BIOGRAPHICAL SKETCH

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NAME: Goldberg, Gary S.

eRA COMMONS USER NAME (credential, e.g., agency login): ggoldberg

POSITION TITLE: Associate Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of Georgia, Athens, GA	B.S.	05/1983	Genetics & Biology
West Virginia University, Morgantown, WV	Ph.D.	06/1990	Genetics & Developmental Biology

A. Personal Statement

I have the expertise, leadership, training, experience, and motivation necessary to successfully carry out this research project. I have a broad background in molecular and cell biology, with specific training and expertise in neoplastic transformation and cancer research. My research includes novel discoveries of fundamental mechanisms by which intercellular communication affects tumor cell growth and migration. As PI or co-Investigator of university and NIH funded grants, I laid the groundwork for the proposed research by developing effective ways to target PDPN to combat tumor cell growth and migration. In addition, I successfully administered projects, mentored students (underlined in citations below), collaborated with other researchers, and produced several peer-reviewed publications from each project. As a result of these previous experiences, I am aware of the importance of frequent communication among project members and of constructing a realistic research plan, timeline, and budget.

I founded Sentrimed as a DBA in 2011 with the mission to prevent cancer, extend survival rates, and improve the quality of life of people with cancer. Sentrimed has since grown into a stable C corporation and licensed intellectual property that I invented, which is now a secure intellectual property portfolio. Major patents licensed from this agreement protect the use of MASL to combat cancer. Rowan University and I are both major shareholders in Sentrimed. Thus, Rowan and Sentrimed have joined forces to achieve the goals outlined in this project which builds upon my work.

Ongoing and recently completed projects that I would like to highlight include:

1 R15 CA235347-01 (Goldberg PI) 02/01/19-01/31/22
NIH NCI PDPN to prevent and combat oral cancer

PC11-21CV (Goldberg PI) 01/11/21-01/10/22
New Jersey Health Foundation Developing MASL as a novel therapeutic agent

16800 (Goldberg PI) 03/01/19-02/30/22
Camden Health Research Initiative Targeting podoplanin to prevent and treat inflammatory arthritis

67104 (Goldberg PI) 07/01/18-06/30/22
Osteopathic Heritage Foundation Targeting PDPN to combat oral cancer

Ciations:

a. Retzbach, E.P., Sheehan, S.A., Nevel, E., Batra, A., Phi, T., Kato, Y., Baredes, S., Fatahzadeh, M., Shienbaum, A.J., and **Goldberg, G.S.** (2018) Podoplanin emerges as a functionally relevant oral cancer biomarker and therapeutic target. *Oral Oncology* 8: 126–136. PMID 29496040.
b. Hamilton, K.L., Sheehan, S.A., Retzbach, E.P., Timmerman, C.A., Gianneschi, G.B., Tempera, P.J., Balachandran, P., and **Goldberg, G.S.** (2021) Effects of Maackia amurensis seed lectin (MASL) on oral squamous cell carcinoma (OSCC) gene expression and transcriptional signaling pathways. Journal of *Cancer Research and Clinical Oncology*. 147:445-457. PMID: 33205348.
c. Sheehan, S.A., Retzbach, E.P., Shen, Y., Krishnan, H., and Goldberg, G.S. (2022) Heterocellular N-cadherin junctions enable nontransformed cells to inhibit the growth of adjacent transformed cells. Cell Communication and Signaling. PMID: 35177067.
d. Retzbach, E.P., Sheehan, S.A., Krishnan, H., Zheng, H., Zhao, C., and **Goldberg, G.S.** (in press) Independent effects of Src kinase and podoplanin on anchorage independent cell growth and migration. Molecular Carcinogenesis.

