Uncontrolled blood loss due to traumatic injuries and fierce war is a significant cause of death in both civilian and militant people globally. Hemorrhage is the most suggestive problem among both civilians and militants. It is demanding to control blood loss during surgery and military battles. Approximately 50% of wounded soldiers die of hemorrhage before getting to the hospital. Delayed medications during traumatic injuries or military fighting might lead to bacterial infection in wounds, which causes an increased mortality rate. Due to the increasing number of traumatic injuries nowadays, it is essential to synthesize hemostatic dressing materials that can potentially promote blood clotting through the independent mechanism of the human system. The traumatic wounds are instantly covered with dressing materials that protect the injury from blood loss, tissue damage, and bacterial infection. Bacterial infection is another significant public health threat. Antibiotics are widely used to treat bacterial infections. However, excessive use of antibiotics increases the generation of multidrug-resistant bacteria, leading to the failure of antibiotic therapy and prolonged hospitalization time, thus increasing the mortality and economic burden. Therefore, it is essential to develop safe and effective antibacterial agents.

The research aims to design and produce novel **"three-in-one" biomaterials using biopolymers, hybrid protein-inorganic nanoflowers, and plant extracts**. Many studies are focused on obtaining dressing materials with good biocompatibility. However, current solutions still need to be improved in controlling bacterial infection, blood loss, and strong clot adhesion to the hemostatic dressing, which causes pain, secondary bleeding, and possible infection during wound dressing removal. Therefore, the designed wound dressings will be a sponge that is porous, soft, and easy to remove**.** The various components of the designed material serve different roles. The biopolymer serves a triple function: (1) enhance the antibacterial ability of the hemostatic wound dressing material, (2) facilitate the adhesion of blood cells, and (3) facilitate the clotting ability of blood. The hybrid nanoflowers serve dual roles: (1) they will increase the antibacterial activity of the hemostatic wound dressing material, and (2) activate various clotting cascades, thereby enhancing blood clotting capacity. Plant extracts mainly enhance antimicrobial and anti-inflammatory properties.

A complete and rich characterization of the physicochemical properties will be performed. The most promising materials will be evaluated for their biocompatibility. Indeed, it will be interesting to perform biological studies using a non-standard, innovative model: **3D artificial skin equivalents**. Studies into potential dressing agents are carried out, mainly on mouse or human fibroblast cell lines. Since cells making up human skin tissue grow within an organized three-dimensional (3D) matrix continually surrounded by neighboring cells, standard monolayer (2D) cell cultures do not recapitulate the physiological architecture of the skin. The 3D artificial skin model consists of normal human epidermal keratinocytes and human dermal fibroblasts. Therefore, using this type of model will be an essential and innovative approach to new dressing materials. Antimicrobial properties will also be investigated using two bacterial strains: *Staphylococcus aureus* and *Pseudomonas aeruginosa*, which are the most common bacteria associated with wound infections.

The project is expected to combine nanotechnology and materials chemistry with medical science, which could lead to significant advances in medical science, particularly wound healing. The findings of this study will provide important information on factors impacting the synthesis of biomaterials containing nanoflowers and natural active ingredients most relevant to the subject of material chemistry. The outcomes may largely contribute to developing the science of controlling hemorrhage and treating bacterial infections of wounds, which are significant factors in mortality among militants. Designing and obtaining new biomaterials will also help to understand the interactions of active substances in biomaterials with factors in the wound healing environment. This, in turn, will speed up healing processes and improve patients' quality of life in the long run. The latter is, in fact, crucial since many patients experience fear of disfigured bodies and possible future psychological implications and limitations caused by wounds that won't heal. Hence, social sciences may benefit from this study. Additionally, using biodegradable biomaterials in dressings may encourage patients and their care providers to use environmentally neutral products.