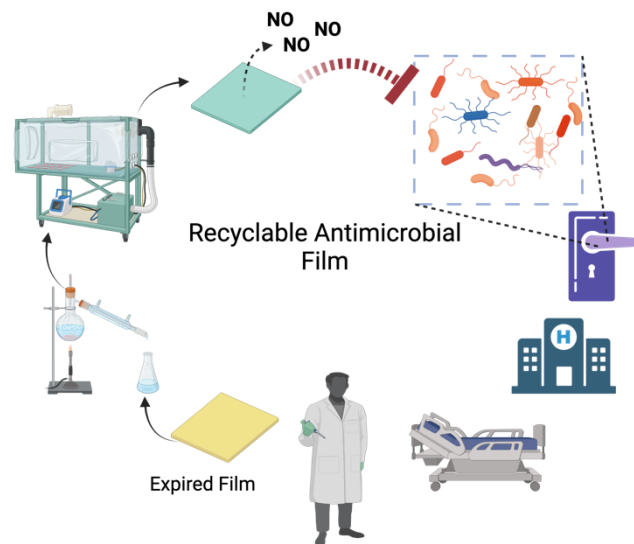


## Development of first-in-class recyclable and long-lasting surface sanitizers

With the prevalence of a contagious disease like coronavirus, surface sanitization is a key element in inhibiting the spread of the disease. Although applying currently available sanitizers (such as 70% ethanol) to surfaces like doorknobs can disinfect them, with each new exposure, the surface becomes contaminated again. Technically, it may not be possible to keep such surfaces consistently free of microbes. This is particularly crucial in crowded areas like hospitals, airports, and other public spaces. Additionally, the overwhelming majority of available sanitizers are water-based, limiting their utility on certain surfaces, such as water-sensitive electronic devices like computers, phones, ATMs, and medical devices used in hospitals. Nitric oxide (NO) is a short-lived, diatomic, lipophilic gas that plays an integral role in immune cell signaling and biochemical reactions that help immune cells defend against bacteria, fungi, viruses, and parasites. When NO is secreted by activated immune cells, it diffuses across cellular membranes, causing nitrosative and oxidative damage to invading pathogens. Learning from the mammalian immune system, NO-releasing biomaterials have been widely used as antimicrobial coatings for medical implants. However, being a gas limits the utility of NO as a surface sanitizer in public areas. **To address this issue, we are developing NO-releasing films and fibers with a sustained NO release profile and applying them as antimicrobial surface covers for hospital doorknobs, beds, electronic devices, and even personal protective equipment.** It is expected that the NO-releasing films and fibers will significantly kill bacteria, fungi, and viruses, thereby acting as a cheap, green, and recyclable sanitizer in public areas. **The project involves chemical synthesis, characterization of biomaterials, preparing films, and evaluating the antimicrobial properties of the developed films.**



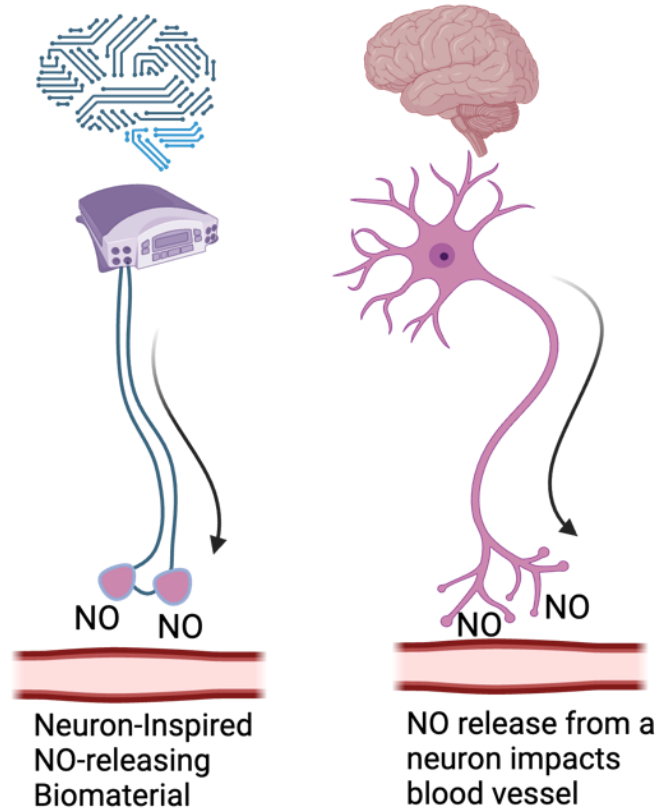
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### Synthesis of neuron inspired nitric oxide releasing biomaterials

As one of the most important neurotransmitter nervous system, NO is involved in multiple physiological functions depending on a complex balance between its concentration duration of exposure. It is neither stored in synaptic vesicles nor released by exocytosis, but simply diffuses from nerve terminals.

Inspired by human neuronal system, our team, in collaboration with labs at The Polish Academy of Sciences, is **developing the first generation of biomaterials that release NO in response to electric stimulation.**

This is an interdisciplinary research project that **involves a wide range of techniques from chemical synthesis and characterization and developing novel biomaterials to start-of the art electric responsive drug delivery systems.**



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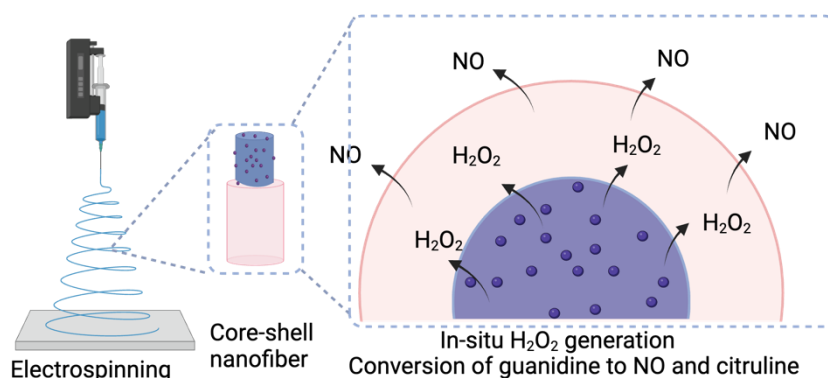
## Novel nitric oxide-releasing biomaterials for wound dressing applications.

