

MOLECULAR MECHANISMS OF NEURONAL AGING AND NEURODEGENERATION

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Background. Aging of the nervous system is accompanied by complex molecular changes that contribute to the development of neurodegenerative diseases. Understanding these mechanisms is crucial for developing effective treatment and prevention strategies.

Material and Methods. This review aims to analyze current data on the molecular mechanisms of neuronal aging and neurodegeneration, their impact on neurosciences, drug screening, and regenerative medicine, while discussing the advantages and limitations of existing research approaches.

Results:

- 1. Oxidative Stress and Mitochondrial Dysfunction:** Aging increases oxidative stress and disrupts energy metabolism, leading to neuronal damage and contributing to neurodegenerative diseases.
- 2. Proteostasis Dysfunction and Protein Aggregation:** Decreased activity of protein degradation systems, such as the ubiquitin-proteasome and autophagy-lysosome pathways, leads to the accumulation of abnormal proteins and aggregates characteristic of neurodegenerative conditions.
- 3. Neuroinflammation:** Age-related changes in the hypothalamus, including increased inflammatory activity and reduced neuronal function, contribute to cognitive decline and neurodegeneration.
- 4. DNA Damage and Repair Impairment:** The accumulation of DNA damage and decreased repair efficiency with aging may drive neurodegenerative processes.

Discussion. Current research focuses on therapeutic strategies targeting key molecular mechanisms of neurodegeneration. For instance, blocking stress responses in microglia or preventing toxic lipid formation has been shown to reverse Alzheimer's symptoms in preclinical models. Additionally, the identification of specific hypothalamic cells affected by aging opens new possibilities for interventions aimed at slowing down aging processes and reducing cognitive decline risk.

Conclusion. Understanding the molecular mechanisms of neuronal aging and neurodegeneration is essential for developing effective therapeutic approaches. Despite existing challenges, progress in this field promises significant advancements in neurosciences, drug screening, and regenerative medicine.

Keywords: Neurodegeneration, neuronal aging, oxidative stress, mitochondrial dysfunction.