

Stimuli2BioScaffold

Projecto *Stimuli2BioScaffold* - Optimização de estímulos em *BioScaffolds*: da modelação numérica aos testes *in vitro*

Referência: PTDC/EME-SIS/32554/2017

Financiamento Concedido: 239.999,34 €

Duração do projeto: 51 meses

Data de início do projeto: 01/01/2018

Data de fim do projeto: 31/08/2022

Composição do consórcio:

- 1) Instituto Politécnico de Leiria (IPLeiria); Centro para o Desenvolvimento Rápido e Sustentado de Produto (CDRSP), Unidade de Investigação FCT UIDB/04044/2020 e UIDP/04044/2020;
- 2) Associação do Instituto Superior Técnico para a Investigação e o Desenvolvimento (IST-ID); Instituto de Bioengenharia e Biociências (IBB), Unidade de Investigação FCT UIDB/04565/2020 and UIDP/04565/2020.

Instituição Proponente: IPLeiria

Financiamento	Projecto cofinanciado por Fundos FEDER através do Programa Operacional Competitividade e Internacionalização (POCI) - COMPETE 2020, pelo Programa Operacional Regional de Lisboa (PORLisboa) e por Fundos Nacionais através da FCT - Fundação para a Ciência e a Tecnologia.
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Localização do Investimento	CDRSP (IPLeiria): Centro (79,13%) IBB (IST-ID): Lisboa (20,87%)
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Síntese do Projeto

Nas próximas décadas é esperado que as fraturas ósseas tenham um impacto significativo em termos económicos e sociais na Europa, devido ao envelhecimento da população e à mudança de hábitos de vida da população jovem. Actualmente, os tratamentos utilizados incluem muitas vezes abordagens farmacológicas que visam fornecer nutrientes adicionais aos tecidos. No entanto, estes fármacos por vezes não conseguem estimular a formação de tecido, devido não só à sua administração incorrecta, como também à sua difusão para tecidos adjacentes. Deste modo, alternativas baseadas na engenharia de tecido (ET) têm emergido na última década. Ainda assim, apesar dos grandes avanços feitos nesta área (materiais biodegradáveis, tecnologias de impressão 3D, aplicação de scaffolds ou nanopartículas providos com fármacos) são necessários estudos que repliquem o mais correctamente e rapidamente o tecido ósseo ou cartilaginoso original. Uma das estratégias mais usadas em ET consiste na cultura de células *in vitro* antes da

sua implantação in vivo. No entanto, a alta taxa de mortalidade das células quando em ambiente in vivo, abre espaço para o estudo de novas estratégias que permitam produzir células in vitro através de um maior controle dos estímulos transmitidos de modo a potenciar o seu crescimento e diferenciação. O Projeto Stimuli2BioScaffolds pretende desenvolver uma plataforma de elementos finitos (EF) que permita otimizar numericamente os parâmetros de aplicação isolada ou simultânea da estimulação mecânica, elétrica ou magnética em células mesenquimatosas (MSCs) aplicadas em bioscaffolds colocados num bioreactor. Destacam-se três tarefas: 1) desenvolver um modelo numérico de EF que permitirá determinar a geometria otimizada do bioreactor. Este permite a optimização da aplicação dos três tipos de estimulação definidos. O modelo numérico permitirá estudar a influência dos parâmetros da estimulação na distribuição do campo eléctrico induzido numa região alvo do bioscaffold. Este procedimento é crucial para facilitar o crescimento ou a diferenciação celular nos bioscaffolds com geometria customizada; 2) construir um bioreactor inovador que permita a aplicação e optimização dos parâmetros da estimulação já referidos com uma geometria inovadora proposta na tarefa anterior. Este equipamento permitirá a utilização de geometrias de scaffolds customizadas; e 3) validar a ferramenta numérica desenvolvida e o bioreactor construído através de estudos in vitro que permitirão avaliar o crescimento e a diferenciação celular das células MSCs que serão colocadas no scaffold localizado na região central do bioreactor. A ferramenta numérica proposta e validada contribuirá para otimizar os parâmetros envolvidos na estimulação e assim, acelerar o processo de regeneração dos tecidos. Estão assim reunidas as condições para reduzir o número de estudos in vivo, salvando a vida de inúmeros animais e contribuindo para uma poupança significativa dos custos económicos envolvidos.