In recent years, NO has emerged as a crucial molecule in wound healing and tissue engineering, acting as a guardian for grafts and medical implants. Furthermore, the well-established antimicrobial properties of NO-releasing biomaterials contribute to their significance. While a variety of NO donors have been developed for potential therapeutic use in various biomedical applications, challenges such as limited NO payloads, rapid NO release, and a lack of organ or tissue specificity have constrained their clinical applications. Consequently, there is a pressing need to design new, stable, and tunable NO donors.

The enzymatic conversion of L-arginine to L-citrulline via nitric oxide synthase (NOS) stands as the primary natural source of NO in the body. However, in the presence of peroxides like hydrogen peroxide ( $H_2O_2$ ), both L and D-arginine can nonenzymatically generate NO. This non-enzymatic NO synthesis reaction, though effective, operates slowly and requires high (mM) concentrations of  $H_2O_2$ . To expedite the NO synthesis reaction, catalysts such as supported iron (III) porphyrins, combined with irradiation using ultrasound (US), have been employed. Nevertheless, the suitability of these approaches for NO synthesis under physiological conditions is questionable, given the high concentrations of  $H_2O_2$  required. This poses a significant drawback, as organic peroxides and  $H_2O_2$  are highly reactive and cytotoxic, making it improbable to encounter such concentrations naturally.

To overcome these limitations, **our objective is to develop a core/shell scaffold for wound dressing and implant coating applications, employing in situ  $H_2O_2$  generation and the conversion of various functional groups into NO.**

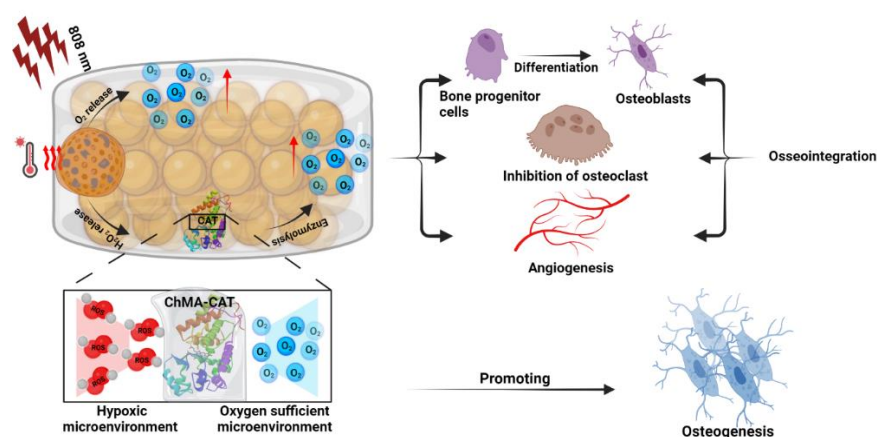
The project necessitates the chemical synthesis of novel polymers and the development and characterization of wound dressing materials using techniques such as electrospinning or casting polymers.



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## Light-triggered oxygen-releasing hydrogel

Bone abnormalities, infections, tumor resection, and trauma can cause critical-sized bone defects that cannot heal naturally during a patient's lifespan. Local microvascular ruptures accompanying bone defects hinder bone regeneration due to interrupted blood oxygen and supply, creating a hypoxic microenvironment. Low oxygen levels impede the proliferation and viability of bone stem cells *in vitro* and inhibit their metabolic transformation and osteogenesis, significantly reducing the expression of osteogenic markers and mineralization. Consequently, hypoxia reduces the therapeutic efficacy of bone regeneration and repair. Hypoxia not only decreases cell activity but also increases pro-inflammatory mediators such as reactive oxygen species (ROS). ROS plays a dual role in bone tissue. Elevated ROS levels can lead to cell death and disrupt osteogenic differentiation, impeding the expression of osteogenic markers. Conversely, ROS can enhance the proliferation and activity of osteoclast progenitor cells, impacting the regulation of bone homeostasis. Consequently, effective bone tissue regeneration requires an adequate oxygen supply and alleviation of ROS toxicities. The main goal of this project is to develop a **new hydrogel that can regenerate bone tissue by triggering a light-activated, photothermal self-oxygen supply and reactive oxygen species (ROS) scavenging mechanism** (Fig 1). To achieve this, we will synthesize particles that can generate and carry oxygen by simultaneously loading  $\text{CaO}_2$ , (oxygen generator), and saturated perfluorocarbons (PFC), (oxygen carrier), into the porous structure of photothermal polydopamine particles (MPDA). To protect the  $\text{CaO}_2$  from undesired decomposition, we will cover the MPDA particles with a superhydrophobic phase change material called lauric acid (LA). This outer layer of protection will ensure that water does not access the  $\text{CaO}_2$  until it is required. The MPDA particles will be embedded into a hydrogel modified with catalase, an enzyme that decomposes  $\text{H}_2\text{O}_2$  to  $\text{O}_2$ , a byproduct of  $\text{CaO}_2$  decomposition.



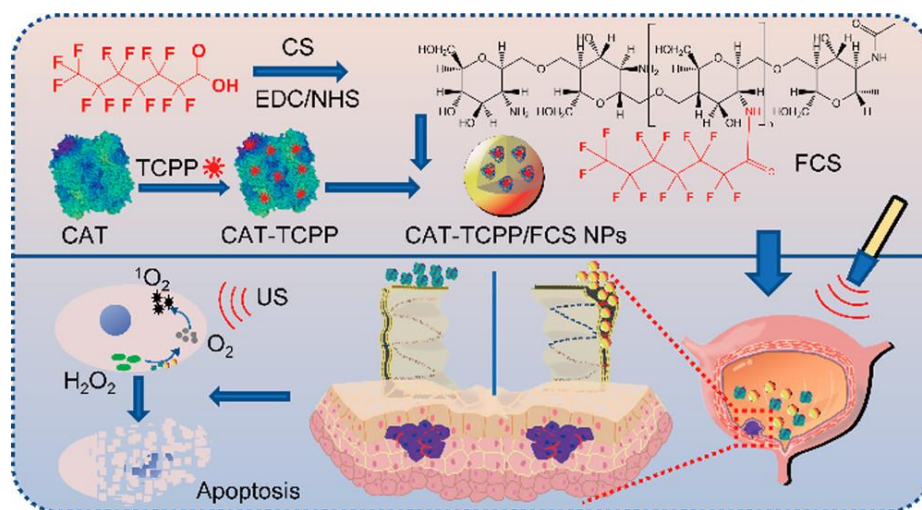
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## ROS-responsive oxygen-generating and preserving nanoparticles

