к снижению этого параметра при частотах 10–15 Гц (рисунок 1, Б). При этих частотах увеличивается вклад упругого компонента в механические свойства клеток, следовательно, поведение клеток более становится похожим на поведение твердого тела.

Таблица 2 – Тангенс потерь для клеточной линии ZR-75 в температурном диапазоне 34–45 °С

t, °C	34	35	36	37
η	0,13(0,077;0,150)	0,16(0,119;0,175)	0,12(0,097;0,143)	0,09(0,049;0,104)
t, °C	38	39	40	41
η	0,13(0,110;0,130)	0,12(0,109;0,127)	0,14(0,115;0,210)	0,16(0,109;0,335)
t, °C	42	43	44	45
η	0,17(0,149;0,198)	0,14(0,086;0,173)	0,18(0,149;0,177)	0,09(0,053;0,132)

Выводы

Полученные данные показывают, что в отличие от клеток линии ВТ-20 клетки линии ZR-75 характеризуются особой чувствительностью к механическим вибрациям в инфразвуковом интервале, при частотах 10–15 Гц вклад упругого компонента в вязкоупругие свойства увеличен. Это предполагает, что колебания в разных частях клетке согласуются и увеличиваются по амплитуде, что может способствовать нарушению структуры мембран и цитоскелета и приводить к гибели клеток. В отличие от клеток линии ZR-75 клетки линии ВТ-20 характеризуются особой чувствительностью параметров вязкоупругих свойств к изменению температуры. Установленные особенности вязкоупругого поведения клеток разных клеточных линий важны для понимания механизмов регуляции онкогенеза разных молекулярно-биологических подтипов рака молочной железы.

Работа выполнена в рамках темы БРФФИ Б22М-087 «Определить с помощью атомно-силовой микроскопии закономерности влияния температуры на механические свойства поверхности клеток рака молочной железы»

СПИСОК ИСПОЛЬЗОВАННОЙ ЛИТЕРАТУРЫ

1. Cell stiffness predicts cancer cell sensitivity to ultrasound as a selective superficial cancer therapy / E. Bergman [et al.] // Bioengineering & Translational Medicine. – 2021. – Vol. 6. – e:10226.

2. Measuring nanoscale viscoelastic parameters of cells directly from AFM force-displacement curves / Y. M. Efremov [et al.] // Sci. Rep. – 2017. – Vol. 7. – e:1541.

УДК 576.311.346.7

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ENERGY DEPRIVATION INFLUENCE ON MITOCHONDRIAL ACTIVITY

Introduction

Any dysfunction in mitochondria can results in an abnormal or pathological development in cells, there are various types of mitochondria (Mt) in cells, can be classified according to their age, size, health and physiological activity. Mt can generate harmful byproducts (reactive oxygen species or ROS) during energy production, which might damage mitochondrial components and affect the life of mitochondria and the cell (e.g. aging). Chaperones, proteasomes

and sirtuins are proteinous structures, which function as a regulator and protect Mt from these harmful products.

Goal

To study the influence of energy deprivation on mitochondrial activity (MtA), the principle of chaprones, proteosomes and sirtuins influence.

Material and methods of research

Scientific publications Pub-Med and Google scholar, analysis and generalization

The results of the research and their discussion

Electron transport chain or ETC is a sequence of enzymes that carry electrons from reduced NADH and FADH2 to the final acceptor – oxygen. Reactive oxygen species (ROS) formation, chemical compounds in which oxygen has an intermediate oxidation state and high reactivity, normal controlled process. Any processes of O2 consumption lead to the formation of ROS. Normally functioning mitochondria, up to 5% of O2 is converted into ROS, with dysfunction of mitochondria, ROS production increases sharply. ROS attack any molecule of the cell and initiate chain reactions. As a result of these reactions, cellular structures are damaged: membranes, proteins, DNA. This leads to cell damage and cell mutation, death or carcinogenesis. ROS are formed as a result of enzymatic and non-enzymatic reactions. These reactions take place in various subcellular structures of the cell.

Mitochondria are one of the main structures that form ROS in cells. Mitochondrial ROS producers include enzymes of the outer and inner membranes, some TCA enzymes, and enzymes of the mitochondrial ETC, also of microsomal ETC: cytochromes P450 and b5. An increase in the concentration of ROS in mitochondria causes a vicious circle of processes: active radicals provoke a series of chain reactions leading to dysfunction of mitochondria, damage to the ETC, mitochondrial DNA, a drop in the efficiency of oxidative phosphorylation and, ultimately, to an increase in ROS production [1, 4].