Principais Objetivos

O Projeto Stimuli2BioScaffolds pretende desenvolver uma plataforma de elementos finitos (EF) que permita otimizar numericamente os parâmetros de aplicação isolada ou simultânea da estimulação mecânica, elétrica ou magnética em células mesenquimatosas (MSCs) aplicadas em bioscaffolds colocados num bioreactor. Destacam-se três tarefas:

1. Desenvolver um modelo numérico de EF que permitirá determinar a geometria otimizada do bioreactor. Este permite a optimização da aplicação dos três tipos de estimulação definidos. O modelo numérico permitirá estudar a influência dos parâmetros da estimulação na distribuição do campo eléctrico induzido numa região alvo do bioscaffold. Este procedimento é crucial para facilitar o crescimento ou a diferenciação celular nos bioscaffolds com geometria customizada;
2. Construir um bioreactor inovador que permita a aplicação e optimização dos parâmetros da estimulação já referidos com uma geometria inovadora proposta na tarefa anterior. Este equipamento permitirá a utilização de geometrias de scaffolds customizadas;
3. Validar a ferramenta numérica desenvolvida e o bioreactor construído através de estudos in vitro que permitirão avaliar o crescimento e a diferenciação celular das células MSCs que serão colocadas no scaffold localizado na região central do bioreactor;

A ferramenta numérica proposta e validada contribuirá para otimizar os parâmetros envolvidos na estimulação e assim, acelerar o processo de regeneração dos tecidos. Estão assim reunidas as condições para reduzir o número de estudos in vivo, salvando a vida de inúmeros animais e contribuindo para uma poupança significativa dos custos económicos envolvidos.

Scientific Outputs

Books/Book chapters (A1)

2020

[A1-01] Cristiana Fernandes, Carla Moura, Rita Ascenso, Sandra Amado, Nuno Alves, Paula Pascoal-Faria*. Title "Comprehensive Review on Full Bone Regeneration Trough 3D Printing Approaches". Book chapter in the book under the working title "Design Engineering and Manufacturing", InTechOpen, Published in 2020 (<https://doi.org/10.5772/intechopen.90864>).

International journal papers (A2)

2022

[A2-01] Meneses, J., Fernandes, S., Alves, N.M., Pascoal-Faria, P., Miranda, P.C., "How to correctly estimate the electric field in capacitively coupled systems for tissue engineering: a comparative study." Sci Rep 12, 11049 (2022). <https://doi.org/10.1038/s41598-022-14834-2> (Published, Nature Scientific Reports, Q1,IF: 4.996).

[A2-02] Biscaia, S., Silva, J.C.,Moura, C.S., Viana, T., Tojeira, A., Mitchell, G.R., Pascoal-Faria, P., Ferreira, F.C., Alves, N.M., "Additive manufactured poly (ϵ -caprolactone)-graphene scaffolds: lamellar crystal orientation, mechanical properties and biological performance" Polymers 14, 1669 (2022). <https://doi.org/10.3390/polym14091669> (Published, Q1, IF: 4.967).

Conference Articles peer reviewed

[A2-03] Joao Meneses, Sofia R. Fernandes, Abhishek Datta, Sandra Amado, Nuno Alves, and Paula Pascoal-Faria, "Numerical modelling of a bioreactor design targeting optimal conditions for cell culture", AIP Conference Proceedings 2425, 220003 (2022) <https://doi.org/10.1063/5.0081336>. Work presented at the 18th International Conference of Numerical Analysis and Applied Mathematics, Rhodes, Greece, 2020;

[A2-04] Sofia R. Fernandes, João Meneses, Abhishek Datta, Sandra Amado, Nuno Alves, and Paula Pascoal-Faria , "Comparison of electromagnetic stimulation fields generated by different experimental setups: A biophysical analysis", AIP Conference Proceedings 2425, 220004 (2022) <https://doi.org/10.1063/5.0081338>. Work presented at the 18th International Conference of Numerical Analysis and Applied Mathematics, Rhodes, Greece, 2020;

2021

[A2-05] J. C. Silva, C. S. Moura, G. Borrecho, A. P. A. de Matos, J. M. S. Cabral, R. Linhardt, F. C. Ferreira, Effects of glycosaminoglycan supplementation in the chondrogenic differentiation of bone marrow- and synovial- derived mesenchymal stem/stromal cells on 3D-extruded poly (ϵ -caprolactone) scaffolds. *International Journal of Polymeric Materials and Polymeric Biomaterials*. 70(3) (2021) <https://doi.org/10.1080/00914037.2019.1706511>;

[A2-06] F.F. Garrudo, D.E.S. Nogueira, C.A.V. Rodrigues, F.A. Ferreira, P. Paradiso, R. Colaço, A.C. Marques, J.M.S. Cabral, J. Morgado, R. Linhardt, F.C. Ferreira, Electrical stimulation of neural differentiating iPSCs on novel coaxial electroconductive nanofibers. *Biomaterials Science*. 9 (2021) 5359-5382 <https://doi.org/10.1039/D1BM00503K>;

Conference Articles peer-reviewed

[A2-07] Meneses, J., Moura, C.S., Datta, A., Miranda, P.C., Alves, N.M., Pascoal-Faria, P., "The influence of scaffold design in electrical field distribution for tissue engineering", (accepted for publication). Work presented at the 19th International Conference of Numerical Analysis and Applied Mathematics, Rhodes, Greece, 2021.