The rapid tumor growth reduces oxygen diffusion which leads to hypoxia and activation of hypoxia-inducible factors (HIFs). Hypoxia-inducible factors play a pivotal role in various aspects of cancer progression, including enhancing cell survival, proliferation, metastasis, and drug resistance by altering main regulators and downstream mediators. Hypoxic conditions have been shown to lead to the generation of hydrogen peroxide, which serves as a source of reactive oxygen species (ROSs). Therefore, the decomposition of hydrogen peroxide into oxygen appears to be an initial solution to alleviate local hypoxia in a tumor environment. Peroxidase enzymes such as catalase, can decompose hydrogen peroxide into oxygen through oxidation and reduction reactions. However, the limited stability of CAT in the presence of proteases reduces its applicability *in vivo*. In this work, we **aim to alleviate hypoxia in a tumor environment by in situ converting hydrogen peroxide into oxygen and preserving it with perfluorocarbons (PFCs)**, which are hydrophobic materials that can adsorb inert gases, including oxygen and nitrogen. To achieve this goal, PFCs will be conjugated on hyaluronic acid with a ROS-responsive bridge, which can release them in a tumor environment. We hypothesize that by conjugating PFC on hyaluronic acid, its biocompatibility will be improved before reaching the tumor environment. Then, the ROS-responsive bridge will be broken by hydrogen peroxide of the tumor environment and the PFC will be released. The released PFCs will agglomerate and create oxygen-preserving sites in the tumor environment. Moreover, the hyaluronic acid nanoparticles will be functionalized with catalase to convert the hydrogen peroxide of the tumor to oxygen. We hypothesize that immobilizing catalase on hyaluronic acid can improve its stability *in vivo* without reducing its activity. The generated oxygen by the immobilized catalase will be trapped in the PFC sites and enhance the efficiency of cancer treatments.



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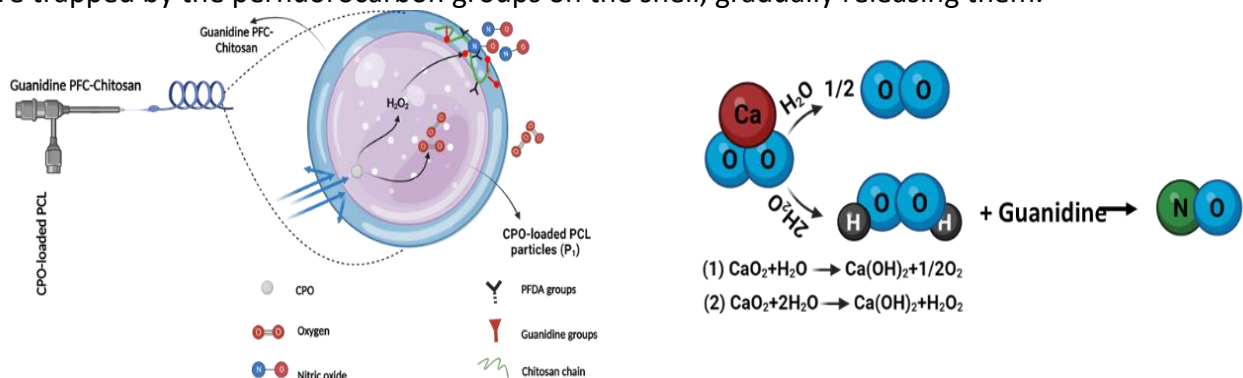
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### In situ oxygen and nitric oxide generating core-shell particles

Hypoxia and accumulation of reactive oxygen species (ROS) lead to blocking extracellular matrix (ECM) synthesis, collagen production, and capillary angiogenesis, therefore impeding wound healing. Using calcium peroxide (CPO) to alleviate hypoxia may result in an unwanted burst release of oxygen ( $O_2$ ), and hydrogen peroxide ( $H_2O_2$ ). Moreover, nitric oxide (NO) represents a potential wound therapeutic agent due to its ability to regulate inflammation and eradicate bacterial infections. L-arginine is the sole substrate for NO synthases and the immediate precursor to NO production. In this work, we aim to **synthesize core-shell particles for the simultaneous delivery of  $O_2$  and NO**. The core-shell particles, with CPO-loaded polycaprolactone (PCL) particles as the core, and functionalized chitosan with perfluorocarbons and guanidine groups as the shell (Figure). We hypothesize that the CPO-loaded PCL can supply  $O_2$  and  $H_2O_2$  through CPO decomposition (Figure). The generated  $H_2O_2$  reacts with the guanidine on chitosan to produce NO (Figure). Then, the released  $O_2$  and NO are trapped by the perfluorocarbon groups on the shell, gradually releasing them.



