PATENT ASSIGNMENT

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SUBMISSION TYPE:	NEW ASSIGNMENT
NATURE OF CONVEYANCE:	ASSIGNMENT

CONVEYING PARTY DATA

Name	Execution Date
Bing Lim	12/22/2010
Wencai Zhang	12/22/2010

RECEIVING PARTY DATA

Name:	Agency For Science, Technology and Research
Street Address:	1 Fusionopolis Way
Internal Address:	#20-10
City:	Connexis
State/Country:	SINGAPORE
Postal Code:	138632

PROPERTY NUMBERS Total: 1

Property Type	Number
Application Number:	13884891

OP $40.00 13884891

CORRESPONDENCE DATA

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ATTORNEY DOCKET NUMBER:	S1507.70102US00
NAME OF SUBMITTER:	Eileen M. MacKenzie
Signature:	/Eileen M. MacKenzie/
Date:	09/20/2013

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DATED 22 day of Dec 2010

LIM, BING
ZHANG, WENCAI

as Assignors

And

AGENCY FOR SCIENCE, TECHNOLOGY AND RESEARCH

as Assignee

DEED OF ASSIGNMENT
Of
Invention & Patent Application

Yu Sarn Audrey & Partners
24 Raffles Place
#27-01 Clifford Centre
Singapore 048621
Tel (65) 6358 2865
Fax (65) 6358 2864
Email: enquiries@yusarn.com

THIS DEED is made on _____ day of _____ 201__

BETWEEN

(1) **LIM, BING** and **ZHANG, WENCAI** both c/o Genome Institute of Singapore, 60 Biopolis Way, #02-01, Singapore 138672 (the "**Assignors**"); and

(2) **AGENCY FOR SCIENCE, TECHNOLOGY AND RESEARCH** a statutory board established in Singapore having its registered office at 1 Fusionopolis Way, #20-10, Connexis, Singapore 138632 (the "**Assignee**")

WHEREAS:

The Assignors are the inventors in relation to the invention listed in Schedule 1 (hereinafter called the "**Invention**") and the patent application listed in Schedule 2 (hereinafter called the "**Patent Application**").

NOW THIS DEED HEREBY WITNESSES as follows:

ASSIGNMENT

1.1 In consideration of the sum of S$1 now paid by the Assignee to the Assignors (the receipt of which is hereby acknowledged by the Assignors), subject to clause 2 below, the Assignors hereby ASSIGNS absolutely to the Assignee free from encumbrances:

(a) all their right title and interest throughout the world in and to:

(i) the Invention;

(ii) any improvements (the "**Improvements**") on the Invention heretofore or hereafter made or acquired by the Assignors;

(iii) all intellectual property rights in the Invention and Improvements;

(iv) the benefit of the Patent Application to the intent that the grant of any patents thereon shall be in the name of and vest in the Assignee; and

(v) any and all patent or patents on the Invention and/or Improvements that may be granted anywhere in the world;

together with all rights and powers arising or accrued therefrom including the right to sue for damages and other remedies in respect of any infringement of such rights or other acts within the scope of the claims of any published

SCHEDULE 1

Invention

ABSTRACT

TARGETING METABOLIC ENZYMES IN HUMAN CANCER

Lung cancer is a devastating disease and a major therapeutic burden with poor prognosis. The functional heterogeneity of lung cancer (different tumor formation ability in bulk of tumor) is highly related with clinical chemoresistance and relapse. Here we find that, glycine dehydrogenase (GLDC), one of the metabolic enzyme involved in glycine metabolism, is overexpressed in various subtypes of human lung cancer and possibly several other types of cancers. GLDC was found to be highly expressed in tumor-initiating subpopulation of human lung cancer cells compared with non-tumorigenic subpopulation. By array studies we showed that normal lung cells express low levels of GLDC compared to xenograft and primary tumor. Functional studies showed that inhibition of GLDC inhibits significantly the clonal growth of tumor-initiating cells in vitro and tumor formation in immunodeficient mice. Overexpression of GLDC in non-tumorigenic subpopulation convert the cells to become tumorigenic. Furthermore, overexpression of GLDC in NIH/3T3 cells and human primary lung fibroblasts can transform these cells, displaying anchorage-independent growth in soft agar and tumor-forming in mice. Not only is GLDC expressed human lung cancer, it is also up-regulated in other types of cancer, such as colon cancer. RNAi knockdown of GLDC in colon cancer cell line, CACO-2 cells, can also inhibit the tumor formation in mice. Thus GLDC maybe a new metabolic target for treatment of lung cancer, and other cancers.

Figure 1

IN WITNESS WHEREOF this Deed has been executed by the Assignors on the date stated at the beginning.