[A2-08] Meneses, João; Sofia R. Fernandes; Nuno Alves; Paula Pascoal-Faria; Miranda, Pedro Cavaleiro. "Effects of Scaffold Electrical Properties on Electric Field Delivery in Bioreactors." <https://doi:10.1109/EMBC46164.2021.9630711>. Work presented at the 43rd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC), Guadalajara, Mexico, 2021.

[A2-09] Marcelino, P., Silva, J.C., Moura, C.S., Meneses, J., Alves, N.M., Pascoal-Faria, P., Ferreira, F.C. "Design and Fabrication of Curvature-Featuring Scaffolds for Osteochondral Regeneration", (accepted for publication). Work presented at the 19th International Conference of Numerical Analysis and Applied Mathematics, Rhodes, Greece, 2021.

2020

[A2-10] C. S. Moura, J.C. Silva, S. Faria, P. R. Fernandes, C. L. da Silva, J M. S. Cabral, R. Linhardt, P.J. Bártolo, F. C. Ferreira, "Chondrogenic differentiation of mesenchymal stem/stromal cells on 3D porous poly (ϵ -caprolactone) scaffolds: effects of material alkaline treatment and chondroitin sulfate supplementation", *J Biosci Bioeng*. 2020129(6) (2020) 756-764. <https://doi:10.1016/j.jbiosc.2020.01.004>

[A2-11] J. Meneses, J.C. Silva, S. Fernandes, A. Datta, F. Ferreira, C. Moura, et al., "A Multimodal Stimulation Cell Culture Bioreactor for Tissue Engineering: A Numerical Modelling Approach", *Polymers*. 12 (2020) 940. <https://doi:10.3390/polym12040940>

[A2-12] J. C. Silva, M. S. Carvalho, R. N. Udangawa, C. S Moura, J. MS Cabral, C. L. da Silva, F. C. Ferreira, D. Vashishth, R. J Linhardt, "Extracellular matrix decorated polycaprolactone scaffolds for improved mesenchymal stem/stromal cell osteogenesis towards a patient-tailored bone tissue engineering approach", *J Biomed Mater Res (B Appl Biomater)* 108 (2020) 2153-2166. <https://doi.org/10.1002/jbm.b.34554>

[A2-13] J. C. Silva, C. S. Moura, G. Borrecho, A. P. A. de Matos, J. M. S. Cabral, R. Linhardt, F. C. Ferreira, Effects of glycosaminoglycan supplementation in the chondrogenic differentiation of

bone marrow- and synovial- derived mesenchymal stem/stromal cells on 3D-extruded poly (ε-caprolactone) scaffolds. *International Journal of Polymeric Materials and Polymeric Biomaterials*. 1-16 (2020) <https://doi.org/10.1080/00914037.2019.1706511>

2019

[A2-14] J.C. Silva, C.S. Moura, G. Borrecho, A. P. A de Matos, C. L. da Silva, J. C. Cabral, P. J. Bártolo, R. J., Linhardt, F.C. Ferreira, Extruded Bioreactor Perfusion Culture Supports the Chondrogenic Differentiation of Human Mesenchymal Stem/Stromal Cells in 3D Porous Poly(ε - Caprolactone) Scaffolds. *Biotechnol. J.* 2019, 1900078. <https://doi.org/10.1002/biot.201900078>

[A2-15] Paula Pascoal-Faria, Pedro Castelo Ferreira, Abhishek Datta, Sandra Amado, Carla Moura and Nuno Alves, “Electrical Stimulation Optimization in Bioreactors for Tissue Engineering Applications”, *Applied Mechanics and Materials*, Vol. 890, pp 314-323, julho 2019; <https://doi:10.4028/www.scientific.net/AMM.890.314>

Conference Articles peer-reviewed

[A2-16] Nuno Alves, Miguel Belbut Gaspar, and Paula Pascoal-Faria, “Computer-aided optimization in additive manufacturing: Processing parameters and 3D scaffold reconstruction”, *American Institute of Physics* 2116, 230005, julho 2019. <https://doi.org/10.1063/1.5114231>

[A2-17] Chris Thomas, Yu Huang, Paula Pascoal-Faria, Abhishek Datta, “High-Resolution Head Model of Transcranial Direct Current Stimulation: A Labeling Analysis”, *Conf Proc IEEE Eng Med Biol Soc.*, julho 2019. <https://doi.org/10.1109/EMBC.2019.8857181>.

International oral presentations (B1)

2022

[B1-01] Pascoal-Faria, P; Meneses, J.; Marcelino, P.; Silva, J.C.; Moura, C.S.; Datta, A.; Ferreira, F.C.; Alves, N.M., “Numerical Modelling Impact in the Design and Operation of Tissue Engineering Systems.” presented at afternoon session D - Numerical modelling of the manufacturing of complex systems, RESIM 2022 / BIODIG 2022 Centre for Rapid and Sustainable Product Development, Polytechnic Institute of Leiria, 3 June 2022.

