



University of Kentucky
UKnowledge

Toxicology and Cancer Biology Presentations

Toxicology and Cancer Biology

5-28-2014

Antagonistic Effects of MYC and Hypoxia in Channeling Glucose and Glutamine into *De Novo* Nucleotide Biosynthesis

Teresa W-M Fan

University of Kentucky, teresa.fan@uky.edu

Anne Le

Johns Hopkins University

Zachary Stine

University of Pennsylvania

Ye Yang

University of Kentucky, ye.yang@uky.edu

Karen Zeller

Johns Hopkins University

See next page for additional authors

Right click to open a feedback form in a new tab to let us know how this document benefits you.

Follow this and additional works at: https://uknowledge.uky.edu/toxicology_present



Part of the [Medical Toxicology Commons](#), and the [Oncology Commons](#)

Repository Citation

Fan, Teresa W-M; Le, Anne; Stine, Zachary; Yang, Ye; Zeller, Karen; Zhou, Weiqiang; Ji, Hongkai; Higashi, Richard M.; Dang, Chi; and Lane, Andrew N., "Antagonistic Effects of MYC and Hypoxia in Channeling Glucose and Glutamine into *De Novo* Nucleotide Biosynthesis" (2014). *Toxicology and Cancer Biology Presentations*. 1.

https://uknowledge.uky.edu/toxicology_present/1

This Presentation is brought to you for free and open access by the Toxicology and Cancer Biology at UKnowledge. It has been accepted for inclusion in Toxicology and Cancer Biology Presentations by an authorized administrator of UKnowledge. For more information, please contact UKnowledge@lsv.uky.edu.

Authors

Teresa W-M Fan, Anne Le, Zachary Stine, Ye Yang, Karen Zeller, Weiqiang Zhou, Hongkai Ji, Richard M. Higashi, Chi Dang, and Andrew N. Lane

ORAL PRESENTATION

Open Access

Antagonistic effects of MYC and hypoxia in channeling glucose and glutamine into *de novo* nucleotide biosynthesis

Teresa Fan¹, Anne Le², Zachary Stine³, Ye Yang¹, Karen Zeller⁴, Weiqiang Zhou⁵, Hongkai Ji⁵, Richard Higashi¹, Chi Dang³, Andrew Lane^{1*}

From *Metabolism, Diet and Disease 2014: Cancer and metabolism*
Washington DC, USA. 28-30 May 2014

Background

Cell proliferation requires up regulation of nucleotide biosynthesis for making new DNA and RNA to support protein bio-synthesis. MYC is a major transcription factor that regulates metabolic processes essential for cell division, and is overexpressed in many cancers. The nutrient sources and integration of the metabolic pathways for nucleotide biosynthesis that enable MYC-dependent cell division are poorly defined. Using Stable Isotope Resolved Metabolomics (SIRM) we have determined the fate of atoms from ¹³C₆-glucose, ¹³C₅, ¹⁵N₂-glutamine, or ²H-glycine into nucleotides under varied conditions of MYC expression in the MYC-inducible P493-6 B-lymphocyte [2] and several lung cell lines.

Materials and methods

P493-6 cells, A549, PC9 and HPLD1 cells were grown in the presence of [U-¹³C]-glucose, [U-¹³C,¹⁵N]-Gln or [²H₂]-Gly for one cell division. P493-6 cells, which have an inducible MYC gene were grown under four sets of conditions, namely MYC On/Off under 21% or 1% oxygen. Media samples were taken at timed intervals, and the cells were harvested, and extracted. Isotopomer and isotopologue distributions were measured in the free nucleotides and in metabolites that characterize the related pathways of glycolysis, PPP, Krebs cycle, serine, glutathione and nucleobase biosynthetic pathways. In parallel, gene expression data and MYC promoter occupancies were interrogated.

Results

MYC increased incorporation of ¹³C from glucose and glutamine into newly synthesized glycine and aspartate, which are channeled into nucleotides. MYC suppression in lung adenocarcinoma PC9 and A549 cells induced opposite effects on carbon flow into nucleotides. Exogenous ²H-Glycine was preferentially incorporated into glutathione both in transformed cells and primary lung HPLD1 cells, whereas glucose-derived ¹³C Gly was incorporated into purines. Although hypoxia enhances glycolysis and maintains ribose synthesis in P493 cells, it antagonizes channeling toward nucleobase synthesis and reduces MYC-induced proliferation. MYC increased coordinately expression of the relevant metabolic genes associated directly and indirectly with nucleotide biosynthesis, which correlates with cell proliferation and cell cycle distribution data.

Conclusions

These results reveal the coupling of bioenergetics and nutrient availability to cell proliferation through regulation of metabolic channeling in *de novo* nucleotide biosynthesis. MYC coordinately regulates genes for nucleotide biosynthesis as well as the associated pathways for serine and glycine synthesis, which feed into the purine pathway. MYC enhances channeling of glucose-derived Gly into purines and Gln-derived Asp into pyrimidines.

Authors' details

¹Graduate Center for Toxicology and Markey Cancer Center, University of Kentucky, Lexington, KY, USA. ²Department of Pathology and Oncology, School of Medicine, Johns Hopkins University, Baltimore, MD 21231, USA. ³Abramson Cancer Center, University of Pennsylvania, Philadelphia, PA 19104, USA. ⁴Department of Medicine, School of Medicine, Johns Hopkins University, Baltimore, MD 21231, USA. ⁵Department of Biostatistics,

¹Graduate Center for Toxicology and Markey Cancer Center, University of Kentucky, Lexington, KY, USA

Full list of author information is available at the end of the article

Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD 21231, USA.

Published: 28 May 2014

doi:10.1186/2049-3002-2-S1-O10

Cite this article as: Fan *et al.*: Antagonistic effects of MYC and hypoxia in channeling glucose and glutamine into *de novo* nucleotide biosynthesis. *Cancer & Metabolism* 2014 **2**(Suppl 1):O10.

**Submit your next manuscript to BioMed Central
and take full advantage of:**

- Convenient online submission
- Thorough peer review
- No space constraints or color figure charges
- Immediate publication on acceptance
- Inclusion in PubMed, CAS, Scopus and Google Scholar
- Research which is freely available for redistribution

Submit your manuscript at
www.biomedcentral.com/submit

