
Postgraduate Certificate in Biofabrication Fabrication

Introduction to Biofabrication

Biofabrication is a multidisciplinary field that combines tissue engineering and additive manufacturing to produce functional biological structures. In this explanation, we will cover key terms and vocabulary related to the Introduction to Biofabrication course in the Postgraduate Certificate in Biofabrication.

Additive manufacturing: also known as 3D printing, is a process of creating a three-dimensional object by adding material layer-by-layer based on a digital model.

Bio-inks: materials used in biofabrication that contain living cells, biomaterials, and/or bioactive molecules.

Biomanufacturing: the production of biological products on a large scale, including vaccines, therapeutics, and cell-based therapies.

Biomaterials: materials that interact with biological systems, including natural and synthetic polymers, ceramics, and metals.

Cell behavior: how cells respond to their environment, including proliferation, differentiation, migration, and apoptosis.

Cell-laden constructs: 3D structures that contain living cells, created through biofabrication.

Cell seeding: the process of introducing cells into a 3D scaffold or construct.

Computer-aided design (CAD): the use of computers to create 2D or 3D models for manufacturing or engineering purposes.

Decellularized extracellular matrix (dECM): the extracellular matrix (ECM) of a tissue or organ that has been treated to remove cells, leaving behind a scaffold made of ECM components.

Extracellular matrix (ECM): the supportive structure that surrounds cells in tissues and organs, composed of proteins, glycosaminoglycans, and other molecules.

Functional tissue engineering: the creation of functional tissues or organs for use in regenerative medicine or drug discovery.

Hydrogels: crosslinked networks of hydrophilic polymers that can absorb large amounts of water, used as bio-inks in biofabrication.

Layer-by-layer fabrication: a biofabrication technique that creates 3D structures by adding layers of bio-ink on top of each other.

Microextrusion: a biofabrication technique that uses a syringe to extrude bio-ink through a nozzle, creating filaments that can be used to build 3D structures.

\Scaffolds\: 3D structures that provide support for cells to grow and differentiate, used in tissue engineering and biofabrication.

\Stereolithography (SLA)\: a 3D printing technique that uses a laser to cure photosensitive resin layer-by-layer, creating a 3D object.

\Tissue engineering\: the use of cells, biomaterials, and/or bioactive molecules to create functional tissues or organs for use in regenerative medicine or drug discovery.

\Tissue models\: 3D structures that mimic the properties of tissues or organs, used in drug discovery and toxicology testing.

\Vascularization\: the formation of blood vessels in a tissue or organ, essential for delivering nutrients and oxygen.

\Biocompatibility\: the ability of a material to interact with living tissue without causing harm or adverse reactions.

\Bioprinting\: a subset of biofabrication that uses 3D printing technology to create cell-laden constructs.

\Cell patterning\: the process of arranging cells in a specific pattern or configuration.

\Cell viability\: the percentage of living cells in a population.

\Crosslinking\: the process of chemically or physically linking polymer chains together, used to create hydrogels.

\Gradient\: a continuous change in the concentration of a molecule or substance.

\Hydrophilic\: having an affinity for water, used to describe materials that absorb water easily.

\Hydrophobic\: having an aversion to water, used to describe materials that repel water.

\Porosity\: the percentage of void space in a material or structure.

\Printability\: the ability of a bio-ink to be extruded through a nozzle and form a stable filament.

\Resolution\: the smallest feature size that can be created by a 3D printing or biofabrication technique.

\Shear stress\: the force exerted on a material due to fluid flow, important in biofabrication as high shear stress can damage cells.

\Viscosity\: the thickness or resistance to flow of a liquid, important in biofabrication as high viscosity can make extrusion difficult.

\Z-stacking\: the process of creating 3D structures by stacking 2D layers on top of each other.

\Biofabrication challenges\:

- * Maintaining cell viability during the fabrication process
- * Creating structures with sufficient mechanical strength and porosity
- * Ensuring adequate vascularization for larger tissue constructs
- * Scaling up fabrication for clinical applications
- * Regulatory challenges for cell-based therapies

Examples of biofabrication applications:

- * \In vitro\ tissue models for drug discovery and toxicology testing
- * Personalized medicine, including patient-specific implants and tissue grafts
- * Tissue engineering for regenerative medicine, including skin, cartilage, and bone grafts
- * Bioprinted organoids for disease modeling and drug screening
- * Biodegradable scaffolds for tissue engineering
- * Biomaterials for drug delivery and diagnostics

Practical applications:

- * Designing and optimizing bio-inks for specific applications
- * Developing and testing new biofabrication techniques
- * Creating tissue models for drug discovery and toxicology testing
- * Fabricating tissue grafts for regenerative medicine
- * Validating and characterizing bioprinted constructs
- * Collaborating with interdisciplinary teams, including biologists, engineers, and clinicians.

In conclusion, biofabrication is a rapidly evolving field that combines tissue engineering and additive manufacturing to produce functional biological structures. Understanding the key terms and vocabulary related to this field is essential for successful implementation and application. Through the use of interdisciplinary collaboration and innovative techniques, biofabrication has the potential to revolutionize regenerative medicine, drug discovery, and personalized medicine.