Histological processing and evaluation of soft tissues and mineralized samples

Brief description

Histological techniques allow the study of the organization, composition, and functional state of tissues through procedures such as fixation, sectioning, staining, and microscopic examination. These methodologies are essential in biomedical research, pathology, tissue engineering, and biomaterial evaluation, as they enable the identification of structural alterations, tissue regeneration, and material integration.

The laboratory employs two complementary approaches. On the one hand, paraffin processing is used for soft tissues and previously decalcified samples, allowing the preparation of thin sections and the application of a wide range of stains. On the other hand, mineralized samples and dental materials are processed without decalcification to study hard tissues and a wide variety of biomaterials, from ceramics and metals to resins and regenerative materials. This enables analyses ranging from conventional histology to the evaluation of the tissue–material interface, relevant in regenerative medicine, dentistry, and implant development.

These methodologies are part of the biomedical and biotechnological industry, with applications in basic and translational research, biomaterial validation, and support for experimental studies.

Figure 1. *EXAKT equipment used for the processing of mineralized samples and dental materials.*

How does it work?

The procedure begins with the reception, registration, and fixation of the samples to ensure their proper preservation. In the paraffin workflow, tissues undergo dehydration, clearing, paraffin embedding, and thin sectioning using a microtome, followed by staining with routine techniques (such as hematoxylin-eosin) or special stains adapted to the study's requirements. This process produces high-quality histological slides suitable for a wide range of morphological and experimental applications.

For mineralized samples or those containing dental materials, the procedure is different: after fixation, the samples are embedded in hard synthetic resins that preserve the integrity of both the tissue and the materials present. Once polymerized, precise sectioning and progressive polishing are performed to obtain thin, uniform sections suitable for microscopic examination. This methodology enables the analysis of hard structures, tissue–material interfaces, integration, osteoconduction, and inflammatory responses, while preserving the original architecture of the sample.

Finally, both approaches can be complemented with specific stains that highlight cells, fibers, extracellular matrix, or particular deposits, facilitating detailed analysis under the microscope.

What problem does it solve?

- Allows detailed study of tissue morphology, essential for characterizing biological processes, pathologies, regeneration, or structural alterations.
- Facilitates the analysis of samples that cannot be decalcified, including biomaterials, prostheses, implants, and cements, while preserving their interface with the tissue.
- Provides reproducible and standardized techniques that enable comparison of results across experimental studies and validation of new therapies or materials.
- Minimizes loss of structural information by using specific methodologies for materials of different hardness.

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What future products will it develop?

The research will enable the development of new methods to study dental and biomedical tissues and materials, as well as tools to analyze novel materials used in tissue regeneration. Preparation and staining techniques for hybrid materials will also be developed, and objective criteria will be established to assess their integration and performance in tissues. These advances will facilitate the design of safer and more effective materials for clinical and experimental applications.

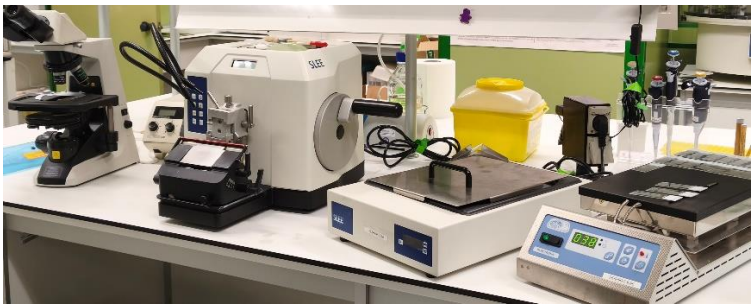

Figure 2. *Paraffin processing line, including a tissue processor, microtome, flotation bath, heating plate, and microscope, used for the processing and analysis of soft tissues and decalcified samples.*

Competitive advantages compared to other research

The laboratory incorporates conventional histological techniques alongside advanced methods for high-hardness samples, offering a highly specialized service that is uncommon. These methodologies make it possible to work with tissues and materials that cannot be processed using paraffin techniques, avoiding decalcification and preserving the original structure.

In addition, the combined use of multiple stains and preparation methods provides greater precision and analytical capacity, especially in complex studies involving biomaterials or tissue–material interfaces. The applied techniques have proven to yield high-quality, reproducible sections suitable for advanced research, improving the interpretation of structural and functional data.

Where has it been developed?

These techniques are carried out in the Histology Laboratory of ETEP group (Etiology and Therapeutics of Periodontal and Peri-implant Diseases), where qualified personnel perform the processing and analysis of soft tissues, mineralized samples, and materials used in dentistry.

The laboratory provides specialized guidance, methodological support, development and optimization of protocols tailored to each project, and participation in research studies, continuously developing and refining new histological preparation techniques.

And furthermore…

This technology enables:

- Integrating advanced histological analysis into research involving dental or biomedical tissues and materials.
- Supporting researchers and clinicians by providing detailed structural information that complements functional, microbiological, or mechanical studies.
- Evaluating and comparing biomaterials under development for their optimization and validation in preclinical research.

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