Self-Healing in Biological and Manmade Systems

Kaveri Salunke, Hannah Ullberg, Tyler Betker, Dr. Pradeep Rohatgi
Department of Biomedical Engineering, Department of Materials Science and Engineering

Introduction

•Shape restoration exists in many ways in biological systems

•Process of self-healing in manmade materials are similar in many ways

•Manmade materials can self-heal using capsules that contain polymers or a solution

•These are released when a rupture in the metal breaks open the capsule which heals the rupture

•Self healing in biological systems occurs similarly

•Best example of self healing in the body is the skin

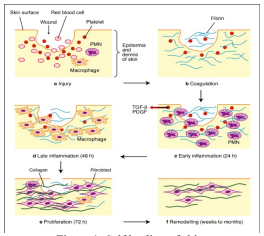

Figure 1: Self healing of skin

Objective

•Examine similarities and differences between biological and manmade systems

•Observe how manmade systems behave and how they can be used in the human body

•Identify what biological and manmade systems can learn from each other

Requirements for Human Body

- Low cytotoxicity to minimize immune responses and potential tissue damage
  - Using mesh nets to grow tissue and cell samples
- Capable of withstanding body's harsh environments
- Implanted as easily as current biomaterials and implants
- Should be biodegradable so the body can eliminate it
- Manmade materials should be able to last as long as possible without the worry of degrading
- Accelerate the healing process of the skin or other self-healing in the body

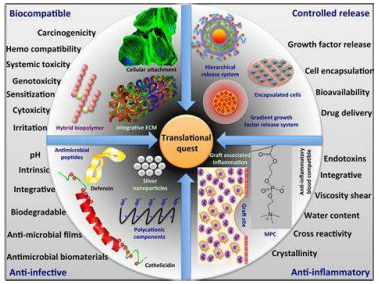

Figure 2: Requirements of manmade systems in order for them to be compatible with the human body

Manmade Systems

- Self-healing of manmade systems such as metals are very similar in concept
- If a rupture were to occur in the metal, it will be able to self heal and regain its strength
  - This is very similar in biological systems as well
- Different components are used in both metals and the human body to carry out the process of self-healing
- Clotting factors and they way they clot are similar in both systems
- Applying self-healing to manmade material implants can be possible in implants such as knee and hip joint replacements, insertion of rods, etc.
  - They would last longer and repetitive surgery would not be required to reinsert a new one
- One thing manmade systems can learn from biological systems is how much faster manmade systems heal

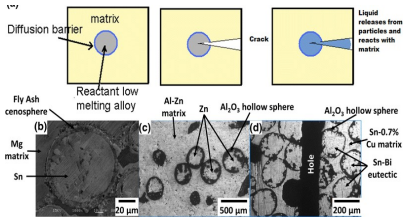

Figure 3: Self healing of metal alloy

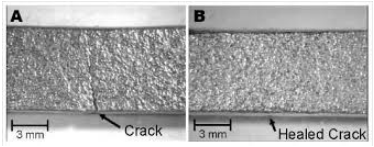

Figure 4: Before and after images of healed crack

Conclusions

•Similarities between the two systems makes it possible to apply self-healing materials in the human body

•Metals and other biomaterials would have to be compatible with the body

•Materials used cannot cause an immune response or damage to any other tissues and organs

•Procedures today such as implanting stents, rods, or other metals in the body works since the body is able to adapt to it

•The biomaterials being used have to be easily removeable if needed and if an injury is detected

•Materials used should be degradable if not needed so that the body can get rid of it

•Some research can be done in order to make manmade systems faster at healing

•One thing that can be done to make manmade systems autonomous is to have them detect things such as changes in pH, stress, temperature, etc. in the human body

Future Work

•Use of nanotechnology to enhance self-healing

•Use of nanoparticles for minor or smaller self-healing mechanisms

•Body's reaction to the self-healing metals and manmade systems

•Use of stem cells and self-healing metals when put together

•Examine how well biological and manmade systems can work together to make a wound, bone break, tissue, etc. heal faster

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