ADVANCED SILICATE-BASED THERAGENERATIVE PLATFORMS FOR SIMULTANEOUS CANCER THERAPY AND TISSUE REGENERATION

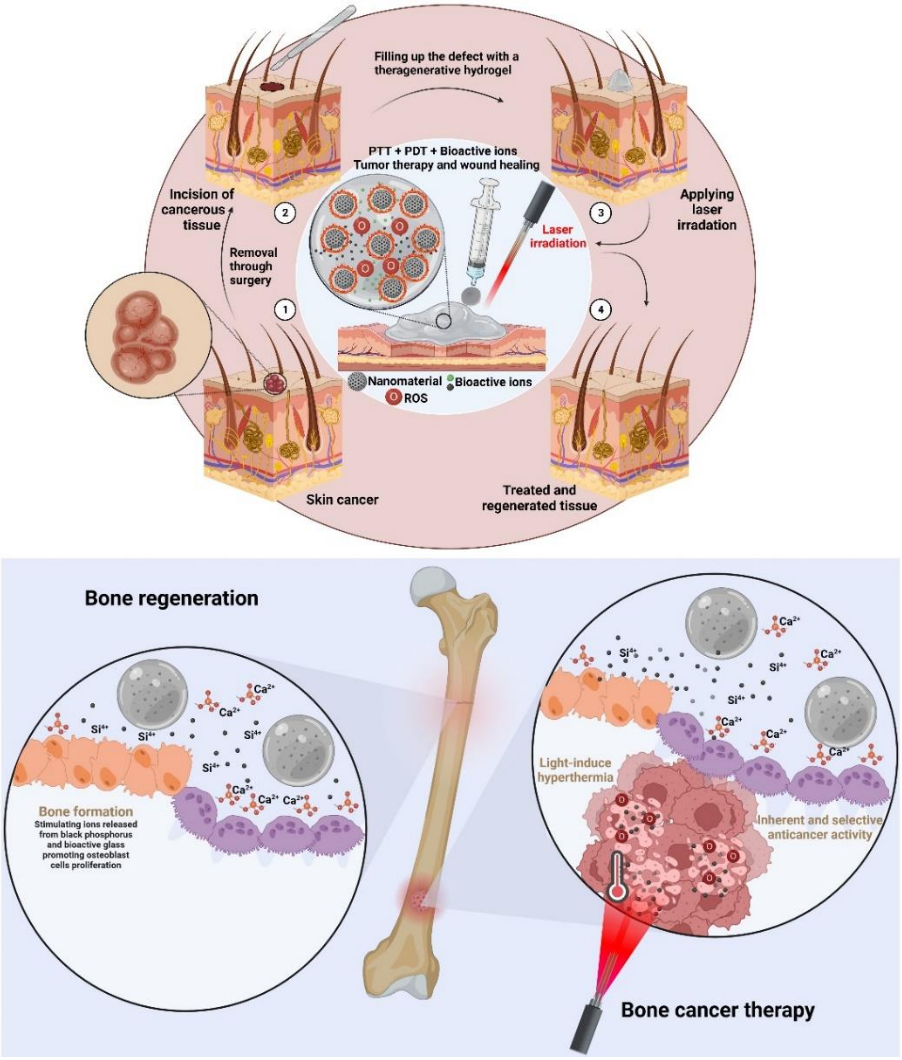
Ashkan Bigham – Advisors: Prof. Maurizio Ventre; Dr. Maria Grazia Raucci
Curriculum: Ingegneria dei Materiali e delle Strutture

Tissues and organs of body may undergo wide variety of diseases and treatment of them potentially can induce damage to the surrounding healthy tissues and organs. Therefore, in parallel to the applied therapeutic techniques, the damaged tissues can be regenerated by multifunctional platforms. Recently, considerable attention has been devoted to a new multifunctional group called theragenerative; this term resulted from the combination of therapy and regeneration. These biomaterials are of great importance because they can be responsive to external stimuli to induce photothermal therapy, photodynamic therapy, and magnetic hyperthermia or even they can induce anticancer activity through intrinsic anticancer activity and/or chemodynamic therapy without any stimulus [1]. Up to now, theragenerative platforms have been applied in bone, skin, and breast cancer therapy and regeneration and the *in vitro* and *in vivo* results were promising.

Silicate-based ceramics refer to crystalline and amorphous compounds made of mainly silica and extensive subcategories. Their degradable nature and biocompatibility led them stand out in the bioceramics family. One of the competitive advantages of silicate-based ceramics to calcium phosphate compounds is their bioactivity even if they are sintered at high temperatures [2]. Ceramics generally suffer from brittleness and so higher sintering temperatures are applied to address this issue. However, these temperatures turn most of the ceramics into bio-inerts biomaterials—incapable of interacting with the biological medium leading to the formation of a fibrotic tissue around it and loosening. In contrary to calcium phosphates, silicate-based ceramics do not lose their bioactivity even after being completely sintered at high temperatures. Nonetheless, it has been exhibited that the ions released from these silicate-based bioceramics—SiO_4^{4-}, Ca^{2+}, PO_4^{3-}, etc. can promote bone and skin healthy cells towards proliferation [3].

2D materials have gained interest in biomedical applications in the last decade due to extraordinary physicochemical properties. Mxenes like MoS2 have also become very popular in cancer therapy. These materials are responsive to external light and ultrasound irradiations by which different anticancer approaches can be adopted. Based on the wavelength of applied light, these 2D nanomaterials can induce photothermal therapy (PTT) and photodynamic therapy (PDT). The former or PTT relates to the increasing in the local temperature up to a level by which the cancer cells undergo irreversible damage while no damage would be induced to healthy cells. The latter or PDT ascribes to the oxidative stress these materials can apply on the cancer cells; the irradiation mainly in the wavelength of 600 nm to the nanomaterials soaked in physiological medium causes change in the surface electrons and holes leading to the production of reactive oxygen species (ROS). These ROSs are high in concentration and can induce cytotoxicity and apoptosis to cancer cells [4,5].

This project aims at design and development of different theragenerative platforms for cancer therapy and regeneration (**Scheme 1**). Injectable hydrogels will be designed and prepared for minimal invasive surgery encompassing silicate-based nanomaterials and 2D nanomaterials. Moreover, 3D bone scaffolds based on silicate-based nanomaterials will be fabricated for bone cancer therapy and regeneration. Different silicate-based nanomaterials and 2D nanomaterials are intended to involved for this purpose. The platforms will undergo physicochemical, morphological, and mechanical investigations to reach optimized properties and then enters to the *in vitro* studies to assess the therapeutic and regenerative potential by using healthy and cancer cell lines.



Scheme 1. Theragenerative platforms for simultaneous cancer therapy and regeneration. (Top) Schematic illustration of a theragenerative injectable hydrogel for skin cancer therapy and regeneration; the cancerous tissue after diagnosis is resected and replaced with an injectable hydrogel which not only eradicate remained cancerous cells but also promoted the regeneration process. **(Down)** An illustration of applying light-responsive theragenerative nanocomposites with intrinsic anticancer activity; the nanocomposites with and without light irradiation could eradicate cancer cells and stimulate bone tissue regeneration.

References:

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Ashkan Bigham, PhD student XXXVIII cycle, May 2023
ashkan.bigham@ipcb.cnr.it; ashkanbigham@gmail.com