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Postgraduate Certificate in Biofabrication Fabrication

## Computational Modeling in Biofabrication

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**\*\*Additive manufacturing (AM):\*\*** A process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies.

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

**\*\*Biofabrication:\*\*** The use of automated systems to create biological structures in a controlled manner, with applications in tissue engineering, regenerative medicine, and drug discovery.

**\*\*Biological fabrication:\*\*** A subfield of biofabrication that involves using living cells, microorganisms, or enzymes to create functional biological structures, such as tissues and organs.

**\*\*Cell-laden hydrogel:\*\*** A hydrogel that contains living cells, used as a bio-ink in biofabrication.

**\*\*Computational modeling:\*\*** The use of mathematical and computational approaches to simulate and predict the behavior of complex systems, such as those found in biofabrication.

**\*\*Digital fabrication:\*\*** The process of creating physical objects from digital designs, including additive manufacturing, subtractive manufacturing, and other automated fabrication techniques.

**\*\*Fabrication:\*\*** The process of creating physical objects from raw materials, including both traditional and digital techniques.

**\*\*Hydrogel:\*\*** A cross-linked polymer network that can absorb and retain large amounts of water, used as a bio-ink in biofabrication.

**\*\*Laser-assisted bioprinting (LaBP):\*\*** A biofabrication technique that uses a laser to selectively transfer cells and biomaterials onto a substrate, creating complex three-dimensional structures.

**\*\*Microextrusion:\*\*** A biofabrication technique that uses a computer-controlled syringe to deposit bio-inks in a layer-by-layer manner, creating three-dimensional structures.

**\*\*Scaffold:\*\*** A temporary support structure used in tissue engineering to provide a framework for cells to grow and differentiate.

**\*\*Stereolithography (SLA):\*\*** A type of additive manufacturing that uses a laser to selectively cure a photosensitive resin, creating three-dimensional objects.

**\*\*Subtractive manufacturing:\*\*** A manufacturing technique that involves removing material from a solid block to create a desired shape, as opposed to adding material, as in additive manufacturing.

**\*\*Tissue engineering:\*\*** The use of cells, biomaterials, and engineering principles to create functional tissue

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substitutes for medical applications.

**Three-dimensional (3D) bioprinting:** A biofabrication technique that uses 3D printing technology to create complex three-dimensional structures from bio-inks, including cells, biomaterials, and bioactive molecules.

**Two-dimensional (2D) bioprinting:** A biofabrication technique that uses 2D printing technology to create planar structures from bio-inks, including cells, biomaterials, and bioactive molecules.

**Vat photopolymerization:** A type of additive manufacturing that uses a vat of photosensitive resin and a light source to selectively cure the resin, creating three-dimensional objects.

**Bioprinting:** A subset of biofabrication that involves using 3D printing technology to create complex three-dimensional structures from bio-inks, including cells, biomaterials, and bioactive molecules.

**Biofabrication simulation:** The use of computational models to simulate and predict the behavior of biofabrication processes, including the interactions between bio-inks, scaffolds, and cells.

**Biological systems modeling:** The use of mathematical and computational approaches to simulate and predict the behavior of biological systems, such as those found in biofabrication.

**Computer-aided design (CAD):** The use of computer software to create, modify, and analyze designs for manufacturing and engineering applications.

**Computer-aided manufacturing (CAM):** The use of computer software to control and automate manufacturing processes, including additive manufacturing and digital fabrication.

**Digital twin:** A virtual model of a physical object or system, used for simulation, prediction, and optimization.

**Finite element analysis (FEA):** A computational modeling technique used to predict the behavior of structures and systems under various loads and conditions.

**Multi-material biofabrication:** The use of multiple bio-inks and fabrication techniques to create complex, multi-material structures in biofabrication.

**Multi-physics simulation:** The use of computational models to simulate and predict the behavior of systems that involve multiple physical phenomena, such as fluid dynamics, heat transfer, and structural mechanics.

**Parametric design:** A design approach that uses mathematical relationships to create flexible, adaptable designs, often used in combination with computer-aided design and manufacturing.

**Rheology:** The study of the flow and deformation of matter, used to characterize the properties of bio-inks and other materials used in biofabrication.

**Topology optimization:** A computational modeling technique used to optimize the distribution of

materials in a structure for maximum performance, often used in combination with additive manufacturing.

**\*\*Bioprinting process:\*\*** A series of steps involved in creating a three-dimensional structure using biofabrication technology, including design, material preparation, fabrication, and post-processing.

**\*\*Bio-ink preparation:\*\*** The process of mixing and formulating bio-inks, including cells, biomaterials, and bioactive molecules, for use in biofabrication.

**\*\*Cell viability:\*\*** The percentage of living cells in a population, used as a measure of the effectiveness of biofabrication processes.

**\*\*Computational fluid dynamics (CFD):\*\*** A computational modeling technique used to simulate and predict the behavior of fluids, such as those found in biofabrication processes.

**\*\*Fabrication post-processing:\*\*** The process of finishing and preparing a three-dimensional structure after fabrication, including cleaning, sterilization, and functionalization.

**\*\*Material characterization:\*\*** The process of measuring and analyzing the properties of materials used in biofabrication, including rheology, biocompatibility, and printability.

**\*\*Precision medicine:\*\*** A medical approach that takes into account individual genetic, environmental, and lifestyle factors to create personalized treatments, often using biofabrication and tissue engineering techniques.

**\*\*Scaffold design:\*\*** The process of creating a three-dimensional structure that provides a framework for cells to grow and differentiate, often using computer-aided design and manufacturing techniques.

**\*\*Tissue maturation:\*\*** The process of allowing a three-dimensional structure to develop and mature over time, often using culture conditions and bioreactors.

**\*\*Biofabrication challenges:\*\*** The technical, ethical, and regulatory issues that arise in the development and use of biofabrication technology, including cell sourcing, biocompatibility, and scale-up.

**\*\*Biofabrication limitations:\*\*** The technical and practical limitations of biofabrication technology, including resolution, speed, and cost.

**\*\*Biofabrication opportunities:\*\*** The potential applications and benefits of biofabrication technology, including personalized medicine, regenerative medicine, and drug discovery.

**\*\*Computational modeling challenges:\*\*** The technical, ethical, and regulatory issues that arise in the development and use of computational modeling in biofabrication, including accuracy, validation, and interpretation.

**\*\*Computational modeling limitations:\*\*** The technical and practical limitations of computational modeling in biofabrication, including complexity, uncertainty, and computational resources.

**\*\*Computational modeling opportunities:\*\*** The potential applications and benefits of computational

modeling in biofabrication, including design optimization, process control, and predictive maintenance.

**\*\*Digital fabrication challenges:\*\*** The technical, ethical, and regulatory issues that arise in the development and use of digital fabrication technology, including automation, standardization, and cybersecurity.

**\*\*Digital fabrication limitations:\*\*** The technical and practical limitations of digital fabrication technology, including resolution, speed, and cost.

**\*\*Digital fabrication opportunities:\*\*** The potential applications and benefits of digital fabrication technology, including mass customization, rapid prototyping, and distributed manufacturing.