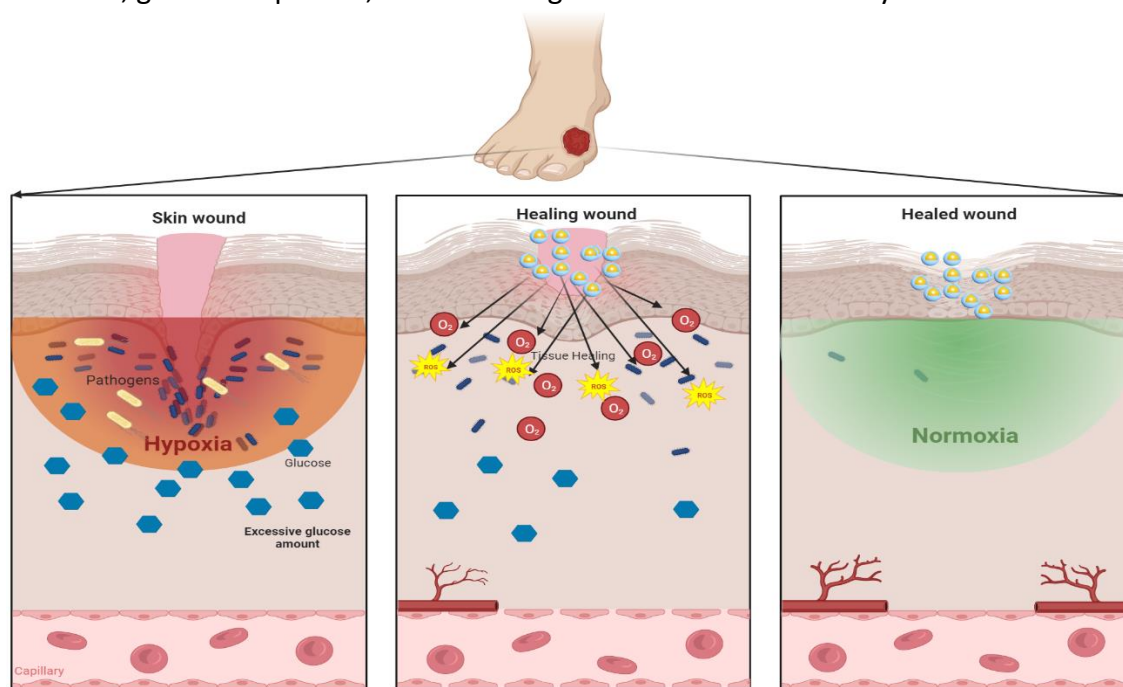
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#### Related articles:

- [1] X. Zhang, J. Fan, C.-S. Lee, S. Kim, C. Chen, M. Lee, Supramolecular hydrogels based on nanoclay and guanidine-rich chitosan: injectable and moldable osteoinductive carriers, *ACS applied materials & interfaces*, 12 (2020) 16088-16096.
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## Multifunctional nanozyme complex for diabetic wound healing

Chronic diabetic wounds pose significant challenges to the healing process due to high glucose levels, impaired physiology, and limited oxygen delivery. Nanotechnology offers promising solutions by utilizing nanozymes, specifically gold (Au) and platinum (Pt) nanozymes. These materials exhibit glucose oxidase-like (GOD) and peroxidase-like (POD), Catalase-like (CAT) activities which can promote wound healing in multiple ways. The nanozyme complex combines the strengths of Au and Pt nanozymes to address various aspects of wound healing. It generates reactive oxygen species (ROS), including hydroxyl radicals, to eliminate bacteria and prevent infections. Simultaneously, it depletes glucose, and generates oxygen, inhibiting bacterial growth and accelerating tissue regeneration. Additionally, its photothermal properties induce hyperthermia at the wound site, further aiding in bacterial elimination, improving circulation, and stimulating growth factors. This project aims to develop a novel core-shell platinum/gold phenolic nanozyme complex using tannic acid (TA) as a reducing agent. The key steps include optimizing the Au to Pt molar ratio, characterizing the complex, and evaluating its GOD, POD, and CAT activities. This multifunctional nanozyme complex holds promise for acute wound healing by targeting infection, glucose depletion, and tissue regeneration simultaneously.



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Related literature:

1. <https://doi.org/10.1021/acsnano.3c06833>
2. <https://doi.org/10.1021/acsnano.3c04134>

## Targeted Enhancement of Platinum Nanozymes for Cancer Therapy: Polymeric Ligand Engineering for Superior Catalytic and Therapeutic Delivery

Nanozymes, nanomaterials with enzyme-mimicking activities, offer a new frontier in cancer therapy by simulating multi-enzyme systems to catalyze therapeutic reactions within the tumor microenvironment. Platinum (Pt) nanozymes, in particular, exhibit a broad spectrum of enzyme-like activities, including oxidase, peroxidase, and catalase mimetics, which can be exploited for targeted cancer therapy through the modulation of reactive oxygen species, drug release, and bioimaging. This project aims to enhance the functionality of Pt nanozymes through surface engineering with chitooligosaccharide and other polymeric ligands such as polyethylene glycol (PEG), polyvinylpyrrolidone (PVP), and polyaniline (PANI). By optimizing the interaction between Pt nanozymes and these ligands, the project seeks to improve catalytic efficiency, enhance bioimaging capabilities, and achieve precise therapeutic delivery. Additionally by integrating Pt nanozymes with carbon and graphene quantum dots, the research explores the quantum dots' photoluminescent properties for real-time bioimaging. Further, the conductive and expansive surface of graphene quantum dots is investigated for its potential to boost electron transfer, thereby enhancing the catalytic efficiency of Pt nanozymes for improved biosensing and therapeutic applications. This work offers a comprehensive understanding of Pt nanozymes coated with chitooligosaccharide and polymeric ligands, as a novel pathways for efficient, targeted cancer therapy strategies.



Schematic illustration of for the synthesis of surfaced ligand-engineered platinum nanozyme dopped on carbon quantum dot (SLE-Pt-PQD) (*Abstract of the Master thesis project' created in Biorender.com*)

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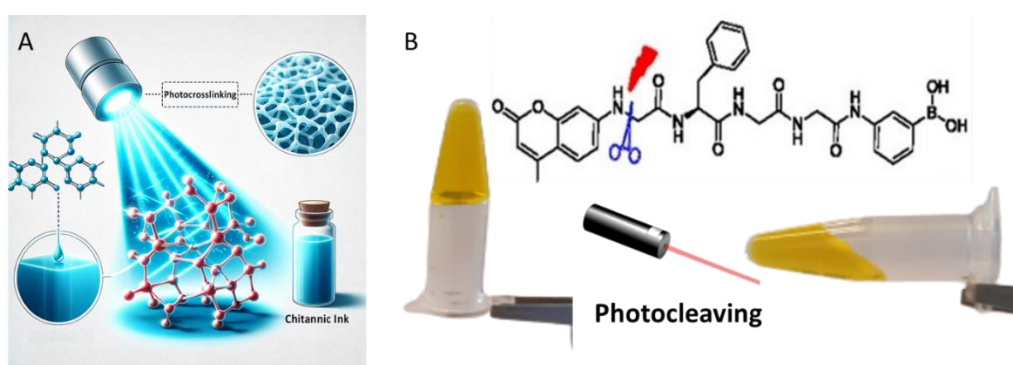
Related Literature:

1. <https://doi.org/10.1016/j.cej.2024.149312>
2. <https://doi.org/10.1016/j.nantod.2023.101768>
3. <https://doi.org/10.1002/adma.202300387>



## New class of chitosan-based biomaterials ink

The landscape of drug discovery and development is undergoing a transformation, thanks to the emergence of 3D bioprinting. Tissue engineering, with its ability to create 3D tissue constructs that closely resemble native human tissues, has the potential to overcome these challenges and transform the drug discovery process. Traditionally, 3D bioprinting has relied on animal-based materials like gelatin and collagen predominantly sourced from bovine, which carry the risk of transmissible diseases. To support living cells during the printing process. In response, this project **seeks to develop sustainable and ethical bioinks, focusing on the use of chitosan, a biopolymer derived from the shells of crustaceans like shrimp and crabs**. Unlike bovine-derived gelatin and collagen, chitosan is sourced from marine organisms and does not carry the same risks of disease transmission, presenting a safer and more ethically sound option for bioprinting applications. Moreover, chitosan functional groups such as the amino groups and the primary and secondary hydroxyl groups at the C-2, C-3, and C-6 positions, allow extensive chemical modification of chitosan to design chitosan-based hydrogels for 3D printing applications. Chitosan and its derivatives, in the form of hydrogels or pastes, have been utilized in various 3D printing methods for their potential use in tissue engineering, such as for the regeneration of bone, cartilage, nerve, and blood vessels as well as drug delivery systems. In this regard, carboxymethyl chitosan, a water-soluble derivative of chitosan has not been extensively utilized in 3D printing applications compared to chitosan. This project aims to develop a new class of bioink using chitosan and cellulose derivatives for designing visible light curable biomaterials ink and light-responsive support ink.



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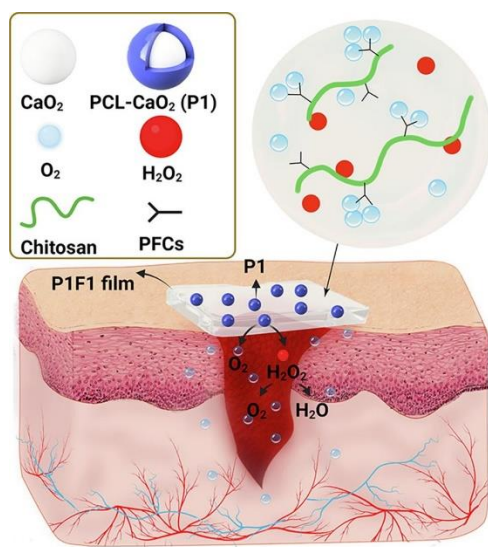
Related literature:

1. <https://doi.org/10.1039/D1GC01799C>
2. <https://doi.org/10.1002/smt.202301341>

## Oxygen Carriers Meet Nanozymes: A Novel Pt Nanozyme-Integrated System for Enhanced Wound Healing

Addressing hypoxia in chronic wounds is pivotal for effective healing. This project explores a new approach by combining oxygen-releasing materials with Pt nanozymes within an injectable hydrogel, offering sustained oxygen supply and reactive oxygen species (ROS) scavenging with enhanced stability and efficacy. The Pt nanozymes, chosen for their dual catalase and superoxide dismutase activities, provide a broader therapeutic action compared to traditional enzymes, alongside the prolonged release of oxygen due to their integration with calcium peroxide (CPO) and perfluorocarbon (PFC) in polycaprolactone (PCL) particles. This multi-component system promises not only to mitigate hypoxia but also to ensure a controlled, extended therapeutic effect, vital for the regeneration of damaged tissues. This research will encompass **the synthesis and characterization of Pt nanozyme-loaded PCL particles, their integration with CPO and PFC into an injectable hydrogel, and the evaluation of the system's O<sub>2</sub> generating and ROS scavenging capabilities *in vitro***. The ultimate goal is to demonstrate the system's potential to improve hypoxic wound healing outcomes through sustained oxygen delivery, enhanced ROS scavenging, and overall improved stability and functionality compared to current biotherapeutic approaches.

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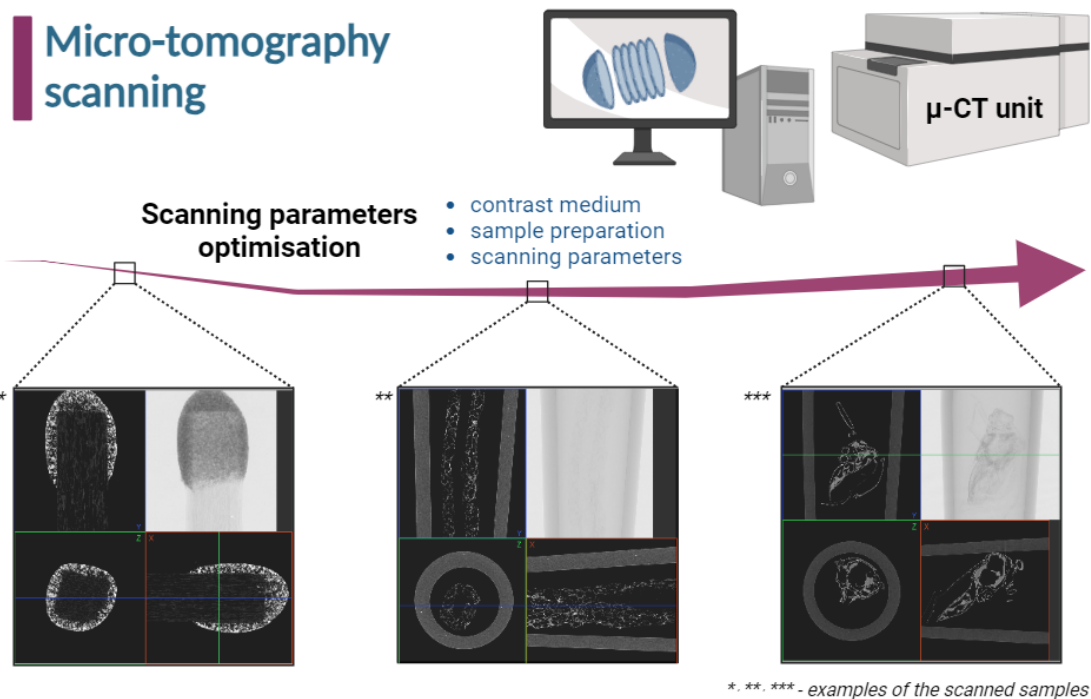
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Related literature:

1. <https://doi.org/10.1016/j.cej.2023.145072>
2. <https://doi.org/10.1021/acsami.0c14822>

## Discovering the inside – optimization of the scanning conditions to precisely explore the interior of 3D structures

Micro-computed tomography ( $\mu$ CT) is widely used for the study of mineralized tissues, but a similar use for soft tissues is hindered by their low X-ray attenuation. This limitation can be overcome by the recent development of different staining techniques. Staining with Lugol's solution stands out among these techniques for its low complexity and cost. During this project, the aim is to optimize the quality and reproducibility of the staining to increase the resolution of soft-matter visualization in the context of hydrogels for tissue regeneration. **The project include optimizing the Lugol staining process for hydrogel materials by evaluating the effect of different concentrations and a variation in sample storage times before/after staining.** Finally, the potential of staining techniques to evaluate interior porosity of soft hydrogel material will be demonstrated. This information is foreseen to help improve the understanding of the regenerative process involving soft tissues and hydrogels providing a 3D context to histological and SEM-based findings.



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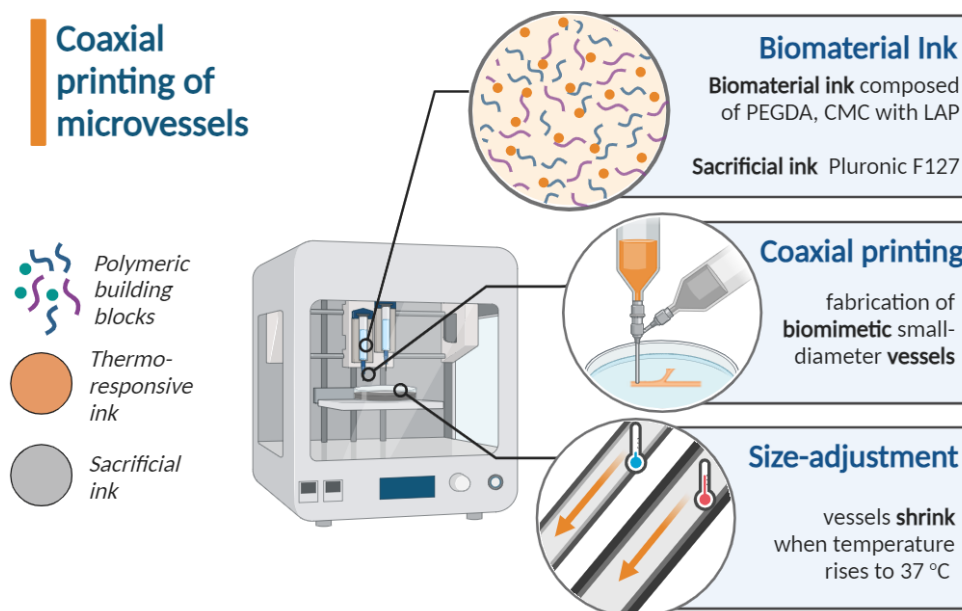
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- <https://doi.org/10.1007/s10856-017-6024-2>
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## Biomimetic Core-Shell Printing of Vascular Structures with the Ability to Shrink After Fabrication

Vascularization is key to the success of tissue engineering, and also one of the biggest challenges. 3D bioprinting techniques stand out among other methods used to create artificial vasculature. Among them, coaxial 3D printing has arguably captured the most attention allowing easy and inexpensive manufacturing of complex multimaterial structures in a one-step fabrication. Nonetheless, the challenge remains in fabricating small diameter vessels (<80  $\mu\text{m}$ ), one that is crucial to provide oxygen and nutrients to the cells, as well as eliminate metabolic waste. One of the ideas that can reduce the size of engineered vessels and bring them closer to their native counterparts is post-manufacturing shrinkage. In this mechanism the fabricated larger-diameter vessels reduce their lumen diameters post-fabrication in response to an environmental stimulus e.g. temperature.

Within this project, **we will explore the opportunities of core-shell extrusion printing for the creation of biomimetic vessels from biocompatible hydrogel materials. Using thermoresponsive polymeric blocks (NIPAM) we will optimize the hydrogel post-printing shrinkage and monitor the structural changes.** In the latter stages, we will test the mechanical behavior and perfusion abilities of the fabricated 3D models.



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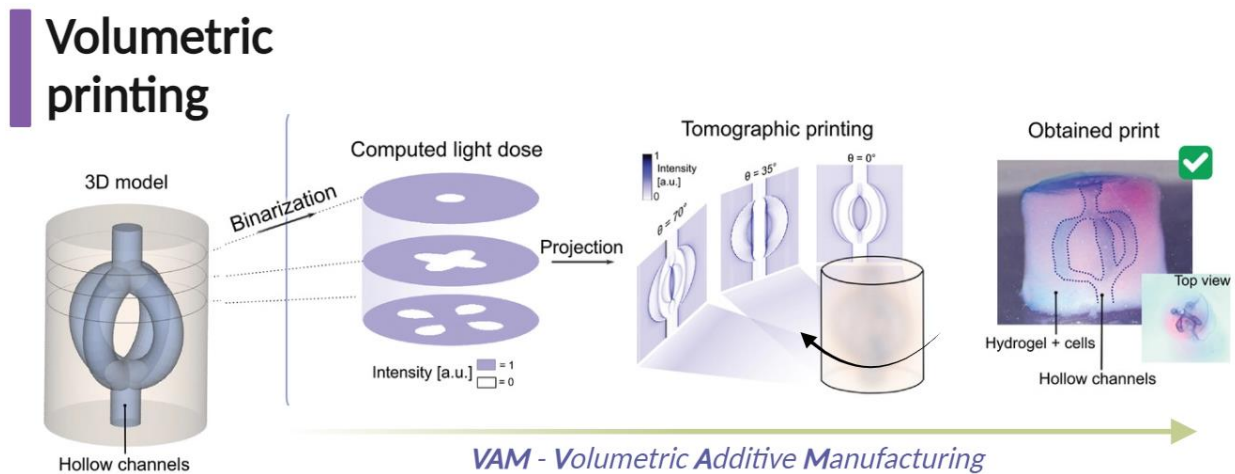
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## Advanced Biomaterials and Volumetric Additive Manufacturing (VAM) for Customized Tissue Engineering Applications