[B1-02] Pascoal-Faria, P; Mitchell, G.R., “Digital Twins for Complex Manufacturing processes - Tissue Engineering Bioreactors.” presented at AFTERNOON SESSION D - Numerical modelling of the manufacturing of complex systems, RESIM 2022 / BIODIG 2022 Centre for Rapid and Sustainable Product Development, Polytechnic Institute of Leiria, 3 June 2022.

[B1-03] Silva, J.C.; Barbosa, F.; Carvalho, M.S.; Garrudo, F.F.F.; Cabral, J.M.S.; Linhardt, R.J.; Ferreira, F.C., “Bio-inspired and bioactive fibrous scaffolds for bone and cartilage tissue engineering” Oral presentation at the International Conference on Polymer Science and Composite Materials (ICPSCM 2022), Virtual conference at 14 - 15 April 2022.

[B1-04] Meneses, J.; Silva, J.C.; Alves, N.M.; Santos, T.; Miranda, P.C.; Pascoal-Faria, P., “Bioreactor Digital Twin - An essential modelling tool to estimate cellular local environmental conditions in experimental tissue engineering;” presented at International Conference on Computational Bioengineering (ICCB2022), Session - Computer Modelling for Tissue Engineering Applications II, held at Instituto Superior Técnico, Lisbon, Portugal, 11 - 13 April 2022.

[B1-05] Pascoal-Faria, P.; Meneses, J.; Datta, A.; Silva, J.C.; Ferreira, F.C.; Moura, C.S.; Alves, N.M. “Cell Culture Bioreactor Manufacturing, from Material Selection to Numerical Models.” Mater. Proc. 2022, 8, 50. Presented at Congresso da Sociedade Portuguesa de Materiais, XI International Materials Symposium, Leiria, Portugal, 10-13 April 2022.

2021

[B1-06] Silva, J.C.; Meneses, J.; Garrudo, F.F.F.; Alves, N.M.; Ferreira, F.C.; Pascoal-Faria, P., “Effects of electrical stimulation on human mesenchymal stem/stromal cells osteogenic differentiation: refining protocols towards enhanced in vitro bone formation” Oral presentation at the International Conference on Computational Bioengineering (ICCB2022), Session - Computer Modelling for Tissue Engineering Applications II, held at Instituto Superior Técnico, Lisbon, Portugal, 11 - 13 April 2022. 2021

[B1-07] Marcelino, P., Silva, J.C., Moura, C.S., Meneses, J., Garrudo, F., Alves, N.M., Pascoal-Faria, P., Ferreira, F.C. “Design and fabrication of curvature-mimicking scaffolds for osteochondral tissue regeneration: a mathematical approach”, Oral presentation at the 7th edition of the Symposium on Computational Tools for Direct Digital Manufacturing (CT4DDM) of the 19th International Conference of Numerical Analysis and Applied Mathematics (ICNAAM 2021), Rhodes, Greece, September 20-26, 2021.

[B1-08] Jan Marxen, Nuno David, Sérgio Lopes e Tiago Charters de Azevedo, Nuno Alves and Paula Pascoal-Faria, “Bone modelling validation using micro CT data”, Oral communication presented at the seventh edition of the Symposium on Computational Tools for Direct Digital Manufacturing (CT4DDM), held within the International Conference on Applied Mathematics ICNAAM 2021, 20-26 September 2021.

[B1-09] Meneses, J., Moura, C.S., Datta, A., Miranda, P.C., Alves, N.M., Pascoal-Faria, P., “The influence of scaffold design in electrical field distribution for tissue engineering”. Oral presentation at the 19th International Conference of Numerical Analysis and Applied Mathematics, Rhodes, Greece, September 20-26, 2021.

[B1-10] Meneses, João; Sofia R. Fernandes; Nuno Alves; Paula Pascoal-Faria; Miranda, Pedro Cavaleiro. "Effects of Scaffold Electrical Properties on Electric Field Delivery in Bioreactors.", Oral presentation at the 43rd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC), Guadalajara, Mexico, 2021.

[B1-11] Meneses, J., Alves, N.M., Datta, A., Pascoal-Faria, P., "From Numerical Models to Bioreactor Design in Tissue Engineering", presented at Encontro Nacional da Sociedade Portuguesa de Matemática 2021 (ENSPM 2021), held online, 12-16 July 2021.

[B1-12] Meneses, J.; Silva, J.C.; Fernandes, S.R.; Datta, A.; Moura, C.S.; Ferreira, F.C.; Miranda, P.; Alves, N.M.; Pascoal-Faria, P. “Digital Twin: A new tool for tissue engineering”, Oral presentation

at the International Conference on Polymer Science and Composite Materials Conference – Polymer Connect 2021, Lisboa, Portugal, Virtual event, July 05th-07th 2021.