B. Positions, Scientific Appointments, and Honors

Positions:

06/90-08/90 Research Associate, Anatomy, West Virginia University, Morgantown, WV.
08/90-12/93 Junior Researcher, Molecular Oncology, Cancer Research Center of Hawaii, Honolulu, HI.
01/94-12/94 Research Associate, Anatomy, University of Western Ontario, London, Ontario.
01/95-05/95 Research Associate, Biological Sciences, State University of New York, Buffalo, NY.
09/97-12/97 Visiting Scientist, International Agency for Cancer Research, Lyon, France.
07/98-06/99 Invited Scientist, National Cancer Center Research Institute, Tokyo, Japan.
05/95-03/03 Res. Assistant Professor, Biological Sciences, State University of New York, Buffalo, NY.
02/02-02/04 Invited Scientist, National Cancer Center Research Institute, Tokyo, Japan.
07/00-12/04 Res. Assistant Professor, Physiology & Biophysics, SUNY, Stony Brook, NY.
08/04-06/13 Associate Professor, Molecular Biology, UMDNJ, Stratford, NJ.
10/10-now Associate Member, Cancer Institute of New Jersey, New Brunswick, NJ.
07/13-now Associate Professor, Molecular Biology, Rowan University, Stratford, NJ.

Selected Awards and Honors (since 2012):

2012 Invited Presenter, Peter Wall Institute for Advanced Studies Colloquium, Fondation Hugot of the Collège de France, Paris, France
2012 Global Center of Excellence award, Program for Integrated Functional Molecular Medicine for Neuronal and Neoplastic Disorders, Japanese Ministry of Education, Culture, Sports, Science and Technology
2012 Invited Presenter, Carcinogenesis and Chemoprevention Meeting, Rutgers University, Piscataway, NJ.
2012 Invited Presenter, Tanabe-Mitsubishi Pharma Lecture, Asahikawa, Japan
2012 Invited Presenter, Princeton University, Princeton, NJ.
2013 Invited Presenter, Jiaotong University Hospital and Medical School, Xi'an, China
2013 Invited Presenter, New Jersey Medical School, Newark, NJ.
2013 Invited Presenter, Cancer Institute of New Jersey, New Brunswick, NJ.
2013 Invited Organizer, Science Xpression Workshop in Biomedical Research, A Coruña, Spain
2013 Breakout Session Leader, The Halifax Project for Cancer Research, Halifax, Nova Scotia
2014 Invited Presenter, Peter Wall Institute, University of British Columbia, Vancouver, Canada.
2014 Invited Presenter, University of Texas Southwest Medical Center, San Antonio, TX.
2014 2014 Best of Health Care Award, South Jersey Biz Magazine.
2014 Certificate of Recognition for Creative and Outstanding Scholarship, Rowan University
2014 Research Travel Award and Invited Presenter, Nagoya University, Nagoya Japan.
2014 2014 Award for Excellence in Graduate Research, Rowan University (for student Harini Krishnan).
2014 Certificate of Recognition for Creative and Outstanding Scholarship, Rowan University.
2015 Research Travel Award and Cell Communication and Cancer Workshop Leader, Sao Paulo University and Sao Paulo Research Foundation (FAPESP), Sao Paulo, Brazil.
2017 Founded and Organizing First International Podoplanin Meeting at Nagoya University, Nagoya, Japan.
2019 Meeting Organizer Travel Award, PDPN Central International PDPN Meeting at Maui Westin.
2019 Research Travel Award, University of Sao Paulo, Sao Paulo, Brazil.
2019 Invited Organizer and Presenter Travel Award, Cell communication disorders leading to cancers & other diseases, Nagoya University Institute for Advanced Research, Nagoya, Japan.

Intellectual Property:

1. United States Patent 10,213,481
   Compositions and Methods to Treat Inflammatory Joint Disease.
   Maria D. Mayan Santos, Fancisco J. Blanco, Paula C. Fernandez, and **Gary S. Goldberg**.
   International Application# PCT/US14/45229; filed July 2, 2014; issued 02/26/19.
2 United States Patent 9,809.631
   Targeting of Podoplanin with Lectin for the Use of Prevention and Treatment of Cancer.
   Gary S. Goldberg and Yongquan Shen.
   USPTO# 14/921,641; filed 10/23/15; allowed 7/7/17; issued 11/7/17.
3. United States Patent 9,448,195
   Electrophysiological Recording System and Methods of Using Same.
   Alonso P. Moreno, **Gary S. Goldberg**, Abhijit Mondal, Ian Harvey, and Brian Baker.
   PCT/US# 11/44128 filed 7/15/11; USPTO# 13/810,402 filed 1/15/13; issued 9/20/16
4. United States Patent 9,169,327
   Targeting of Podoplanin with Lectin for the Use of Prevention and Treatment of Cancer.
   Gary S. Goldberg and Yongquan Shen.
   USPTO# 13/218,717; PCT/US2012/052192; filed 8/26/11; allowed 9/14/15;
   issued 10/27/15.
5. United States Patent 8,114,593
   Cancer Biomarker Genes and Gene Products and Methods for Using the Same.
   Gary S. Goldberg and Yongquan Shen.
   USPTO# 12/401,849 filed 3/11/09; allowed 11/7/11; issued 2/14/12.

Registered Trademarks:

1. "Sentrimed" **Gary S Goldberg**.
   Reg. No. 5,289,608, S/N 87309205, filed 1/20/17, published 7/4/17, registered 9/19/17.
2. "MASL" **Gary S Goldberg**.
   Reg. No. 5,356,628, S/N 87386961, filed 3/27/17, published 8/1/17, registered 12/12/17.

Registered Copyrights:

"Problem Base Learning Medicine" **Gary S. Goldberg** and Shumin Guo
Reg. No. TXu 2-116-117, certified 9/7/18.

Commercial Ventures:

Sentrimed (University Startup) - Founder and Chief Scientific Officer
NJ DBA 09/10, converted to NJ LLC 1/11, converted to NJ C-Corp 12/12

Clinical Experience:

08/13-07/15	Targeting podoplanin to combat oral cancer (50 patient ex vivo IRB study)
04/17-present	Using MASL to combat oral cancer (IRB and FDA approved Phase 1 clinical trial)

C. Contributions to Science

1. I have developed an academic and industrial program to study and combat cancer. My efforts are built on a wide foundation of research and teaching at national and international institutes including the IARC in Lyon, NCC in Tokyo, Stony Brook University, and UMDNJ which is now Rowan University. These collaborations include recent work on extracellular vesicles and cancer progression stemming from an academic agreement I established between Rowan University and Sao Paulo University in Brazil. My broad training has also motivated me to co-author a textbook on cancer chemotherapy, and develop a dynamic online teaching platform (www.pblmed.com) that is being used as a core resource for medical school problem-based learning programs. I also founded PDPN Central (www.pdpn.info) as an organization to support podoplanin research and clinical applications, and organized the first and second International Podoplanin Meetings in 2017 and 2019, respectively. Most significantly, I founded Sentrimed Inc., which has licensed IP from Rowan to target PDPN and inhibit cancer progression, resulting in an IRB (#Pro20140000009) and FDA IND (#118210) approved Phase 1 clinical trial entitled "Using MASL to combat oral cancer" (clinicaltrials.gov #NCT04188665) in Aim 3 of this application.
   a. Cancer Chemotherapy: Basic Science to the Clinic (2020) **Goldberg, G.S**. and Airley. R. **Goldberg G.S.** (Ed) Wiley-Blackwell, John Wiley and Sons, Ltd. ISBN-13: 978-1118963852.

b. Krishnan, H., Miller, W.T., Blanco, F.J., and **Goldberg, G.S.** (2019) Src and podoplanin forge a path to destruction. *Drug Discovery Today* 24, 241-249. PMID: 30077780.
c. Anna. Ralph, A.C.L., Valadão, I.C., Cardoso, E.C., Garcilazo, F.S.G., Martins, V.R., Oliveira, L.M.S., Bevilacqua, E.M.A.F., Geraldo, M.V., Jaeger, R.J., **Goldberg, G.S.,** and Freitas, V.M. (2020) Environmental control of mammary carcinoma cell expansion by acidification and spheroid formation in vitro. *Nature Scientific Reports.* 10, 21959-21970. PMID: 33319820.
d. Sheehan, S.A., Hamilton, K.L., Retzbach, E.P., Balachandran, P., Krishnan, H., Leone, P., Lopez-Gonzalez, M., Suryavanshi, S., Kumar, P., Russo, R., and **Goldberg, G.S**. (2021) Evidence that *Maackia amurensis* seed lectin (MASL) exerts pleiotropic actions on oral squamous cells with potential to inhibit SARS-CoV-2 infection and COVID-19 disease progression. *Experimental Cell Research.* 403:112594-112560. PMID: 33823179.

