharp cut surface. The first ones were considered as newly formed vessels by sprouting angiogenesis. The latter represented incompletely injected or fractured vessels respectively [9, 10].

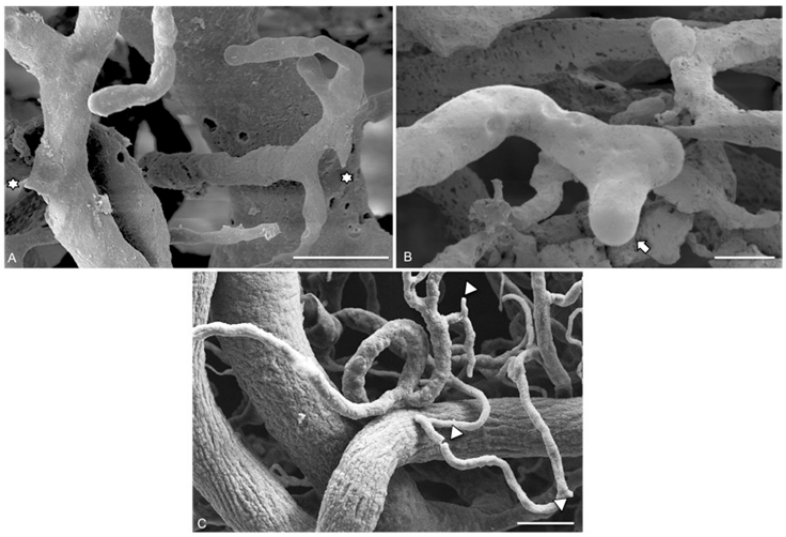

Fig. 2 Vessels with different types of blind endings. In (A), observe vessels with tapering tips (asterisks) representing vascular growth by sprouting. In (B), the arrow marks a rounded termination, suggesting an incompletely injected vessel. In (C), note vessels with sharp endings (arrowheads), suggesting fractured vessels. Scale bar: 20μm – SEM

In addition, it was possible to identify vascular channels (Figure 3), presenting an irregular surface. The rough surfaces of these vascular formations were their main characteristic, denoting tumor cells in direct contact with the resin at the time of injection. This finding showed that the oral squamous cell carcinoma has blood vessels with fragmented endothelium, allowing a direct contact of intravascular fluid with tumor interstitium [11].

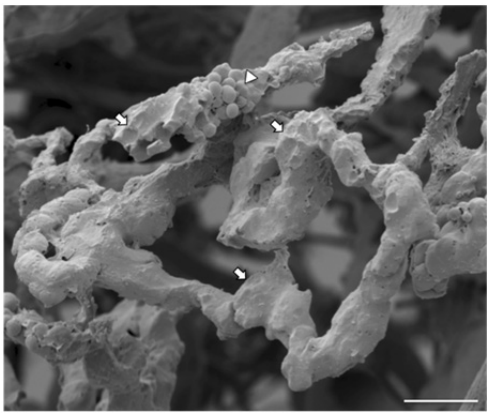

Fig. 3 Vascular channels. Note the presence of irregular cell imprints (arrows), probably caused by tumor cells that composed these vessel walls. Scale bar: 25μm – SEM

Rounded structures without nuclear imprints were indicative of resin leakage (Figure 4). It is known that tumor vessels have large fenestrae among endothelial cells, generating the development of such vascular figures [12].

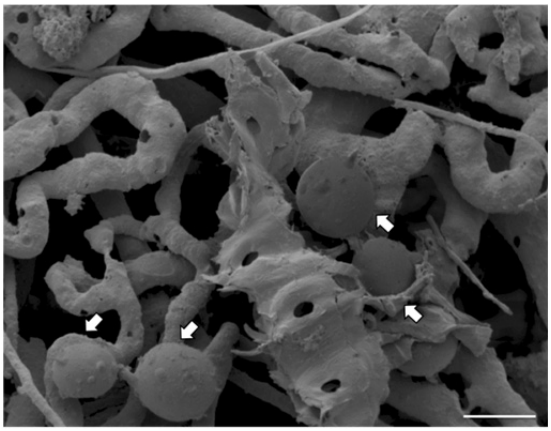

Fig. 4 Resin leakage (arrows). Scale bar: 25μm – SEM

In addition to courses that teach the steps of an investigation, our method is based on an active learning model, stimulating students to work in a close contact with experienced researchers.

Integration of students and teachers comprises a number of requirements to result in successful researches. Firstly, students may have to collaborate to write their projects. This ensures their participation in all facets of a project, providing a sense of "proprietorship", as well as providing exposure to a high level of scientific thinking. During this process, students receive technical training and access to the university facilities. Secondly, active learning allows students the opportunity to explore their talent and creativity to find solutions to their own questions, having some control over the direction of their activities. In addition, mentors need to spend significant time providing not only scientific knowledge, but also emotional and social support.

Undergraduate students must learn how to work and think independently, and choose a career before graduation. On the other hand, these students also need to research in a reasonable amount of time and publish in scientific journals, aiming to be prepared for their future careers.

This paper described the development and implementation of a method of active learning through integrative seminars in the discipline of histology from UFPel. This methodology has radically increased the number of opportunities in the field of scientific research for undergraduate students, keeping aligned with the objectives at multiple levels of an institution that has the education and research as its basis.

4. References

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