[B1-13] João Meneses, Abhishek Datta, Nuno Alves, Pedro Cavaleiro Miranda and Paula Pascoal-Faria, "Bioreactor Design Challenges and Opportunities: Combining Direct Digital Manufacturing and Numerical Models" presented at ICDDMAP 2021, Session C -Mathematics and Industry, organized by Centre for Rapid and Sustainable Product Development, Polytechnic Institute of Leiria, and Karnatak University, Dharwad, India in virtual mode at 20-22 May 2021. Won Best Presentation Award in Session C.

[B1-14] Silva, J.C.; Moura, C.S.; Carvalho, M.S.; Cabral, J.M.S.; Pascoal-Faria, P.; Alves, N.M.; Linhardt, R.J.; Ferreira, F.C. "Additive manufacturing-based biomimetic/bio-instructive scaffolds and bioreactors for bone, cartilage and osteochondral tissue engineering" Oral presentation at ICDDMAP 2021, Session F - Biomanufacturing, organized by Centre for Rapid and Sustainable Product Development, Polytechnic Institute of Leiria, and Karnatak University, Dharwad, India in virtual mode at 20-22 May 2021.

[B1-15] Jan Marxena, Sérgio Lopesa, Nuno Lopesa, Nuno Alves, Paula Pascoal-Faria, "Topology Optimization Applied to Bio-Scaffold Design: A Mathematical Approach to Tissue-Engineering", Oral communication presented at the ICDDMAP 2021: International Conference on Direct Digital manufacturing and Polymers, 20-22 May 2021; presenting at the session Mathematics and Manufacturing.

2020

[B1-16] Joao Meneses, Sofia R. Fernandes, Abhishek Datta, Sandra Amado, Nuno Alves, and Paula Pascoal-Faria, "Numerical modelling of a bioreator design targeting optimal conditions for cell culture". Work presented at the 18th International Conference of Numerical Analysis and Applied Mathematics, Rhodes, Greece, September 17-23, 2020.

[B1-17] Sofia R. Fernandes, João Meneses, Abhishek Datta, Sandra Amado, Nuno Alves, and Paula Pascoal-Faria, "Comparison of electromagnetic stimulation fields generated by different experimental setups: A biophysical analysis". Work presented at the 18th International Conference of Numerical Analysis and Applied Mathematics, Rhodes, Greece, September 17-23, 2020.

[B1-18] João Meneses, Nuno Alves, Sofia R. Fernandes, Carla Moura, Abhishek Datta, Sandra Amado, P C Miranda, Paula Pascoal-Faria, "Numerical Modelling of Multi-Coupling Electrodes and Bioreactor Combined System for Electric Stimulation in Tissue Engineering", presented at RESIM 2020 / BIODIG 2020 Centre for Rapid and Sustainable Product Development, Polytechnic Institute of Leiria (Leiria, Portugal), June 04-05, 2020.

[B1-19] J. C. Silva, M. S. Carvalho, R. N. Udangawa, C. S. Moura, J. M. S. Cabral, C. L. da Silva, F. C. Ferreira, D. Vashishth, R. J. Linhardt, "Enhancing synthetic scaffolds biological performance and osteoinductive properties using stem cell-derived extracellular matrix". Oral presentation by João Silva, Polymer Connect - Polymer Science and Composite Materials Conference, Sana Malhoa Hotel Lisbon, Portugal, February 26-28, 2020.

2019

[B1-21] Paula Pascoal-Faria, João Meneses, Abhishek Datta, Carla Moura, Frederico Ferreira, Sandra Amado, Nuno Alves, Electrical stimulation of bioscaffolds for tissue engineering: a numerical analysis, presented by Paula Pascoal-Faria at 17th Edition of the International Conference on Applied Mathematics – 22-28th September 2019 - Rhodes, Greece (Accepted for publication AIP Conference Proceedings)

[B1-22] Nuno Alves, Cristiana Fernandes, Carla Moura, João Meneses, Abhishek Datta and Paula Pascoal-Faria, Functionally graded scaffolds for bone tissue engineering: a computational mechanical approach, presented by Paula Pascoal-Faria at 5th Computational Tools for Direct Digital Manufacturing (CT4DDM) of the International Conference on Applied Mathematics – 22-28th September 2019 - Rhodes, Greece (Accepted for publication, AIP Conf Proceedings)

[B1-23] Nuno Alves, Miguel Belbut Gaspar, and Paula Pascoal-Faria, “Computer-aided optimization in additive manufacturing: Processing parameters and 3D scaffold reconstruction”, presented by Nuno Alves at 17th Edition of the International Conference on Applied Mathematics – 22-28th September 2019 – Rhodes, Greece.

[B1-24] Chris Thomas, Yu Huang, Paula Pascoal-Faria, Abhishek Datta, “High-Resolution Head Model of Transcranial Direct Current Stimulation: A Labeling Analysis”, Oral presentation at Conf Proc IEEE Eng Med Biol Soc., julho 2019 – Berlin, Germany.