2. Intercellular communication has been reported to inhibit cancer progression. However, mechanisms underlying the effect of cell junctions on tumor cell behavior have not been elucidated. I collaborated with other researchers to find that connexins mediate the transfer of specific molecules between cells to induce the expression of growth inhibitory factors and suppress transformed cell growth. This work identified molecular pathways by which intercellular junctions between cancer cells inhibit tumor cell growth and cancer progression. I served as primary and lead investigator for these studies.
   a. Goldberg, G.S., Lampe, P.D., Sheedy, D., Stewart, C.C., Nicholson, B.J., and Naus, C.C.G. (1998) Direct identification and analysis of transjunctional ADP from Cx43 transfected C6 glioma cells. *Experimental Cell Research* 239, 82-92. PMID: 9511727.
   b. Goldberg, G.S., Lampe, P.D., and Nicholson, B.J. (1999) Selective transfer of endogenous metabolites through gap junctions composed of different connexins. *Nature Cell Biology* 1, 457-459. PMID: 10559992.
   c. Goldberg, G.S., Bechberger, J.F., Tajima, Y., Merritt, M., Omori, Y., Gawinowicz, M.A., Narayanan, R., Tan, Y., Sanai, Y., Yamasaki, H., Naus, C.C.G., Tsuda, H., and Nicholson, B.J. (2000) Connexin43 suppresses MFG-E8 while inducing contact growth inhibition of glioma cells. *Cancer Research* 60, 6018-6026. PMID: 11085522.
   d. Goldberg, G.S., Moreno, A.P., and Lampe, P.D. (2002) Gap junctions between cells expressing connexin 43 or 32 show inverse permselectivity to adenosine and ATP. *Journal of Biological Chemistry* 277, 36725-36730. PMID: 12119284.

3. After identifying molecular pathways by which intercellular junctions suppress transformed cells growth, I sought to elucidate specific signaling mechanisms affected by these pathways. The Src and Abl nonreceptor tyrosine kinases are powerful factors that promote tumor cell growth and migration. I collaborated with other researchers to elucidate novel aspects of how these kinases utilize effectors to promote tumor invasion and metastasis. We found that Src and Abl work together to stabilize the Robo1 receptor on the cell membrane to promote tumor cell migration. We also found that Src phosphorylates specific tyrosine residues on the adaptor protein Cas in order to promote anchorage dependent growth, and other tyrosine residues to promote cell migration. In this way, we discovered unique kinase activities that essentially separate anchorage independence from cell motility as two independent hallmarks of cancer. I served as primary and lead investigator for most of these studies.
   a. Goldberg, G.S., Alexander, D.B., Pellicena, P., Zhang, Z.-Y., Tsuda, H., and Miller, W.T. (2003) Src phosphorylates Cas on tyrosine 253 to promote migration of transformed cells. *Journal of Biological Chemistry* 278, 46533-46540. *(highlighted in issue cover illustration)* PMID: 12972425.
   b. Patwardhan, P., Shen, Y., Goldberg, G.S., and Miller, W.T. (2006) Individual Cas phosphorylation sites are dispensable for processive phosphorylation by Src and cellular transformation. *Journal of Biological Chemistry* 281, 20689-20697. PMID: 16707485.
   c. Shen, Y., Khusial, P.R., Li, X., Ichikawa, H., Moreno, A.P., and Goldberg, G.S. (2007) Src utilizes Cas to block gap junctional communication mediated by connexin43. *Journal of Biological Chemistry* 282, 18914-18921. PMID: 17488714.
   d. Khusial, P.R., Vadla, B., Krishnan, H., Ramlall, T.F., Shen, Y., Ichikawa, H., Geng, J.-G., and Goldberg, G.S. (2010) Src activates Abl to augment Robo1 expression in order to promote tumor cell migration. *Oncotarget* 4, 198-209. (highlighted in news section and issue cover illustration) PMID: 21301049.

