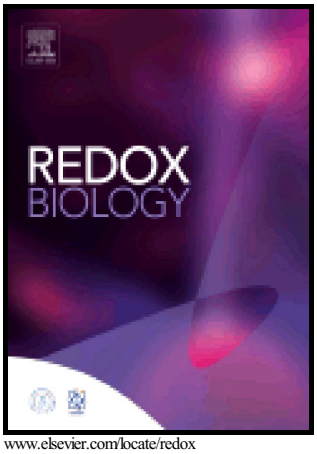

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Balaraman Kalyanaraman

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Teaching the basics of cancer metabolism: Developing antitumor strategies by exploiting the differences between normal and cancer cell metabolism

Balaraman Kalyanaraman*

Department of Biophysics and Free Radical Research Center, 8701 Watertown Plank Road, Medical College of Wisconsin, Milwaukee, Wisconsin USA

*Corresponding author: balarama@mcw.edu

Abstract

This review of the basics of cancer metabolism focuses on exploiting the metabolic differences between normal and cancer cells. The first part of the review covers the different metabolic pathways utilized in normal cells to generate cellular energy, or ATP, and the glycolytic intermediates required to build the cellular machinery. The second part of the review discusses aerobic glycolysis, or the Warburg effect, and the metabolic reprogramming involving glycolysis, tricarboxylic acid cycle, and glutaminolysis in the context of developing targeted inhibitors in cancer cells. Finally, the selective targeting of cancer mitochondrial metabolism using positively charged lipophilic compounds as potential therapeutics and their ability to mitigate the toxic side effects of conventional chemotherapeutics in normal cells are discussed. I hope this graphical review will be useful in helping undergraduate, graduate, and medical students understand how investigating the basics of cancer cell metabolism could provide new insight in developing potentially new anticancer treatment strategies.

Keywords: OXPHOS, oxidative phosphorylation; TCA, tricarboxylic acid; GLUT, glutamine transporter; HK, hexokinase; PDH, pyruvate dehydrogenase; 2-DG, 2-deoxyglucose

Introduction

A few months ago, I was invited to teach a course on “targeting cancer metabolism” to students at Anna University in Chennai, Tamil Nadu, India (Fig. 1). These lectures were part of Anna University’s recently launched Global Initiative of Academic Networks (GIAN) program, a project of the Ministry of Human Resource Development, Government of India. One of the goals of GIAN is to provide a platform to initiate future teaching and research collaborations between Anna University and the Medical College of Wisconsin in Milwaukee, USA. Teaching this course was especially gratifying to me, because it allowed me to “give back” to the city where I grew up and was educated from first grade through receipt of my Bachelor’s degree. My visit was hosted by Dr. Anuradha Dhanasekaran, director and head of the Center for Biotechnology at Anna University. I gave six lectures covering the basics of cancer metabolism, redox signaling, metabolic imaging, and the side effects of standard-of-care antitumor drugs. In this review, I will focus on the basics of cancer metabolism.

Targeting cancer cell metabolism: New anticancer treatment strategies