[B1-25] Apresentado - Paula Pascoal-Faria, “Application of different stimuli to solve bone tissue engineering issues”, International Conference on Direct Digital Manufacturing and Polymers, February 2019, Dharwad, Karnatak, India. URL: <http://icddmap.ipleiria.pt/icddmap-2019/>

2018

[B1-26] J.C. Silva, C.S. Moura, G. Borrecho, A.P.A. Matos, J.M.S. Cabral, R.J. Linhardt, F.C. Ferreira, Extruded Perfusion Bioreactors: a versatile custom-made platform to study shear stress in cartilage tissue engineered constructs, presented by JC Silva at 26th Annual Meeting of the European Orthopaedic Research Society (EORS) - 27th September 2018-Galway, Ireland (Abstract published in Orthopaedic Proceedings 2018 100-B: Suppl 15, page 111.)

[B1-27] J.C. Silva, C.S. Moura, G. Borrecho, A.P.A. Matos, J.M.S. Cabral, R.J. Linhardt, F.C. Ferreira, Extruded perfusion bioreactor as a customizable culture platform to study fluid shear stress stimuli in articular cartilage tissue engineered constructs, presented by FC Ferreira at 12th Symposium of the European Society of Biochemical Engineering Sciences, ESBES 2018. 9-12 September 2018, Lisbon, Portugal

[B1-28] Apresentado – Paula Pascoal-Faria, "Computer aided optimization in additive manufacturing: processing parameters and 3D scaffold reconstruction", Fourth edition of the Symposium Computational Tools for Direct Digital Manufacturing (CT4DDM), held within the International Conference on Applied Mathematics ICNAAM 2018 (September 13-18), Rhodes, Greece. URL: <http://embc.embs.org/2019/>

[B1-29] Apresentado - Paula Pascoal-Faria, " Numerical Modeling of Electrical Stimulation on scaffolds for tissue engineering", 4th IPLEiria International Health Congress: Global Health Trends, May 2018, Leiria, Portugal. URL: <http://health.ipleiria.pt/>

[B1-30] Apresentado – Paula Pascoal-Faria, “Stimuli optimization for bioscaffolds placed at a bioreactor for in vitro tissue engineering applications”, 15th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering and the 3rd Conference on Imaging and Visualization, March 2018, Berlim, Germany. URL: <http://cmbbe2018.tecnico.ulisboa.pt/>

National oral presentations (B2)

2022

[B2-01] João Meneses, Nuno Alves, P C Miranda, Paula Pascoal-Faria, “Multiscale Numerical Models for Tissue Engineering Applications”. Work presented at the Jornadas Doutorais, February 2022, which took place at FCUL, Lisbon, Portugal.

2021

[B2-02] Jan Marxena, Sérgio Lopesa, Nuno Lopesa, Nuno Alves, Paula Pascoal-Faria, “Topology Optimization: Applications in Bioscaffold Design held on the parallel session of Undergraduate Enrolled in Research Projects”, Oral communication presented at the Encontro Nacional da Sociedade Portuguesa de Matemática 2021 (ENSPM2021), 12-16 July 2021.

[B2-03] João Meneses, Abhisked Datta, Nuno Alves, Pedro Cavaleiro Miranda and Paula Pascoal.Faria, "Bioreactor Design: Combining Direct Digital Manufacturing and Numerical Models". Work presented at the Ciência 2021 - Science and Technology in Portugal Summit, 28-30 June 2021, which took place at the Lisbon Congress Centre, Portugal.

2018

[B2-04] J.C. Silva, C.S. Moura, G. Borrecho, A.PA.. Matos, J.M.S Cabral, R.J. Linhardt, F.C. Ferreira, Extruded scaffolds and perfusion bioreactors to study fluid shear stress stimuli in articular cartilage tissue engineered constructs, Soft Matter in Biomedicine, Invited presentation, Faculty of Sciences, Universidade de Lisboa, Lisboa, 12 October 2018, Lisbon, Portugal

Reports

Annual Progress Report 2019;

Annual Progress Report 2020;

Final Report 2022.

Organization of conferences and seminars (D)

2022

[D-01] Symposium Integrative Multiscale Modelling Approaches to Tissue Engineering at the 43rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBCConference), 01-05 November 2021.

[D-02] MATERIAIS 2022, twentieth edition of the Congresso da Sociedade Portuguesa de Materiais, eleventh edition of the International Symposium on Materials and the second Iberian Meeting on Materials Science: Exploring a Better Future, 10-13 April 2022 | Marinha Grande, Portugal.

[D-03] Lab Session of the Multiscale Modelling within the easter school on additive manufacturing on the MATERIAIS 2022, twentieth edition of the Congresso da Sociedade Portuguesa de Materiais, eleventh edition of the International Symposium on Materials and the second Iberian Meeting on Materials Science: Exploring a Better Future, 10-13 April 2022 | Marinha Grande, Portugal

[D-04] Session Undergraduate that Published on the Encontro Nacional da Sociedade Portuguesa de Matemática (ENSPM2022), 18-20 July 2022 | Tomar, Portugal.

