of external ligands. Increasing the number of Smads to two significantly improves information transmission as well as the ability to discriminate between different functionalities from small mutations in signaling pathways and allowed for the development of cross-regulation. Insensitivity to cross-talk also could increase robustness due to redundancy in signaling pathways. Conversely, bacterial two component systems are much less robust against cross-talk which may provide an explanation for the lack of cross-regulation in most two component systems.

3011-Pos Board B781
A 3D Integrated Model of Cardiomyocytes Revealed the Important Role of Cardiac T-Tubule Structure for the Maintenance of Contractile Function
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T-tubules in mammalian ventricular myocytes are invaginations of the surface membrane which couple membrane depolarization with intracellular Ca2+ signaling to facilitate the coordinated contraction. Deletion of t-tubules (detubulation) has been reported in heart diseases, although the complex nature of the cardiac excitation-contraction (E-C) coupling process makes it difficult to experimentally establish causal relationships between detubulation and cardiac dysfunction. Alternatively, numerical simulations have been proposed, however, the majority of models treat the subcellular spaces as lumped compartments, and are thus unable to dissect the impact of morphological changes in t-tubules. We developed a 3D finite element model of cardiomyocytes in which subcellular components including t-tubules, myofilibrils, sarcoplasmic reticulum, and mitochondria were modeled and arranged realistically. Based on this framework, electrophysiology, E-C coupling, metabolism and mechanical deformation are simulated by solving multiple reaction diffusion equations for Ca2+ and energy metabolites, and the mechanical equilibrium. The model reproduced the Ca2+ transients and contraction observed in experimental studies with and without the t-tubule system and revealed that the asynchronous contraction caused by a large area of detubulated region can impair contractile efficiency.

3012-Pos Board B782
Finite-Element Model of the Silk Electrogelation Process
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Driven by the desire to fulfill major needs for medical adhesives that fully degrade with time, adhere to wet tissues, control bleeding, and are mechanically robust, a unique new material called "e-gel". The e-gel forms during a process called electrogelation, at a low-voltage, direct-current field causes a sol-gel transition in an aqueous silk protein solution. The e-gel forms during a process called electrogelation, at a low-voltage, direct-current field causes a sol-gel transition in an aqueous silk protein solution. The e-gel forms during a process called electrogelation, when a low-voltage direct-current field causes a sol-gel transition in an aqueous silk protein solution. The e-gel forms during a process called electrogelation, when a low-voltage direct-current field causes a sol-gel transition in an aqueous silk protein solution. The e-gel forms during a process called electrogelation, when a low-voltage direct-current field causes a sol-gel transition in an aqueous silk protein solution. The e-gel forms during a process called electrogelation, when a low-voltage direct-current field causes a sol-gel transition in an aqueous silk protein solution. The e-gel forms during a process called electrogelation, when a low-voltage direct-current field causes a sol-gel transition in an aqueous silk protein solution. The e-gel forms during a process called electrogelation, when a low-voltage direct-current field causes a sol-gel transition in an aqueous silk protein solution. The e-gel forms during a process called electrogelation, when a low-voltage direct-current field causes a sol-gel transition in an aqueous silk protein solution. The e-gel forms during a process called electrogelation, when a low-voltage direct-current field causes a sol-gel transition in an aqueous silk protein solution. The e-gel forms during a process called electrogelation, when a low-voltage direct-current field causes a sol-gel transition in an aqueous silk protein solution.

3013-Pos Board B783
Multivalent Systems of Catch Bonds Exhibit Ideal Bond Behavior
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Catch bonds play a critical role in the phenomenon of leukocyte rolling and adhesion. All selectin isoforms have been shown to form catch-slip bonds with their ligands, and in vivo presumably act as systems of several parallel receptor-ligand bonds. Little is known, however, about how the unusual kinetics of the catch bond manifest as systems, nor how the inherent compliance of the molecules themselves alters the behavior of the system. We conducted Monte Carlo simulations and derived a closed form probabilistic expression for mean bond lifetime based on reliability theory. Both approaches were based on a single model that included the variables of contact area between the opposing surfaces, molecular compliance, and site density, and allowed for the formation of new bonds when receptors and ligands were within range. We found that at high numbers of initial bound receptor-ligand pairs (≥10) and at low molecular stiffness (<1 pN/nm) receptor-ligand clusters behave exhibit "ideal" behavior over the 0-40 pN range - that is, an overall bond lifetime that is invariant with load. This is in agreement with recent experimental data that found ideal bond behavior at high surface densities of E-selectin. The bond lifetimes even at high site densities were reasonable and not orders of magnitude higher than single bonds. In contrast, slip bond (classical Bell model) interactions give rise to disproportionate increases in bond lifetime with bond on-rate; increasing the on-rate 50 to 75 fold increased mean bond lifetime 100 and 1000 fold respectively. The compliance of the receptor-ligands pairs also exerts a strong influence by modulating the contact area between the surfaces. Our results suggest that classical slip bonds alone are untenable for adhesion in biological systems where cells must move relative to one another.

3014-Pos Board B784
Multiscale Modeling of O2 Transport in Articular Cartilage
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Partial pressure of oxygen (pO2) is suggested to have a regulatory effect on chondrocyte biosynthetic activities and its effect during expansion is unknown. We hypothesize that oxygen tension due to mechanical deformation or swelling could be as important as direct mechanical effects on cell biosynthetic activities. While there are plenty of studies on measuring and/or modeling pO2 in articular cartilage (AC) for static (rest) conditions, to our best of knowledge, there are no such studies on pO2 in AC for dynamic conditions such as swelling or tissue deformation. In this study, we attempt to develop a model to study the dynamics of oxygen transport in AC. We design a high-precision hybrid model using the p-type finite element method by which both, diffusion and convection, are incorporated as a single element. We use a domain decomposition method that allow us to use a different type of discretization with independent discretization variables in non-overlapping sub-domains, for a generic three-dimensional approach to elliptic boundary value problems of order two or higher. Results strongly support the idea that during normal activity, the partial pressure of oxygen in AC is uniform and high (close to 50 mmHg) unlike in static conditions where partial pressure has a large gradient from surface to bottom. The formulation developed in this study might be used in determining the necessary flow conditions to cultivate tissue constructs in tissue repair and tissue engineering.

3015-Pos Board B785
Stochasticity in Action Potential duration Enhances Dispersion of Repolarisation at Fast Pacing Rates
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Patch clamp recordings of isolated ventricular myocytes frequently display a temporal variability in the action potential duration. Intercellular coupling...