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Visualizing Metabolic Processes at the Single-Cell Level - Using Genetically Encoded Biosensor and Biomarker

Alireza Heidari[1,2,3,4*], Elena Locci[1,2,3] and Silvia Raymond[1,2,3]

[1]Faculty of Chemistry, California South University, 14731 Comet St. Irvine, CA 92604, USA
[2]BioSpectroscopy Core Research Laboratory, California South University, 14731 Comet St. Irvine, CA 92604, USA
[3]Cancer Research Institute (CRI), California South University, 14731 Comet St. Irvine, CA 92604, USA
[4]American International Standards Institute, Irvine, CA 3800, USA

***Corresponding Author:** Alireza Heidari, Faculty of Chemistry, California South University, 14731 Comet St. Irvine, CA 92604, USA, Email: Scholar.Researcher.Scientist@gmail.com; Alireza.Heidari@calsu.us; Central@aisi-usa.org

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Abstract
Understanding cellular metabolism (how cells use energy) can be key in treating a wide range of diseases, including vascular disease and cancer. Although many techniques can measure these processes in tens of thousands of cells, researchers have not been able to measure them at the single-cell level. Researchers have used a genetically encoded biosensor with artificial intelligence to measure glycolysis. (Process of converting glucose to energy, single endothelial cells, blood vessel cells).
Keywords: Cancer; Cells; Tissues, Tumors; Prevention, Prognosis; Diagnosis; Imaging; Screening; Treatment; Management

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Introduction

Endothelial cells usually form a strong layer inside the blood vessels, but if we need the help of the immune system, we can contract and rupture in this layer. Abnormal contraction can cause blood vessels to leak, leading to a heart attack or stroke. Such contractions in the blood vessels around the lungs can also cause fluid leakage, which occurs in acute respiratory distress syndrome. (This often happens in patients with severe cases of Covid-19.) To better understand how the cell metabolizes in this state of contraction, the researchers turned to resonant energy transfer sensors, genetically encoded biosensors that can measure the amount of lactate inside cells. Lactate is a byproduct of glycolysis. Although the researchers did not develop the sensors, by pairing the sensors with machine learning algorithms, we developed an even more powerful technique that allowed them to image cells, analyze data, and glycolysis reactions at the cellular and subcellular levels. We can examine the details inside the cells, such as certain areas of the cells where there is an increase in glycolysis; this is a key innovation in technology. We were able to measure the amount of glucose cells during contraction and movement, and also found a new mechanism for glucose transport through the cell cytoskeleton (a receptor called GLUT3) that these cells use to absorb glucose [1-510].

Results and Discussion

Understanding how glycolysis works at the cellular level can ultimately lead to therapies that inhibit this process if useful; For example, in the case of leaking blood vessels in patients with atherosclerosis. It can also help patients whose immune systems have reacted strongly to Covid-19 and need help closing the endothelial cell gap around the lungs. If we can find a way to control the contraction, we can reduce the acute respiratory distress syndrome in Covid-19 patients. This method also has important consequences in the treatment of cancer. Endothelial migration and proliferation due to glycolysis are the main cellular processes involved in vascular growth that are essential for tumor survival and growth. Understanding exactly how this works can help researchers kill tumors and prevent them from growing. It can also be used to treat T CAR cells, which the immune system uses to prepare itself for tumors. While this treatment has been life-saving for some, many patients do not respond. Because endothelial cells are important for T cells to penetrate tumors, and cellular metabolism plays an important role in T cell function, researchers believe that modulating cellular metabolism could help build a better immune system. Researchers are currently testing such inhibitors to treat acute CVD-19 acute respiratory distress syndrome at Cancer Research Institute (CRI) of California South University (CSU).

Conclusions

We found that when these cells moved and contracted, we used more glucose, and we also found that the cells absorbed glucose through an unknown receptor. Understanding this trend could lead to better treatments for cancer and vascular disease, including Covid-19. Understanding cellular metabolism is of global importance. By measuring unicellular metabolism, we have a potentially new way of treating a wide range of diseases. This is the first time we can visualize cellular metabolism at different temporal and spatial scales, even at the subcellular level, which could change the language and approach of researchers to study cellular metabolism.