2021

[D-05] Symposium Integrative Multiscale Modelling Approaches to Tissue Engineering at the 43rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBConference), 01-05 November 2021.

[D-06] Session Mathematical applications in health on the Encontro Nacional da Sociedade Portuguesa de Matemática (ENSPM2021), 12-16 July 2021 | Online, Portugal.

[D-07] Session Undergraduate that Published on the Encontro Nacional da Sociedade Portuguesa de Matemática (ENSPM2021), 12-16 July 2021 | Online, Portugal.

[D-08] Session Undergraduate Enrolled in Research Projects on the Encontro Nacional da Sociedade Portuguesa de Matemática (ENSPM2021), 12-16 July 2021 | Online, Portugal.

[D-09] The International Manufacturing Forum Series (IMFS), 2nd September 2021. Morning: "Manufacturing and Digital Twins".

[D-10] 7th Symposium Computational Tools for Direct Digital Manufacturing (CT4DDM), within the International Conference of Numerical Analysis and Applied Mathematics 2021 (ICNAAM 2021), Rhodes, Greece, 20-26 September 2021.

[D-11] The International Manufacturing Forum Series (IMFS), 9th December 2021. Morning: "Multiple Laboratory Trial of Additive Manufacturing"; Afternoon: EU project SoftAware.

2020

[D-12] The International Conference on Polymer Connect, 26-28 February 2020 | Lisbon, Portugal.

[D-13] 6th Symposium Computational Tools for Direct Digital Manufacturing (CT4DDM), within the International Conference of Numerical Analysis and Applied Mathematics 2020 (ICNAAM 2020), Rhodes, Greece, 23-28 September 2020.

[D-14] The International Conference on Advanced Research on Sustainable and Intelligent Manufacturing (RESIM2020), 4-5 June 2020.

2019

[D-15] Biomechanics Session and Multiscale Modelling for 3D/4D (Bio)Printing Session within the 5th Symposium on Computational Tools for Direct Digital Manufacturing, 17th International Conference of Numerical Analysis and Applied Mathematics, 23-28 September, 2019, Rhodes, Greece. Organisers: Nuno Alves, Sandra Amado and Paula Faria <https://cdrsp.ipleiria.pt/icnaamsympadvancedmanufacturing/past-events/>

[D-16] Chair - Paula Pascoal-Faria, Parallel Session “Tissue Engineering Applications”, International Conference on Direct Digital Manufacturing and Polymers, February 2019, Dharwad, Karnatak, India. URL: <http://icddmap.ipleiria.pt/icddmap-2019/>

[D-17] Chair of the Cycle of Seminars CDRSP: Electric fields in the human central nervous system: computational models of new non-invasive techniques, Pedro Cavaleiro Miranda, FCUL (06 august 2019).

2018

[D-18] Biomechanics Session and Multiscale Modelling for 3D/4D (Bio)Printing Session within the 4th Symposium on Computational Tools for Direct Digital Manufacturing, 16th International Conference of Numerical Analysis and Applied Mathematics, 13-18 September, 2018, Rhodes, Greece. Organisers: Nuno Alves, Sandra Amado and Paula Faria.

[D-19] The fourth edition of the Symposium on Computational Tools for Direct Digital Manufacturing (CT4DDM), being held within the 16th International Conference of Numerical Analysis and Applied Mathematics.

Advanced training (E)

PhD Thesis

[E1-01] João Carlos Fernandes da Silva, “Bioengineering strategies towards the in vitro fabrication of hierarchical and biomimetic cartilage constructs”, PhD in Bioengineering: Cell Therapies and Regenerative, SFRH/BD/105771/2014 (FCT PhD Programme). Supervisor: F.C. Ferreira (iBB-IST), Co-supervisors: Professor Robert J. Linhardt (Rensselaer Polytechnic Institute, USA)

MSc/MEng Thesis

[E2-01] Pedro Manuel Mesquita Pereira, “A Bioreactor for chondrocyte differentiation: design, modelling and prototyping”, Biological Engineering (IST), Supervisor: F.C. Ferreira (iBB-IST).

[E2-02] Silvia Gonella, “Towards 3D in vitro models of Osteoarthritis”, Politecnico di Milano, Department Of Electronics, Information and Bioengineering, Supervisors: Sara Mantero (Politecnico di Milano) and Frederico Ferreira (iBB-IST).

[E2-03] Cristiana Fernandes, “Scaffolds and Bioreactor Characterization Towards Bone Regeneration: Proposal of a Computer-Aided Design Model”. Supervisor: Paula Faria. Co-supervisors: Rita Ascenso and Carla Moura.