Tissue engineering is seeking innovative solutions to regenerate, repair, or replace damaged tissues and organs. Additive manufacturing (AM) has emerged as a technology for creating complex, patient-specific geometries. Among AM techniques, Volumetric Additive Manufacturing (VAM) stands out as a groundbreaking layerless fabrication method that allows unprecedented speed and precision in the creation of three-dimensional structures. Unlike traditional layer-by-layer approaches such as Digital Light Processing (DLP) and Direct Ink Writing (DIW), which may take minutes to hours for the production of comparable structures, VAM can fabricate intricate 3D geometries within seconds. This is achieved by irradiating a rotating resin vial with controlled light exposure in specific projections, inducing the crosslinking of the resin into a solid 3D object through voxel-based gelation. This master thesis project aims to explore the innovative domain of Volumetric Additive Manufacturing (VAM) for tissue engineering, focusing on the modification and processing of photocurable biomaterials with light-based curing mechanisms. The research encompasses identifying and modifying biomaterials for optimal biological compatibility and mechanical properties suitable for VAM, optimizing VAM processing protocols for precision and uniformity in 3D constructs, and performing a set of characterization—rheological analysis for viscoelastic properties, mechanical testing for structure durability, and microscopic examination for microarchitecture insights. Through this project, you will gain profound insights into the interdisciplinary fields of biomaterial science and additive manufacturing, acquiring valuable skills in biomaterial modification, process engineering, and structural characterization.



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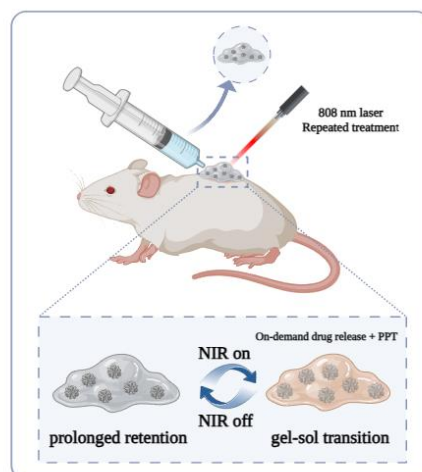
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- <https://doi.org/10.1002/advs.202105144>

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### Construction of nanozymes composite antibacterial system

Chronic wounds in diabetics can be difficult to treat due to a complex and severe inflammatory microenvironment that includes excessive reactive oxygen species (ROS). Therefore, it is crucial to create materials that can reduce the harmful effects of excessive ROS locally. Nanozymes, as a type of nanomaterials with biological enzyme characteristics, can improve the detrimental microenvironment of diabetic wounds by catalyzing the hydrogen peroxide ( $H_2O_2$ ) in the diabetic wound microenvironment through its enzyme-like activity, which has a good potential in the treatment of diabetic wound. Near-infrared (NIR)-responsive hydrogels have exhibited remarkable advantages in biomedical applications, especially for in situ therapeutic delivery, because of their deep-tissue penetration capacity, minimal invasiveness, and high spatiotemporal selectivity. Based on the above, the purpose of this project is to prepare a photothermal responsive hydrogel loaded with nanozyme. To achieve this goal, several steps must be taken:

- A) Prepare the photothermal responsive hydrogel
- B) Incorporate the synthesized nanozyme into gels
- C) Evaluate the physical and chemical properties of the developed hydrogels.



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#### Related literature:

- <https://doi.org/10.1021/acsnano.8b09501>
- <https://doi.org/10.1002/sml.202200165>
- <https://doi.org/10.1016/j.actbio.2019.07.024>
- <https://doi.org/10.1016/j.bioactmat.2023.03.005>

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## Exploring Optimal Biocrude Production via Hydrothermal Liquefaction Using Simplex Centroid Design with a Quinary Food Waste System: Waste to wealth

### Abstract:

Hydrothermal liquefaction (HTL) of food waste represents a promising avenue for sustainable biofuel production, offering significant potential for waste valorization and renewable energy generation. However, optimizing the composition of feedstock mixtures is crucial to maximize biocrude yield and quality. Against this backdrop, the student will utilize the Simplex Centroid design to explore a quinary mixture of locally sourced food waste, specifically coffee grounds, tea waste, pastries (bread) waste, fruit (apple pomace) waste, and vegetable waste, for optimal biocrude production via HTL. These waste streams have been identified as the major contributors to food waste in Belgium (Gelder, 2021). The experimental setup will involve selecting a central point within the simplex, representing an average composition of food waste components, including carbohydrates, lipids, proteins, lignin, and moisture. Additional experimental points will be systematically generated along radial vectors extending towards the vertices of the simplex, covering a broad range of mixture compositions. By systematically varying the proportions of food waste components, the Simplex Centroid design will facilitate the identification of key compositional factors influencing biocrude production. Subsequently, the student will conduct HTL reactions under various generated mixing ratios at specified conditions of temperature, pressure, and residence time. The analysis of experimental data will encompass quantifying biocrude yield and characterizing biocrude properties such as elemental composition, heating value, and functional groups present. Statistical analysis techniques will be employed to determine the optimal mixture composition for maximizing biocrude production. Ultimately, it is anticipated that the findings of this study will contribute to optimizing feedstock composition for HTL-based biocrude production from Belgian food waste, with implications for waste management, renewable energy production, and sustainable resource utilization. Leveraging the Simplex Centroid design, this research advances our understanding of the intricate relationships between feedstock composition and biocrude production, thereby paving the way for more efficient and sustainable biofuel production processes.

*Keywords: hydrothermal liquefaction; mixing modeling; Simplex Centroid Design; food waste; circular economy.*

### Requirements

1. The candidate should have an excellent academic background preferably a BSc (or BEng.) degree in Chemical/Process/Biomaterial Engineering with a minimum of a 2.1 graduating grade point.
2. The candidate should be motivated and have a strong desire to learn and improve.

