Treating Wounds with Ovine Wool Keratin
(Technical Paper)

Examining the Impact of Race on Patient Treatment and Prescriptions
(STS Paper)

A Thesis Prospectus Submitted to the
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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

My general research area will focus on the potential applications of ovine wool keratin as treatment for radiation burns. It is important to approach this project with constraints to prevent endless research. By focusing on the medicinal properties of keratin and framing its ability to continuously release growth factors, I seek to determine if it will make a more effective hydrogel in treating wounds. These wounds will include, but are not limited to; thermal and radiological burns, and continuous radiation injuries. With a possibility of nuclear war in the future of the world, proactive studies like this can positively impact thousands of lives.

Burns are some of the most severe injuries which often cause lifelong damage. These injuries also have a huge effect on the patient's quality of life with everyday tasks becoming difficult due to limitations of operating with burn wounds. There are many cosmetics companies that are turning keratin into hydrogels, however there has not been much application into treating ailments such as radiation dermatitis with a keratin hydrogel. Keratin is a biomaterial with lots of potential in a variety of medicinal applications. It has great capabilities in tissue engineering due to its biocompatibility, ability to biodegrade, and its ability to harbor many growth factors. Keratin based hydrogels have been used in clinical studies on mice in the context of volumetric muscle loss injuries. These keratin hydrogels were backed with growth factors that expedited the regeneration of muscle. Due to keratin hydrogels' large affinity for regeneration, it is currently used to treat burns.

Technical Project

My technical project is currently partnered with Molecular Biologicals, a cosmetics company in Charlottesville, which specializes in using ovine wool keratin to treat these substantial injuries. I will be working with them to determine the most effective way to derive a keratin hydrogel that treats radiation burns. Radiation burns are most common as a side effect to radiation therapy which is a common treatment for cancer. I plan on frequently consulting with researchers at Molecular Biologicals, and even use some of their clinical data in order to make advancements specifically in the area of radiation dermatitis. In addition, by sitting in at meetings between this company and the director of the Radiological and Nuclear Countermeasures Branch based in DC, I will be gaining lots of knowledge into possible applications to aid for war.

An important aspect to consider is how the keratin hydrogel will set off the cascade of reactions known as wound healing. It is important to understand not only how to treat a wound, but how to manipulate the process by which a wound heals. The wound healing process is intricate and with many different factors impacting the way it transpires. Biologically the skin has many specific functions. Primarily it protects the body from the invasions of pathogens. Once this barrier is damaged the body must rid itself of foreign bodies, restore injured vasculature, and then reseal the barrier. According to “Keratin Biomaterials in Wound Healing” there are 4 steps the body undergoes is haemostasis (the formation of clots), inflammation, proliferation (creation and migration of new cells), and then reorganization (the process of restoring a natural/uninjured look to the area). While there won’t be one single wound dressing that is best in all 4 phases of wound healing it is important to demonstrate which specific phases keratin would be most effective and why. It will be important to test keratin

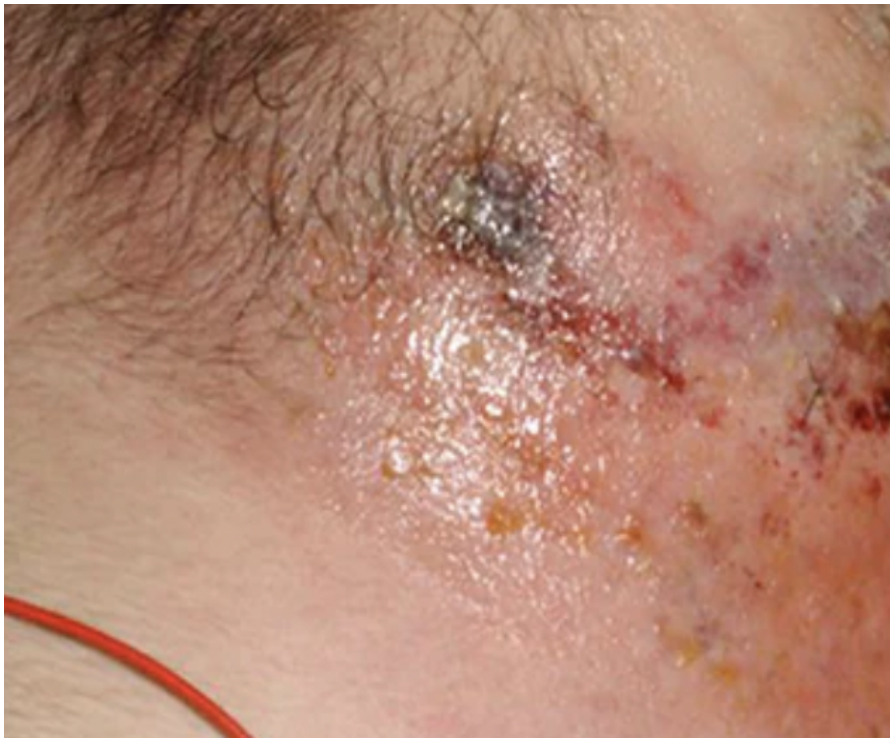
samples over time in order to see how it changes over time. It is possible that entropy will favor keratin to bond in a specific arrangement.

