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The importance of microstructure in R&D and applications of biomaterials and biological modulation in orthopaedics

It is known that musculoskeletal system has complex micro-architecture that is essential to proper function. This micro-architecture needs to support the biological and structural functions, as well as work in sync with many other micro-structures in order to support the entire tissue. When something goes wrong with the micro-architecture of these tissues, this can cause the entire tissue to become unstable and even fail. That is why it is essential for researchers and clinicians to not only assess and treat the macro-structure, but the micro-structure as well.

We have long known the importance of being able to regulate DNA and mRNA in order to treat disorders; however, in recent years, researchers have discovered and investigated the roles of microRNA and circular RNA. Peng et al. [1] have reviewed recent evidence on the role of circular RNA in the pathogenesis of spinal cord injuries, as well as the possibility of using them as a therapeutic target. Remaining in the cell, Guillén et al. [2] have demonstrated that microvesicles and exosomes reduce oxidative stress in chondrocytes taken from osteoarthritis (OA) patients. Oxidative stress contributes to OA development and pain. Reducing oxidative stress may help to ameliorate the development of OA and reduce pain.

Periprosthetic joint infection is a serious post-operative complication in prosthetic surgeries. Biofilms often develop around the prosthetic, which can then fail, requiring further surgery. Malchau et al. [3] characterise biofilms in first time periprosthetic hip or joint infections, which may help researchers and clinicians avoid and treat this problem. Diabetic foot ulcers that lead to osteomyelitis also pose a large challenge to clinicians that may also lead to infection. Wang et al. [4] demonstrate a novel dressing with antibacterial and angiogenic properties to better treat diabetic foot ulcers. Osteochondral defects are areas of damage that may be small, but can have large repercussions. Ai et al. [5] have demonstrated in their review the advantages of tissue engineering to treat osteochondral defects, as well as knowledge gaps that need to be addressed to bridge basic science and possible clinical application.

Several regulating genes and proteins are overexpressed in diseased states that upset the homeostasis balance and further propagate the deleterious changes. Chang et al. [6] demonstrate in their study how cyclooxygenase-2 (COX-2) is increased in rat osteoarthritic chondrocytes, triggering downstream mechanisms. Treatment with celecoxib (a COX-2 inhibitor) reduced COX-2 activity as well as the downstream mechanisms. Two studies in this issue investigate the role of the Wnt/β-catenin signaling pathway, in disease progression and healing. Chen et al. [7] demonstrate that early treadmill running negatively affects rotator cuff healing with an increased expression of Neuropeptide Y that may affect the Wnt/β-catenin signaling pathway that assists healing. Liao et al. [8] also demonstrate the importance of the Wnt/β-catenin signaling pathway in the healing process, by demonstrating the increase in expression when treating osteoarthritis with low-intensity pulsed ultrasound. Anterior cruciate ligament (ACL) injuries are common and in athletes, may severely affect the performance and career. ACL reconstruction is one of the most common orthopaedic surgeries and clinicians are continually looking for novel ways to improve post-surgical healing. Yao et al. [9] conducted a systematic review to investigate biological modulations that may be applied during reconstruction that may improve post-operative outcomes.

Although small, it is essential to understand the microstructures and molecules that make up and influence musculoskeletal homeostasis. Through this understanding, we may be able to influence them and improve the entire tissue structure and ultimately, patient well-being. Novel techniques in both the lab and the clinic allow us to investigate microenvironments like never before and in these studies, we see how these techniques may be able to assist in orthopaedic science and care.

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