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Preface

The Editors and Publishers are to be congratulated on the welcome launch of this new Journal. There has been a great expansion of interest internationally in the areas highlighted by the new Title in recent years.

Perhaps the major imperative leading to this impressive growth of interest is the sheer excitement and challenge of applying knowledge and experience developed over many years in engineering and materials science to the understanding and solution of corresponding problems in biology and medicine. The challenges are immense, starting with the separation at school of life science subjects from mathematics, physics and chemistry at an early stage in several educational systems. Inadequate communication and understanding between practitioners with vastly different backgrounds remain major issues.

It was not long after the publication of the United Kingdom Department of Education and Science Report in 1966, that the term "*Tribology*" was listed in international dictionaries. It was defined simply as

> *"The Science and technology of interacting surfaces in relative motion and the practices related thereto"*

Most industrial nations have now established, active "*Tribology Societies*" and a World Congress brings *Tribologists* together every four years.

The term "*Biotribology*", was introduced only four years after publication of the *"Jost*" Report and defined as

> *"Aspects of tribology concerned with biological systems"*

It has taken another forty five years for specialist Journals in this field to emerge, although more general Journals have encouraged publications in this field. The field covered by "*Biosurface and Biotribology*" are immense, fascinating and diverse.

Material scientists have made major contributions to these fields, particularly in relation to the performance and durability of man-made materials and surfaces in the biological environment. The performance of man-made components such as replacement Teeth; Skin; Cartilage in degenerate Synovial Joints; Heart-Valves and Stents has been spectacular, although in a number of cases there have been disappointments. A remarkable number of people have benefitted from man-made implants, with total joint replacement being recognised as the major success story in orthopaedic surgery in the past century. Many of us have also benefited from the improvements achieved in oral surgery; particularly in relation to the development of satisfactory replacement materials for the worn or damaged enamel surface of teeth, but also in the development of much more effective instruments, including high speed drills.

Many satisfactory bio-tribological devices have emerged through an understanding and appreciation of the expertise and skills in disparate disciplines, offered, for example by tribologists, surgeons and physicians. This has emphasised the need for even greater appreciation of disparate skills and debates have taken place on the implications for the curriculum in many Institutions of Higher Education. This is evident in the growth of short Courses and a wide range of optional Courses in undergraduate and postgraduate schemes of study.

It can be just as challenging, and not infrequently frustrating, for tribologists and materials scientists to communicate adequately with physicians, surgeons, dentists and biologists as it is for life-scientists to explain the behaviour and functioning of biological tissues and systems to engineers. At the same time, this is one of the joys of working in this challenging, multi-disciplinary field.

There are many fascinating illustrations of the role of Biosurface and Biotribology in nature and the Animal World. Adhesion is just as important as Lubrication, as evidenced by Limpets and Geckos, the remarkable adoption of principles of fluid mechanics in the Flagella motors in Bacteria; the disparate forms of lubrication and wear in Teeth; the processing of foodstuffs in the Mouth; the lubrication of Red Corpuscles in narrow capillaries and the magnificent galaxy of lubrication systems evident, for example, in the chest; loaded Synovial Joints and the Eye. An intriguing feature of many applications of surface science and tribology in biology is the emergence of holistic solutions to complex problems. Early studies of the lubrication of synovial joints were primarily concerned with the evidence of single modes of lubrication, but a multitude of lubrication mechanisms protecting the bearing surfaces from wear and damage have now been recognised. Proteins have long been known to play an active role of the formation of protective tribo-films, while the tenacity of elasto-hydrodynamic lubricating films is also evident. The protective action of polymer brushes is increasingly recognised and appreciated. It now seems likely that all

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these mechanisms, acting independently or simultaneously, are important. Growing evidence of the simultaneous adoption by nature of discrete structural, surface film and fluid-flow actions, offers a wonderful opportunity to develop a more complete, holistic appreciation and understanding of the satisfactory performance of many impressive biological systems.

It is timely to welcome the emergence of new Journals to encourage this welcome progress towards integrated assessments of function and performance of biological systems and implants. Many simple experiments, on equipment ranging from reciprocating pin-on-plate and steady rotational pin-on-disc machines, to interferometers and full-scale simulators have been utilised to provide information on the evolving surface features, flow rates, friction, wear and the release of wear particles and metal ions in biological systems. This has been supported by truly impressive modern microscopes and surface analysis equipment. It is nevertheless important to recognise the limitations of simulators, since many tribological characteristics are system and environment dependent and not just well defined material properties such as the elastic modulus; hardness and yield stress. Great care has to be taken in interpreting findings from laboratory tests, and many false leads have been experienced by investigators in these fields.

The success of Mathematical Modelling is also dependent upon the extent to which the interacting surfaces, external variables such as load, speed, viscosity, the environment, surface form and quality, are modelled. The computation can soon become a huge challenge, but it is important to reflect reality as closely as possible. Simulators and modelling nevertheless often provide valuable indications of system performance and thus help to unravel the nature of major functional characteristics of biological systems.

The development of understanding of Biosurface and Biotribology draws upon understanding of the findings from full scale natural systems, well developed laboratory simulators, careful examination and interpretation of interfaces, comprehensive mathematical analysis and modelling, together with careful analysis of the findings by physicians, surgeons, biologists, materials scientists, tribologists, physicists and chemists. The field is indeed challenging, but enormously rewarding and great fun.

The basic problem is that we still have incomplete appreciations of the function of many biological interfaces, particularly where relative motion between surfaces is involved. The Austrian–Swiss Physicist and Nobel Prize Winner, (1945), Wolfgang Ernst Pauli, succinctly summarised the situation when he said, apparently on many occasions.

“God introduced the bulk. The devil invented the interface”

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