By discussing the detriments of previous materials used for wound healing I can show how keratin makes up for these setbacks and is overall a better material for wound healing. A popular material in wound healing is gauze. That was one of the first materials in the modern area used to treat wounds. Previous information dictated that a dry wound healed better than a wet wound. Gauze is able to soak up moisture, and also dissolves into small pieces over time. However, it proved extremely hard to remove, which ultimately gave rise to an era in which biodegradable wound dressings have become popular. Biological hydrogels are essentially biodegradable wound dressings that can deliver growth factors overtime and affect the biology surrounding a wound. To reconnect to the 4 steps of healing keratin is able to create a robust wall to prevent pathological invasions and also create an environment which supports proliferation of cells.

Keratin also shines in its ability to reorganize. This is another crucial aspect in wound healing. Based on “Postsynthetic Modifications of Mammalian Epidermal a-Keratin” by Peter M. Steinart and William Idler, the polypeptides of bovine alpha keratin were tested and have the ability to reassemble filaments spontaneously in vitro. This is a crucial property of keratin that allows it to be better utilized in wound healing, especially in wounds of the skin. Keratin is an important component in the epithelial of the skin, so having a hydrogel that can reorganize filaments in the outer layer of the skin could be crucial in determining how keratin can be effective in healing wounds to the skin. Due to its intrachain disulfide bonds after being implanted these It must be

determined if other biomaterials such as collagen also contain this property. Electron microscopy is a popular method of examining filaments, and can be used to determine if keratin exceeds other biomaterials in reassembling filaments. By studying keratin filaments over time it may be possible to determine if keratin will do a better job restoring the skin after a detrimental wound.

One major problem this project aims to solve is if keratin can aid in injuries sustained in radiation therapy. In order to determine this, the acute effects of radiation therapy and how they affect the skin must be understood. 95% of patients that undergo radiation therapy experience radiation dermatitis, which is inflammation of the skin as a result of radiation. These effects can be felt almost immediately while in some cases it can take months to manifest. Some people experience lesions, inflammation, erythema and dryness. In order for a keratin gel to be effective it must combat these factors. Research will need to be done into keratin based skin products to determine how exactly they help the skin. Simply adding moisture won't be enough, it must show that keratin can also be used in order to prevent and repair damage. It has been commonly thought that ointments increase the damage incurred by radiation therapy, however a study by Penn Medicine study completed in 2018 determined that is a falsehood. This opens the door to using a keratin ointment before therapy in order to prevent catastrophic damage to the skin. The image below shows damage to the skin as a result of cancer therapy.



Time Schedule

This project will require intensive research into the chemical makeup of keratin and all of its medicinal properties. Additionally, there needs to be research into how thermal and chemical burns heal. After enough research is done to make concrete hypotheses, an experiment will be conducted in order to confirm or reject the hypotheses. It will be impossible to design an accurate and helpful project without learning the necessary rudimentary knowledge to truly understand the problem and potential solutions.

STS Project

It is also crucial to determine how racial disparities could affect how this product could be implemented. In a National Library of History Article titled “Racial Disparity in Cancer Treatment” it says there currently exist disparities in timely diagnoses as well as provisions of necessary treatment. The nature of this disease necessitates preemptive

and quick action in order to prevent the rapid proliferation and migration of cancerous cells. There are disparities all the way up to healthcare providers, in which they have not been providing equal amounts of cancer screenings. It was far more likely that a black man would get a cancer diagnosis before any clinical screenings than a white man. This means much more often that white men had more time to take preemptive measures in order to prepare for the potential of having cancer. Obviously this disease catches many people by surprise, but statistics show more of a trend in the black community. At first glance, it seems that socioeconomic situations largely determine the way a person gets diagnosed and then treated for cancer. Furthermore, people of color are more likely to get later stage diagnoses, these diagnoses largely determining whether or not the cancer would be lethal. There is also research to be done to determine how race affects the likelihood of receiving a cancer diagnosis. In order to keep healthcare companies honest for everyone, there needs to be demonstrated effort into promoting equality.

Conclusion

In order to improve the area of wound healing in the context of thermal and radiological skin wounds, I will be investigating the possibility of using a keratin based hydrogel in order to aid healing. This project will demand research into the chemical makeup and biological properties of keratin, as well as physical electron microscopy testing of keratin in order to study its potential regenerative properties. Furthermore, I will be exploring how race affects certain people's ability to benefit from research like this.

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