Assignors

Signed, Sealed and Delivered by)
LIM, BING)
in the presence of)

Witness

Signed, Sealed and Delivered by)
ZHANG, WENCAI)
in the presence of)

Witness

Acknowledgment and Acceptance

Acknowledged and Accepted by)
For and on behalf of)
AGENCY FOR SCIENCE, TECHNOLOGY AND RESEARCH)
On this 22 day of Dec 2010)

SUBBESAN SACHI
GENERAL COUNSEL
AGENCY FOR SCIENCE, TECHNOLOGY AND RESEARCH

Targeting metabolic enzymes in human cancer

Abstract

Lung cancer is a devastating disease and a major therapeutic burden with poor prognosis. The functional heterogeneity of lung cancer (different tumor formation ability in bulk of tumor) is highly related with clinical chemoresistance and relapse. Here we find that, glycine dehydrogenase (GLDC), one of the metabolic enzyme involved in glycine metabolism, is overexpressed in various subtypes of human lung cancer and possibly several other types of cancers . GLDC was found to be highly expressed in tumor-initiating subpopulation of human lung cancer cells compared with non-tumorigenic subpopulation. By array studies we showed that normal lung cells express low levels of GLDC compared to xenograft and primary tumor. Functional studies showed that RNAi inhibition of GLDC inhibits significantly the clonal growth of tumor-initiating cells in vitro and tumor formation in immunodeficient mice. Overexpression of GLDC in non-tumorigenic subpopulation convert the cells to become tumorigenic. Furthermore, overexpression of GLDC in NIH/3T3 cells and human primary lung fibroblasts can transform these cells, displaying anchorage-independent growth in soft agar and tumor-forming in mice. Not only is GLDC is expressed human lung cancer, it is also up-regulated in other types of cancer, such as colon cancer. RNAi-knockdown of GLDC in colon cancer cell line, CACO-2 cells, can also inhibit the tumor formation in mice. Thus GLDC maybe a new metabolic target for treatment of lung cancer, and other cancers.

Figure 1

DATED 22 day of Dec 2010

LIM, BING
ZHANG, WENCAI

as Assignors

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CONTENTS

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(a) all their right title and interest throughout the world in and to:

(i) the Invention;

(ii) any improvements (the "**Improvements**") on the Invention heretofore or hereafter made or acquired by the Assignors;

(iii) all intellectual property rights in the Invention and Improvements;

(iv) the benefit of the Patent Application to the intent that the grant of any patents thereon shall be in the name of and vest in the Assignee; and

(v) any and all patent or patents on the Invention and/or Improvements that may be granted anywhere in the world;

together with all rights and powers arising or accrued therefrom including the right to sue for damages and other remedies in respect of any infringement of such rights or other acts within the scope of the claims of any published

specification of any of the Patent Application or any patent on the Invention and/or Improvements;

(b) the right to apply for prosecute and obtain patent or similar protection throughout the world in respect of the Invention and/or the Improvements and the Patent Application including the right to claim priority therefrom to the intent that the grant of any patents or similar protection shall be in the name of and vest in the Assignee.

FURTHER ASSURANCE

1.2 The Assignors further covenants that:

(a) at the direction and expense of the Assignee they will at all times hereafter do all such acts and execute all such documents as may reasonably be necessary or desirable both to secure the vesting in the Assignee of all rights assigned to the Assignee hereunder in any country whether patent application have been made or not and to assist in the resolution of any question concerning any patent application in respect of the Invention and/or the Improvements, whether in the course of legal proceedings or otherwise to uphold the Assignee's rights herein;

(b) they will forthwith from time to time after making any Improvement whether patentable or not disclose the same to the Assignee and if and whenever required by the Assignee but at the cost of the Assignee will give to the Assignee full particulars as to the nature of making and working the same and will (at the option of the Assignee) either apply for and endeavour to obtain or join with the Assignee in applying for patents in respect of such Improvement and when and if the same shall be obtained will at the like expense execute and do all documents acts and things necessary for vesting the same and the full and exclusive benefit thereof in the Assignee;

GOVERNING LAW

1.3 Governing law: This Deed shall be governed by and construed in accordance with the laws of Singapore.

1.4 Jurisdiction: The parties hereby submit to the non-exclusive jurisdiction of the Singapore courts.

SCHEDULE 1

Invention

ABSTRACT

TARGETING METABOLIC ENZYMES IN HUMAN CANCER

Lung cancer is a devastating disease and a major therapeutic burden with poor prognosis. The functional heterogeneity of lung cancer (different tumor formation ability in bulk of tumor) is highly related with clinical chemoresistance and relapse. Here we find that, glycine dehydrogenase (GLDC), one of the metabolic enzyme involved in glycine metabolism, is overexpressed in various subtypes of human lung cancer and possibly several other types of cancers. GLDC was found to be highly expressed in tumor-initiating subpopulation of human lung cancer cells compared with non-tumorigenic subpopulation. By array studies we showed that normal lung cells express low levels of GLDC compared to xenograft and primary tumor. Functional studies showed that inhibition of GLDC inhibits significantly the clonal growth of tumor-initiating cells in vitro and tumor formation in immunodeficient mice. Overexpression of GLDC in non-tumorigenic subpopulation convert the cells to become tumorigenic. Furthermore, overexpression of GLDC in NIH/3T3 cells and human primary lung fibroblasts can transform these cells, displaying anchorage-independent growth in soft agar and tumor-forming in mice. Not only is GLDC expressed human lung cancer, it is also up-regulated in other types of cancer, such as colon cancer. RNAi knockdown of GLDC in colon cancer cell line, CACO-2 cells, can also inhibit the tumor formation in mice. Thus GLDC maybe a new metabolic target for treatment of lung cancer, and other cancers.

Figure 1

SCHEDULE 2

Patent Application

S/NO.	COUNTRY	PATENT APPLICATION NO.	TITLE OF INVENTION	FILING DATE
1.	SINGAPORE [SG]		TARGETING METABOLIC ENZYMES IN HUMAN CANCER	11 NOVEMBER 2010

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