[E2-04] Pedro Miguel Alves Marcelino, Design and fabrication of 3D-extruded scaffolds for osteochondral tissue engineering: optimization of geometry, curvature, and electroconductivity,

Cofinanciado por:



6 Dec 2021, MSc in Biological Engineering (IST), Supervisors: Dr. João C. Silva and Prof. Frederico C. Ferreira.

[E2-05] Frederico Porto de Freitas Barbosa, Electroconductive and Piezoelectric Nanofibers for Osteochondral Tissue Engineering, 3 Dec 2021, MSc in Biomedical Engineering (IST), Supervisors: Dr. João C. Silva and Prof. Frederico C. Ferreira.

Final year Project

[E3-01] Jan Esquível Marxen, An Introduction to Scaffold Design using Topology Optimization Methods– 2020/2021, Licenciatura em Matemática Aplicada à Tecnologia e à Empresa (LMATE), Área Departamental de Matemática, Instituto Superior de Engenharia de Lisboa, Instituto Politécnico de Lisboa, Supervisors: Nuno David lopes, Sergio Lopes and Paula Faria .

Computational tools (G)

[G-01] Aplicação python para cálculo de campos eléctricos aplicados por sistemas capacitivos com recurso a uma analogia de circuito eléctrico simples e onda sinusoidal (Resolução Analítica);

[G-02] Framework de cálculo de campos eléctricos aplicados por sistemas capacitivos, resolução de circuito eléctrico análogo e forma de onda real (Resolução LTSpice);

[G-03] Framework de cálculo de campos eléctricos aplicados por sistemas capacitivos, directos ou indutivos, por recurso a uma plataforma de elementos finitos com interfaces físicas adequadas ao problema. Resolve sistemas complexos e ondas de forma real (Resolução FEM);

Protótipos laboratoriais (I)

[I-01] Vários protótipos de desenvolvimento foram concluídos ao longo do processo de investigação do projecto, tendo o número de características e capacidades endereçadas aumentado a cada iteração de design e prototipagem;

Patents (O)

[O-01] Paula Pascoal-Faria, Nuno Alves, Carla Moura e João Meneses, “Sistema integrado de bioreator e processo de controlo, Aprendizagem e monitorização da cultura celular utilizando o mesmo”, Pedido de Patente Portuguesa Nº117309 – concedida.

[O-02] Paula Pascoal-Faria, Nuno Alves, Carla Moura e João Meneses, “Sistema integrado de bioreator e processo de controlo, Aprendizagem e monitorização da cultura celular utilizando o mesmo”, Pedido de Patente Europeia ref. 21134-INST-A6829 – pendente.

Other - Posters

[P-01] Barbosa, F.; Silva, J.C.; Garrudo, F.F.F.; Cabral, J.M.S.; Pascoal-Faria, P.; Morgado, J.M.F.; Ferreira, F.C., "Development of Novel Electroactive Nanofibers for Osteochondral Tissue Engineering Applications", Virtual poster presentation at RESIM 2022 / BIODIG 2022 Centre for Rapid and Sustainable Product Development, Polytechnic Institute of Leiria, 3 June 2022.

[P-02] Barbosa, F.; Silva, J.C.; Garrudo, F.F.F.; Cabral, J.M.S.; Pascoal-Faria, P.; Morgado, J.M.F.; Ferreira, F.C., "Fabrication of novel electroconductive PAN/PEDOT:PSS nanofibers for osteochondral tissue regeneration" Mater. Proc. 2022, 8, 117. Poster presentation at Congresso da Sociedade Portuguesa de Materiais, XI International Materials Symposium, Leiria, Portugal, 10-13 April 2022.

[P-03] Silva, J.C.; Udangawa, R.; Manicini, C.; Garrudo, F.; Mikael, P.; Cabral, J.M.S.; Ferreira, F.C.; Linhardt, R.J. "Development of kartogenin encapsulated aligned core-shell nanofibers for articular cartilage tissue engineering". Poster presented at the World Biomaterials Congress 2020 (WBC2020) Virtual, which took place in 11-15 December 2020.

[P-04] J.C. Silva, C.S. Moura, C.L. da Silva, J.M.S. Cabral, R.J. Linhardt and F.C. Ferreira, Extruded perfusion bioreactor: a custom-made platform to enhance the chondrogenic differentiation of mesenchymal stem/stromal cells in 3D porous scaffolds. Poster Presentation at 3rd Stem Cell Community Day 2019, Lisbon, Portugal, 21st November 2019.

[P-05] J.C. Silva, MS Carvalho, RN Udangawa, C.S. Moura, J.M.S. Cabral, FC Ferreira, D. Vashishth, R.J. Linhardt, Extracellular matrix decorated porous polycaprolactone scaffolds for bone tissue engineering, presented by JC Silva at 26th Annual Meeting of the European Orthopaedic Research Society (EORS), - 25-28 September 2018, Galway-Ireland (Abstract published in eCM Online Periodical 2018 – Collection 5, page 48).