

Factors affecting Protein Adsorption on Titanium Orthopaedic Implants

Within Orthopaedics there are a large selection of materials that can be chosen for implantable medical devices such as a replacement femoral head or plates used to support diseased or broken bone. Despite growth in the use of ceramics and different coatings on metals, titanium remains one of the most prevalent metals within medical implants. Throughout this essay I will focus on the chemical interactions between titanium and the body that make it such a popular choice within bioengineering. Though this essay will focus on the chemical properties of titanium, the metal also has a number of useful physical properties that must be considered in detail before implantation such as titanium's low modulus of elasticity that closely matches surrounding bone tissue.

Context:

“A medical device is defined as *implantable* if it is either partly or totally introduced, surgically or medically, into the human body and is intended to remain there after the procedure” (1). Metals make up the majority of implanted devices within the human body with over 95% of implants used within orthopaedics made of metal(2). Titanium, first discovered in 1791 by William Gregor in Cornwall(3), is one of the most commonly used metals within orthopaedic and dental surgery alongside stainless steel. Such wide usage is thanks to titanium's excellent chemical and physical properties that enable high levels of osseointegration and cell proliferation with minimal risk of cytotoxicity, platelet and bacterial adhesion(2).

Cell proliferation (growth in number and/ or size of cells) and osseointegration (the fusion of bone to implant that is inseparable without fracture) are influenced by a number of factors, initially controlled by protein adsorption. Protein adsorption is the adhesion of thin films of proteins to an adsorbent surface such as titanium dioxide. Protein adsorption will be the main discussion point within this essay as it can be used to discuss some of the key concepts within A level chemistry. Namely:

- Catalysis
- Intermolecular forces
- Reaction Rates and Kinetics
- Proteins

An introduction to the Bone Repair process:

Whenever an implant is introduced to bone within the body it is likely the bone is damaged in the process e.g. placing screws to secure a plate. Therefore it is extremely important for the implant not to hinder this repair process.

Fig 1: Stages of Bone Healing (in the event of a transverse fracture)