High concentrations of ROS are universal “tools” for damage to cells and tissues. In this case, in the first place, damage to proteins, endoplasmic reticulum (ER) membranes, DNA (mutations), mitochondria and lipids of cell membranes occurs. This causes disruption of ionic gradients. Cells “swell” due to an increase in membrane permeability for ions and water such as lipid peroxidation. One of the most toxic forms of ROS is the hydroxyl radical (OH•). Its formation in the cell occurs in two main non-enzymatic reactions.

Under conditions of the prevalence of the rate of ROS formation over the rate of their elimination by means of cell antioxidant defense (AOD), oxidative stress (OS leads to cellular stress) develops. This is a state of imbalance between the process of ROS formation and the process of their detoxification with the participation of AOD with excessive formation of radicals and depletion of the AOD system [1].

Chaperones regulate the shape of proteins folding process to their functional structures. Misfolded proteins can clump together and disrupt cellular processes. Chaperones ensure that newly synthesized proteins fold properly and prevent misfolded proteins from aggregating. Under the cellular stress during energy deprivation there is an increase in chaperone production, by various factors such as AMP-activated Protein Kinase (AMPK) which is activated by cellular energy depletion (low ATP/AMP ratio). AMPK can phosphorylate and activate transcription factors like ATF2, which then promote the expression of stress-responsive chaperones.

Proteasomes: Sometimes, despite the rule of Chaperones, proteins become damaged or misfolded beyond repair. breaking down damaged or unnecessary proteins into their amino acid building blocks.

Sirtuins: This class of proteins plays a multifaceted role in cellular stress response, metabolism, and aging. Sirtuins can activate various cellular pathways in response to stress, including

helping to repair damaged proteins and enhancing the activity of Chaperones and proteasomes. Sirtuin activation is heavily influenced by cellular NAD+ (nicotinamide adenine dinucleotide) levels. NAD+ acts as a co-substrate for sirtuins, meaning their enzymatic activity depends on its presence. SIRT1 can deacetylate and activate key chaperones like Hsp70, potentially enhancing their protein folding capacity. Poly(ADP-ribose) Polymerase (PARP) Inhibition: During cellular stress, PARPs consume NAD+ to repair DNA damage. Inhibiting PARP activity prevents this NAD+ depletion, making it more available for sirtuins [2,3,4].

Conclusion

Effects of reactive oxygen species (ROS) generated by mitochondria during energy production. We explored the vicious cycle where increased ROS damages the mitochondria itself, leading to further ROS production damaging cellular structure such as sER membrane, and ultimately cell death. The cellular response to this stress includes the activation of chaperones, proteasomes, and sirtuins. Chaperones assist in proper protein folding, while proteasomes degrade damaged proteins. Sirtuins play a central role by influencing both chaperone and proteasome activity, and their activation is dependent on cellular NAD+ levels.

LITERATURE

1. Harper's Illustrated Biochemistry / Victor W. Rodwell [et al.]. – 30th edit. New York[and oth.] : McGraw-Hill Education, 2015. – 817 p. – P. 113–126.

2. *Min, Z.* The roles of mitochondrial SIRT4 in cellular metabolism / Z. Min, J. Gao, Y. Yu // Frontiers in Endocrinology. – 2019. – T. 9. – C. 421094.

3. *Tang, B. L.* Sirt1 and the mitochondria / B. L. Tang // Molecules and cells. – 2016. – T. 39. – № 2. – C. 87–95.

4. Reactive oxygen-related diseases: therapeutic targets and emerging clinical indications / A. I. Casas [et al.] // Antioxidants & redox signaling. – 2015. – T. 23. – № 14. – C. 1171–1185.

УДК 612.015.1:637.345

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THE INTRICATE RELATIONSHIP BETWEEN LACTASE ENZYME LEVELS AND LACTOSE INTOLERNCE IN HUMANS

Introduction

Individuals with lactose intolerance don't produce enough lactase, also known as β-galactosidase, necessary for converting milk's lactose into simple sugars, glucose and galactose. Lacking lactase means lactose ferments in the colon, leading to gas and symptoms like bloating, diarrhea, and nausea [1].

Lactase-phlorizin hydrolase (LPH) is crucial for digesting milk's lactose. Post-weaning, most people see a drop in this enzyme, a condition termed lactase non-persistence (LNP), leaving them lactose intolerant. Yet, a minority retain high enzyme levels, a genetically complex trait called lactase persistence (LP), enabling lifelong milk digestion – often in communities with a history of herding [2].

LPH, encoded by the LCT gene on chromosome 2q21, is exclusive to the upper intestine's microvilli and peaks during infancy. Two-thirds of adults worldwide exhibit LNP, while about one-third, particularly those from pastoral cultures, have the LP gene passed down dominantly. LP's genetic underpinnings include several mutations in the MCM6 region near the LCT gene [2].