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# OXIDATIVE STRESS EFFECT IN RIBOSOMAL BIOGENESIS IN CANCER CELLS

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# OXIDATIVE STRESS EFFECT IN RIBOSOMAL BIOGENESIS IN CANCER CELLS

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**Abstract.** Oxidative stress is a condition where the levels of reactive oxygen species (ROS) exceed the normal level on the cell's antioxidant defenses. Oxidative stress can cause damage of the DNA, proteins, and lipids. Ribosome biogenesis is the process of making ribosomes. Ribosome biogenesis involves the transcription, processing, and assembly of ribosomal RNA (rRNA) and ribosomal proteins (r-proteins) into functional ribosomal subunits. Cancer is a disease characterized by uncontrolled cell growth, invasion, and metastasis. Cancer cells often have increased levels of oxidative stress and ribosome biogenesis, which can promote their survival, adaptation, and proliferation in the tumor microenvironment. In this review, we discuss how oxidative stress can have different effects on ribosome biogenesis in cancer cells, depending on the type, severity, and duration of the stress, as well as the genetic and epigenetic characteristics of the cells.

**Keywords**: oxidative stress, Ribosome biogenesis, acute lymphoblastic leukaemia, Therapy

## 1. Introduction

### 1.2. Ribosome Biogenesis

Ribosome biogenesis is the very coordinated process which start in the nucleolus. The ribosome are consider as a machine who are responsible for protein synthesis[1],[2],[3]. The ribosome biogenesis is divided into transcription, processing, and the assembly of the rRNAs (ribosomal RNA) and the ribosomal proteins (r-proteins) also, into the functional ribosomal subunits[2],[1].

In the prokaryotic cell, the ribosome biogenesis take place in the cytoplasm with transcription of many ribosome genes[1], where as in eukaryotic cells, the ribosome biogenesis take place in the cytoplasm and in the nucleolus. In the nucleolus it is the specialized region where the rRNA is transcribed and processing[2],[1],[4].

The ribosome biogenesis is very complexed process who are involved a huge number of proteins, more than 250 non-ribosomal assembly factors, which play pivotal role in this process[4]. Ribosome biogenesis play pivotal role in the cell growth, survival, and functions, and is shown to be responsible for many human diseases, for example cancers, aging, and the ribosomopathies[5]. For study of ribosomal biogenesis are developed many protocols and methods such as in vitro-technology, fluorescence microscopy, sequencing of RNAs, mass spectrometry, and CRISP-Cas9[6].

## 2. Oxidative Stress and Ribosome Biogenesis

During the oxidative stress the level of ROS (reactive oxygen species) overcome the normal level in the cell's antioxidant defense[7]. Oxidative stress can cause damage to various cellular components, including DNA, proteins, and lipids[7,21].

Ribosome biogenesis is essential for cell growth, survival, and function[8,9]. The oxidative stress is shown to have negative influence in ribosome biogenesis in many ways. This is based on the duration and severity of the stress[9]. Some possible effects are:

1) Oxidative stress can cause the hyperactive ribosome biogenesis in some cells, by activating a signaling pathway involving nucleolin, β-catenin, and n-Myc[10].
2) The oxidative stress is responsible for ribosome dysfunction. It is shown to be responsible for the damaging the ribosomal RNA or proteins, leading to impaired protein synthesis and quality control. This negative influence is responsible for misfolding proteins in the cell, which than can stimulate the apoptotic process[9].
3) The tumor suppressor protein p53 is activated by oxidative stress. The p53 can regulate ribosome biogenesis. The p53 is responsible for inhibition of the ribosome biogenesis, this may occur by suppressing the expression of ribosomal genes or by causing the degradation of ribosomal proteins. This can cause decrease cell proliferation and cell cycle arrest or apoptosis[8,11].

## 3. Ribosomal Protein Mutation and Acute Lymphoblastic Leukemia

Many diseases are shown to be associated with ribosomal protein mutations[19]. One of them is T-acute lymphoblastic leukemia (ALL), when the ribosomal protein gene mutations are shown to be associated with different genetic lesion[12,13]. These mutations can affect the structure and function of ribosomes, which are essential for protein synthesis. The T-ALL is associated with mutation of ribosomal proteins genes such as[13,12]. These gene mutation in ribosome caused the impair of the ribosome biogenesis, affecting the protein translation, dysregulate work of tumor suppressor protein p53, modulate different signaling pathways, and are shown to affect the epigenetic regulation[13]. This type of ribosomal proteins involved in the T-ALL are under the investigation[12].

## 4. Acute Lymphoblastic Leukemia-The Future Therapy

the Acute lymphoblastic leukemia (ALL) is a type of blood cancer. It is characterized by affection of white blood cells. Chemotherapy or combination therapy are the main treatment for ALL. This type of therapies is given in different phases. The aim of this

treatment is to kill the leukemia cells and prevent them from coming back[14,15,16,20]. Treatment of ALL is depended from many factors. First of one is subtype of ALL. Other is the risk group, and the age and health of the patients, and the end response of the therapy[15]. Sometimes is shown that treatment may cause the side effects. For example, increase infections, bleeding, infertility, or tumor lysis syndrome[15].

### 5. Conclusion

In conclusion, we can say the oxidative stress can have different effects on ribosome biogenesis in cancer cells. This is depended by the type, severity, and duration of the stress, as well as the genetic and epigenetic characteristics of the cells. Understanding the influence of oxidative stress in ribosome biogenesis in cancer cell for the future may be very important by provide new insights into the molecular mechanisms of tumorigenesis and new targets for therapeutic intervention[17,5]

In conclusion, for RP mutations we can say that they have different effects on T-ALL pathogenesis. This is by depending on the type, location, and frequency of the mutation, as well as the genetic background and microenvironment of the tumor cells. Understanding how RP mutations affect T-ALL biology may provide a new strategy for targeting the therapeutic intervention[12,18].

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