Chapter 12
Reactive Oxygen Species in Neurodegenerative Disorders: Mechanisms and Therapeutics

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ABSTRACT

Reactive oxygen species (ROS) are chemically reactive molecules containing oxygen. In the context of neurodegenerative disorders, ROS play a dual role while they are necessary for normal cellular function, their overproduction can lead to oxidative stress, damaging neurons and contributing to the pathogenesis of diseases such as Alzheimer's, Parkinson's, Huntington's, and Amyotrophic Lateral Sclerosis (ALS). This book chapter explores the mechanisms by which ROS contributes to neurodegeneration, including mitochondrial dysfunction, protein aggregation, and inflam-

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mation. Additionally, we discuss current and emerging therapeutic strategies aimed at modulating ROS levels and mitigating oxidative damage, such as antioxidants, gene therapy, and lifestyle interventions. Understanding the balance between ROS production and antioxidant defenses is crucial for developing effective treatments for neurodegenerative diseases.

1. INTRODUCTION

1.1 Overview of Reactive Oxygen Species (ROS)

ROS are produced during the metabolism of oxygen. They might not be radicals at all or free radicals. Molecules classified as free radicals have at least one unpaired valence electron in their outer shell. Rendering them transient and extremely reactive, (Lushchak, 2014). The most well-known ROS are -OH, -H_2O_2, and -O_2. The ROS subclass containing nitrogen compounds is known as reactive nitrogen species (RNS). ROS and RNS both play important roles in maintaining normal cellular processes, including defense against infection, control of several intercellular signaling pathways, and support of proper reproductive system development and conception, (Halliwell & Gutteridge, 2015). However, oxidative stress occurs when ROS overpower the antioxidant defense system, which can cause DNA damage, and ultimately lead to cellular malfunction. Owing to its detrimental impact on cells, OS is related to numerous pathological complaints, such as infertility, (Sisein, 2014). This chapter provides an overview of ROS role in neurodegenerative disease induction.

1.2 ROS and Cellular Function

ROS) is a collection of unique oxygen derivatives that are created during regular aerobic metabolism. The intracellular redox state is actively maintained by a number of ROS-generating and ROS-eliminating mechanisms, which mediates redox. signalling and control the operations of cells. Target proteins' essential, redox-sensitive cysteine residues can be oxidatively modified by reactive oxygen species (ROS), especially hydrogen peroxide. Numerous enzymes and transcription factors (TFs) can have their biological activity, cellular location, and interactions with binding partners regulated by these oxidative post-translational modifications (PTMs). It also leads to degeneration of neuroproteins thus cause various neurodegenerative diseases, (Ahmad, 2017).