### References

- Bezerra, M.A., Lemos, V.A., Novaes, C.G., de Jesus, R.M., Filho, H.R.S., Araújo, S.A., Alves, J.P.S. 2020. Application of mixture design in analytical chemistry. *Microchemical Journal*, **152**, 104336.
- Gelder, K.v. 2021. Weekly household food waste in Flanders (Belgium) 2017-2018, by product type. Statista.

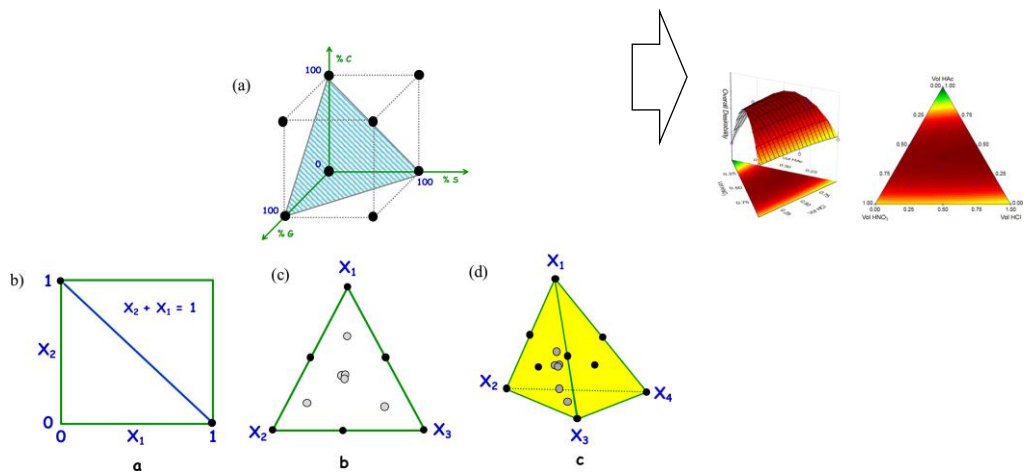


Illustration of the mixture design (adapted from (Bezerra et al., 2020))

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## Kinetic Investigation of Biodiesel Production from Wet Food Waste via an in-situ catalyst-free subcritical transesterification process: A Sustainable Approach to Waste Valorization

### Abstract:

The increasing demand for sustainable energy sources has sparked considerable interest in biodiesel production from renewable feedstocks. This research project aims to investigate the kinetic aspects of biodiesel production from moisture-containing food waste, aiming to contribute to the efficient utilization of organic waste streams and the development of environmentally friendly biofuel production processes. Moist food waste, a substantial component of municipal solid waste, holds promise as a biodiesel feedstock due to its typically high lipid content. The student will delve into the kinetics of transesterification, the primary process involved in converting lipids into biodiesel. In-situ catalyst-free subcritical transesterification reactions will be conducted under varying reaction conditions, including temperature and reaction time, to examine the effects of these parameters on reaction kinetics and product yield. Particularly, the influence of moisture content on kinetics and biodiesel production mechanisms will be investigated. To this regard the student will propose similar mechanisms for instance a series mechanism (wet food waste → in-situ lipid recovery → biodiesel) and will employ basic rate equations based on conventional kinetic reactions such as  $r = \frac{dx_p}{dt} = -kx_p$  for a simple reaction (i.e. P → D+C). These rate equations are ordinary differential equations (ODEs) that will be solved to determine the  $k$  values at different temperatures. It is expected that the experimental outcomes will unveil the intricate kinetics of biodiesel production from moist food waste, along with the impact of moisture content, temperature, and time on reaction rates. The student will employ kinetic modeling to elucidate the reaction mechanisms and derive rate expressions for transesterification under different conditions, thereby providing insights into optimal reaction conditions for maximizing biodiesel yield. It is expected that this research project will contribute to the advancement of sustainable waste valorization strategies by offering a comprehensive understanding of the kinetics of biodiesel production from moist food waste. The findings will provide valuable insights for enhancing product yield and minimizing environmental impacts, thereby fostering the development of a circular economy and reducing reliance on fossil fuels.

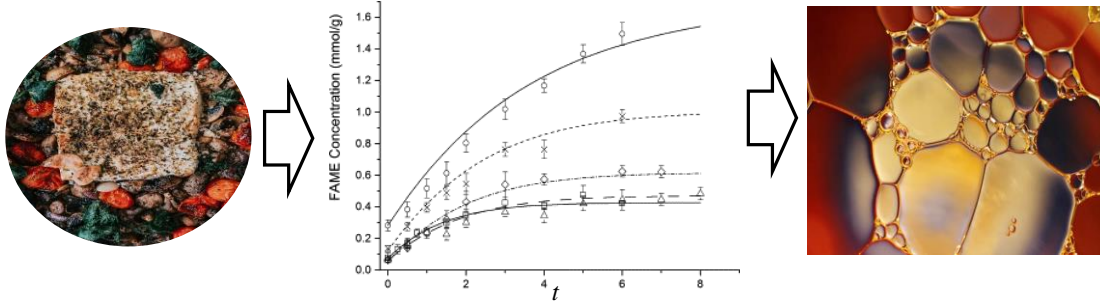
*Keywords: subcritical in situ transesterification; kinetic modeling; catalyst-free; biodiesel; circular economy.*

### Requirements

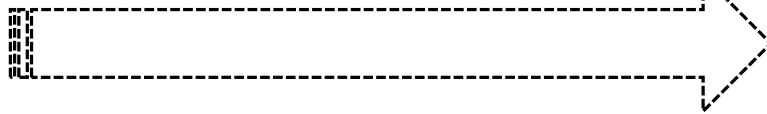
1. The candidate should have an excellent academic background preferably a BSc (or BEng.) degree in Chemical/Process/Biomaterial Engineering with a minimum of a 2.1 graduating grade point.
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### References

Liu, S., Nie, K., Zhang, X., Wang, M., Deng, L., Ye, X., Wang, F., Tan, T. 2014. Kinetic study on lipase-catalyzed biodiesel production from waste cooking oil. *Journal of Molecular Catalysis B: Enzymatic*, **99**, 43-50.



*Kinetics of transforming moisture containing food waste to biodiesel*



Graphical abstract (rate curves adapted from (Liu et al., 2014))

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