

Molecular Mechanisms of Cell Death

Otari bibilashvili

e-mail: otar.bibilashvili@tsu.ge

Department of Biology, Iv. Javakhishvili Tbilisi State University, Tbilisi, Georgia

Cell death is considered one of the most fundamental yet complex processes in modern biology. Historically, it was often perceived as a passive and inevitable demise of the cell; however, contemporary understanding clearly indicates that it is governed by tightly regulated molecular mechanisms. These mechanisms play critical roles in organismal development as well as in the maintenance of homeostasis and immune balance. Apoptosis, necrosis, necroptosis, pyroptosis, and ferroptosis predominate under different conditions, yet in real biological systems they rarely operate in isolation. Rather, it is more appropriate to view them as interconnected elements of a regulatory network, whose activation is strongly influenced by the cellular metabolic state, mitochondrial function, redox balance, lipid membrane composition, and iron homeostasis. From a practical perspective, it is also important that distinct forms of cell death lead to different biological outcomes: some ensure relatively “silent” elimination of cells without inflammation, whereas others actively amplify inflammatory responses and immune activation. Accordingly, the present work examines the molecular foundations of the major forms of regulated cell death and their relationships with the metabolic and biochemical status of the cell.