UNDERGRADUATE SUMMER VACATION SCHOLARSHIP AWARDS – FINAL SUMMARY REPORT FORM 2023/24

NB: This whole report will be posted on the Society's website therefore authors should NOT include sensitive material or data that they do not want disclosed at this time.

Name of student:

Shaz A. Raja

Name of supervisor(s):

Sourav Bhattacharjee

Project Title:

Towards understanding the myotendinous and osteotendinous interfaces: A biomaterial perspective

Project aims:

Tendons present with an interesting force exacting mechanism active on our musculoskeletal tissues. Enriched in collagen fibres (especially collagen I) and being an integral component of the extracellular matrix (ECM), they act as an intermediary linkage between the muscle belly and bones, where the contraction of skeletal muscle fibres transmits the force to the articulating bones that, in turn, facilitate joint movement. Such a unique natural set-up ubiquitous across vertebrate kingdom presents unexplored domains for speculation and introspection, especially what evolutionary advantage(s) nature tried to achieve through it. It also presents a fertile ground to investigate such a muscle→tendon→bone triad for streamlining muscular extraction of locomotive force from a biomaterial perspective. It is established that all of these three components (muscle, tendon, bone—especially the periosteum where the peripheral tendon fibres attach) are rich in fibrous (elastic) proteins. Such knowledge nicely fits the fact that such fibrous proteins are incredibly diverse with almost 30 sub-types of collagen only known in humans. With so much diversity—a hallmark of substantial evolutionary engineering to aid adaptability—doubts remain if these anatomical structures (*viz.,* muscle, tendon, and bone) are different materials or polymorphic representations of the same biomaterial that, in a way, remain the structural (and, at times, functional) unit of what constitutes a vertebrate body. Investigating such an open research question, especially in advanced complex systems like the human body, remains a methodological challenge. The diversity of biomaterials in the (human) body further aggravates the difficulty.

With recent advancements in laser technology, instrumentation, and automation, the current crop of high-end biophotonic tools is providing fresh hope in understanding complicated research questions that have remained largely unexplored. The sophisticated microscopic modality of Fluorescence Lifetime Imaging Microscopy (FLIM) has particularly emerged as a fascinating and enabling tool to evaluate real-life tissue samples from a histopathology vantage. Above all, the FLIM enjoys certain remarkable edges over conventional epifluorescence or confocal microscopy on the merits of being ultrasensitive, while the fluorescence lifetime (τ) of a fluorophore remains unaffected by concentration or quenching effect. It is worth noting here that many of the tissue components, including collagen, are fluorescent and emit at the visible region of the spectrum when illuminated with ultraviolet (UV) light. Thus, these tissue samples may be subjected straightway for FLIM investigation after mounting them on slides that not only enable a granular understanding of the musculotendinous and osteotendinous interfaces but also provide comprehension of these components (muscle, tendon, and bone) from a biomaterial perspective.

Project Outcomes and Experience Gained by the Student

<u>Approach</u>

Tissue sampling from animal limb muscles was conducted under an ethical exemption from the University College Dublin Animal Research Ethics Committee (AREC-E-24-32-Bhattacharjee). In summary, limb muscle samples with adjacent tendon tissue were excised around the myotendinous

junctions. Similarly, tissue samples were collected from the osteotendinous junctions. These tissue samples were processed and mounted on glass slides without staining before FLIM examination.

Project Outcomes

The harvested tissue samples showed excellent autofluorescence under FLIM investigation, with different segments embedded within them exhibiting discernible emission patterns.

Experience Gained

The student gained the following experiences within the scope of this project:

1. Introduction to standard laboratory health and safety practices
2. Introduction to ethical issues associated with the handling of animal tissue
3. Preparation of tissue histology slides
4. Light microscopy techniques and modern tools available for data analysis

Please state which Society Winter or Summer Meeting the student is intending to present his/her poster at:

Anatomical Society Winter Meeting 2025 (University of Central Lancashire, Preston, UK)

Proposed Poster Submission Details (within 12 months of the completion of the project) for an AS Winter/ Summer Meeting – (no more than 300 words)

Brief Resume of your Project's outcomes: **(no more than 200-250 words)**.

The title of your project and a brief 200-250 word description of the proposed/completed project. The description should include sufficient detail to be of general interest to a broad readership including scientists and non-specialists. Please also try to include 1-2 graphical images (minimum 75dpi). NB: Authors should NOT include sensitive material or data that they do not want disclosed at this time.

Title: Towards understanding the myotendinous and osteotendinous interfaces: A biomaterial perspective

The synchrony of action within the combination of muscle, tendon, and bone is essential for the normal functioning of our musculoskeletal system, which, in turn, enables locomotion and our existence. Although from a macroscopic view, these materials (muscle, tendon, and bone) appear to be distinct—with clear boundaries separating them at the myotendinous and osteotendinous junctions—the reality down the dimensionality scale seems different. In this project, an advanced microscopic modality called Fluorescence Lifetime Imaging Microscopy (FLIM) was utilised to understand the organic biomaterials that constituted these tissue components, with an understanding of how these materials coordinated with each other from a structural perspective. The obtained data provided fresh insights into the intricacies of these materials and their interfaces (myotendinous and osteotendinous) with clinical implications, given these junctions are prone to injury.

Other comments:

The data obtained in this project will be published next year in a peer-reviewed journal.

Data Protection/GDPR: I consent to the data included in this submission being collected, processed and stored by the Anatomical Society. Answer YES or NO in the Box below
YES
Graphical Images: If you include graphical images you must obtain consent from people appearing in any photos and confirm that you have consent. A consent statement from you must accompany each report if relevant. A short narrative should accompany the image. Answer N/A not applicable, YES or NO in the box below
N/A

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YES

Signature of student: Shaz Raja *Date: 20/10/2024*

Signature of supervisor: Sourav Bhattacharjee *Date: 19/10/2024*

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