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Authors' Brief Biographies

Prof. Dr. lireza Heidari, Ph.D., D.Sc. is a Full Distinguished Professor and Academic Tenure of Chemistry and also Enrico Fermi Distinguished Chair in Molecular Spectroscopy at California South University (CSU), Irvine, California, USA. He has got his Ph.D. and D.Sc. degrees from California South University (CSU), Irvine, California, USA. Furthermore, he has double postdocs in Project Management, Oncology, Human Cancer Tissues and Synchrotron Radiation from Monash University, Melbourne, Victoria, Australia and also in Nano chemistry and Modern Molecular Electronic-Structure Computations Theory from California South University (CSU), Irvine, California, USA. His research interests include Biophysical Chemistry, Biomolecular and Biomedical Spectroscopy, Quantum Chemistry, Nano chemistry, Modern Electronic Structure Computations, Theoretical Chemistry, Mathematical Chemistry, Computational Chemistry, Vibrational Spectroscopy, Molecular Modelling, Ab initio & Density Functional Methods, Molecular Structure, Biochemistry, Molecular Simulation, Pharmaceutical Chemistry, Medicinal Chemistry, Oncology, Synchrotron Radiation, Synchrocyclotron Radiation, LASER, Anti-Cancer Nano Drugs, Nano Drugs Delivery, ATR-FTIR Spectroscopy, Raman Spectroscopy, Intelligent Molecules, Molecular Dynamics, Biosensors, Biomarkers, Molecular Diagnostics, Numerical Chemistry, Nucleic Acids, DNA/RNA Monitoring, DNA/RNA Hypermethylation & Hypomethylation, Human Cancer Tissues, Human Cancer Cells, Tumors, Cancer Tissues, Cancer Cells, etc. He has participated at more than five hundred reputed international conferences, seminars, congresses, symposiums and forums around the world as yet. Also, he possesses many published articles in Science Citation Index (SCI)/International Scientific Indexing (ISI), Medline/PubMed and Scopus Journals. It should be noted that he has visited many universities or scientific and academic research institutes in different countries such as United States, United Kingdom, Canada, Australia, New Zealand, Scotland, Ireland, Netherlands, Belgium, Denmark, Luxembourg, Romania, Greece, Russia, Estonia, Ukraine, Turkey, France, Swiss, Germany, Sweden, Norway, Italy, Austria, Czech Republic, Hungary, Poland, South Africa, Egypt, Brazil, Spain, Portugal, Mexico, Japan, Singapore, Malaysia, Indonesia, Thailand, Taiwan, Hong Kong, Philippines, South Korea, China, India, Kingdom of Saudi Arabia, Jordan, Qatar, United Arab Emirates, etc. as research fellow, sabbatical and volunteer researcher or visitor and so on heretofore. He has a history of several years of teaching for college students and various disciplines and trends in different universities. Moreover, he has been a senior advisor in various industry and factories. He is expert in many computer programs and programming languages. Hitherto, he has authored more than twenty books and book chapters in different fields of Chemistry. Syne, he has been awarded more than one thousand reputed international awards, prizes, scholarships and honors. Heretofore, he has multiple editorial duties in many reputed international and peer-reviewed journals, books and publishers. Hitherward, he is a member of more than five hundred reputed international academic-scientific-research institutes around

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the world. It should be noted that he is currently the President of the American International Standards Institute (AISI), Irvine, California, USA and also Head of Cancer Research Institute (CRI) and Director of the Bio Spectroscopy Core Research Laboratory at California South University (CSU), Irvine, California, USA.

Elena Loci is a Ph.D. Candidate under the Supervision of Professor Alireza Haidari at Cancer Research Institute (CRI) and Bio Spectroscopy Core Research Laboratory at California South University (CSU), Irvine, California, USA.

Dr. Silvia Raymond, Ph.D., D.Sc. is the current Junior Postdoctoral Research Fellows under the Supervision of Professor Alireza Haidari at Cancer Research Institute (CRI) and Bio Spectroscopy Core Research Laboratory at California South University (CSU), Irvine, California, USA.