Preservation and Storage of Tissue Samples

Once a tissue sample is collected, it needs to be preserved to maintain its structural and molecular integrity. Proper preservation is essential for accurate analysis.

A. Fixation

Fixation involves treating tissue with chemicals that prevent degradation and preserve the natural structure. Some common fixatives are:

- **Formaldehyde**: The most used fixative, particularly for histopathological examination. It cross-links proteins to preserve cell structure.
- **Alcohol (Ethanol)**: Used for preserving cellular content, often for DNA or RNA analysis.
- **Glutaraldehyde**: A stronger fixative used for electron microscopy.

B. Embedding

Embedding involves placing the fixed tissue into a medium (usually paraffin wax or resin) to provide support during sectioning.

- **Paraffin Embedding**: Most common for histological analysis, where the tissue is dehydrated and embedded in wax.
- **Cryopreservation**: For certain types of tissue (especially sensitive ones), freezing with cryoprotectants may be used. This is particularly useful in molecular biology, where DNA/RNA integrity must be preserved.

C. Storage

- **Frozen Storage**: For tissues that require long-term storage (such as in biobanks), freezing in liquid nitrogen or -80°C freezers is standard.
- **Formalin Storage**: For histological samples, formalin-fixed tissues are often stored in formalin containers for later analysis.

Staining and Histological Analysis

Staining is a crucial step in the analysis of human tissue samples, especially under a microscope. The stains enhance the visibility of specific structures and make it easier to identify disease, abnormalities, or cell types.

A. Common Stains

1. **Hematoxylin and Eosin (H&E)**:
    - Hematoxylin stains cell nuclei blue, while eosin stains cytoplasm and extracellular matrix pink. This combination is the most common and provides general tissue architecture.
2. **Immunohistochemistry (IHC)**:
    - Uses antibodies to target specific proteins within tissues, providing insight into molecular pathology (e.g., cancer cell markers).
3. **Special Stains**:
    - **PAS (Periodic Acid-Schiff)**: Stains polysaccharides and mucosubstances, often used in detecting fungal infections.
    - **Trichrome**: Stains collagen and muscle tissue, useful in fibrosis and other connective tissue disorders.

B. Microscopy Techniques

- **Light Microscopy**: For general histological analysis using H&E or special stains.
- **Electron Microscopy**: Used for detailed cellular and sub-cellular examination, especially when studying tissues at the molecular level.

V. Applications of Human Tissue Samples in Biomedical Engineering

1. **Medical Device Testing**: Human tissue samples are often used to test the safety and effectiveness of medical devices such as implants, prosthetics, and surgical tools.
2. **Tissue Engineering and Regenerative Medicine**: Samples can be used to create tissue models, understand disease mechanisms, and develop therapies like stem cell treatments or organ regeneration.
3. **Cancer Research**: Human tissue biopsies (e.g., tumor biopsies) are crucial for studying cancer pathology, drug response, and personalized medicine.
4. **Diagnostics**: Human tissue analysis through biopsy samples or blood tests is essential for diagnosing a wide range of diseases, from infections to autoimmune disorders and cancers.
5. **Pharmacological Testing**: Drugs and therapeutic interventions can be tested on human tissues to predict efficacy and safety before clinical trials.