

Introduction: calcium, a key regulator in biology

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Evolution selected calcium, a small nonmetabolisable metal ion, as one of life's key regulators. While being the most simple signal transducer, calcium initiates complex biological processes. Calcium is ubiquitous, yet its concentration in the cytoplasm and nucleus of cells can be kept very low due to efficiently operating calcium extrusion mechanisms. However, upon exposure of cells to environmental stimuli, calcium concentrations can increase sharply. These so-called calcium transients are used by cells to turn many processes on or off. Exactly how a cell responds to a calcium signal depends on the properties of the transients: these can be small or large, short lasting or sustained, localised to particular subcellular compartments or throughout the cell. One of the

first understood roles for calcium was in excitation-contraction coupling in heart and skeletal muscle, but this is just one of many functions of calcium in health and disease. Calcium regulates the immune response, secretion, cell division, meiosis and is likely to be involved in cell degeneration. Last, but not least, calcium controls brain function. Synaptic communications between neurons and electrical activity-dependent changes in gene expression both need calcium. The new gene expression may be responsible for long-lasting adaptive changes resulting in learning and memory. This series of reviews summarises work on the origin and diversity of calcium signals and highlights recent advances in understanding some of the cellular processes controlled by calcium.