CHAPTER 1
INTRODUCTION

1.1 RATIONALE

Tribology is defined as the study of friction, wear, and lubrication. Biotribology, then, can be similarly defined as the study of friction, lubrication, and wear in biological systems, specifically articular joints. Articular joints are joints that can be moved or articulated; such joints have surfaces that must slide on each other, and therefore possess mechanisms by which they can maintain low friction and wear under normal operation. To prevent the ends of bones from coming into direct contact, each articulating surface is covered by a thin layer of cartilage; this softer, smoother material provides a low-friction, wear-resistant surface for sliding, and protects the bones from potential damage resulting from the high stresses of contact and impact.

Cartilage is a complex material consisting of both solid and fluid components. Although the frictional characteristics of various in vitro and in vivo cartilage systems have been studied extensively for decades, very little is known about the mechanisms by which cartilage is damaged and repaired in the body. The wear properties of cartilage have often been neglected in past studies by other researchers, in part because of the difficulty in accurately measuring and analyzing cartilage wear. The mechanisms of wear of healthy cartilage, and the many factors that affect them, must be better understood before the specific causes of degenerative joint diseases, like osteoarthritis, can be fully ascertained.

The present study, which focuses on the frictional and wear properties of healthy cartilage and synovial fluid, is part of a larger effort undertaken by Dr. M. J. Furey to explain the relationships between the biochemistry of the synovial joint system, cartilage wear and damage, and the causes of osteoarthritis [1,2,3,4,5]. The study is undertaken through collaborative efforts from the departments of Mechanical Engineering, Biochemistry, and Animal Science, and the Virginia Maryland College of Veterinary Medicine.
1.2 OBJECTIVES

The long-term objective of Dr. Furey’s Biotribology study is twofold:

1. Explore and define the connections between tribology, biochemistry, and cartilage wear and damage.

2. Apply this understanding of joint damage to learn about the specific causes of osteoarthritis.

In addition to these broad goals, several objectives are addressed specifically by the present study.

1. Determine the effects, if any, of variation of the lubricant on cartilage wear and friction in the cartilage-on-stainless steel system. The lubricants to be compared were a phosphate-buffered saline solution, this saline reference with added hyaluronic acid, and bovine synovial fluid.

2. Determine the effects of two loads (65 N and 20 N) on cartilage wear and friction in the cartilage-on-stainless steel system.

3. Verify past results obtained by Furey in cartilage-on-stainless steel experiments.

4. Examine detailed records of the friction force, friction coefficient, and vertical displacement, and explain the features that appear from cycle to cycle.

5. Analyze cartilage damage and wear using scanning electron microscopy under high magnification (from 22X to 2000X), and microscopic slides obtained through histological sectioning and staining.

6. Complete the process of modifying the design of the test apparatus, to reduce or eliminate problems with shaft instability.

7. Produce clear and understandable written protocols for all test procedures and analysis techniques; refine procedures for cutting cartilage plugs from their joints to improve the repeatability of this technique.