4. After elucidating some fundamental mechanisms by which cell junctions affect tumor progression, and signaling pathways by which they act, we then sought to use these data to prevent and treat cancer. I developed a Layered Culture System to identify novel biomarkers and chemotherapeutic targets that control the ability of nontransformed cells to normalize the growth of neighboring transformed cells by the process of contact normalization. We found that contact normalization requires direct contact through intercellular junctions, and that, while 10% of the transcriptome, or about 3000 genes are affected by transformation, only 1% of these are actually critical to contact normalization and cancer progression. For example, we identified miR126, FHL1, and SDPR as novel tumor suppressors that are induced by contact normalization, while TMEM163 and PDPN are tumor promoters that are suppressed by contact normalization. Thus, these genes and proteins can serve as functionally relevant cancer biomarkers and chemotherapeutic targets. I served as primary and lead investigator for these studies.
   a. Shen, Y., Jia Z., Nagele R.G., Ichikawa H., and Goldberg G.S. (2006) Src utilizes Cas to suppress Fhl1 in order to promote nonanchored growth and migration of tumor cells. *Cancer Research* 66, 1543-1552. PMID: 16452211.
   b. Li, X., Jia, Z., Shen, Y., Ichikawa, H., Jarvik, J., Nagele, R.J., and Goldberg, G.S. (2008) Coordinate suppression of Sdpr and Fhl1 expression in tumors of the breast, kidney, and prostate. *Cancer Science* 99, 1326-1333. PMID: 18422756.
   c. Li, X., Shen, Y., Ichikawa, H., Antes, T., and Goldberg, G.S. (2009) Regulation of miRNA expression by Src and contact normalization: effects on nonanchored cell growth and migration. *Oncogene* 28, 4272–4283. PMID: 19767772.
   d. Shen, Y., Chen, C.-S., Ichikawa, H., and Goldberg, G.S. (2010) Src induces Pdpn expression to promote cell migration. *Journal of Biological Chemistry* 285, 9649-9656. PMID: 20123990.

5. After identifying PDPN as a potential chemotherapeutic target, I worked with colleagues and students to find ways to target this receptor. We found that specific kinases can phosphorylate the intracellular tail of PDPN to inhibit tumor cell migration, and that the lectin MASL can target the extracellular portion of PDPN to inhibit tumor cell growth and migration. This work forms the foundation for the current proposal to prevent and combat the growth of melnoma cancer cells that escape contact normalization. I served as primary and lead investigator for these studies.
   a. Ochoa-Alvarez, J.A., Krishnan, H., Shen, Y., Acharya, N.K., Han, M., McNulty, D.E., Hasegawa, H., Hyodo, T., Senga, T., Geng, J.-G., Kosciuk, M., Shin, S.S., Goydos, J.S., Temiakov, D., Nagele, R.G., and Goldberg, G.S. (2012) Plant lectin can target receptors containing sialic acid, exemplified by podoplanin, to inhibit transformed cell growth and migration. *PLoS One* 7:e41845. PMID: 22844530.
   b. Krishnan, H., Ochoa-Alvarez, J.A., Shen, Y., Nevel, E., Lakshminarayanan, M., Williams, M.C., Ramirez, M.I., Miller, W.T., and Goldberg, G.S. (2013) Serines in the intracellular tail of podoplanin (PDPN) regulate cell motility. *Journal of Biological Chemistry,* 288, 12215-12221. (published as “report” - reserved for “topics of exceptional novelty, significance and broad interest …. within the top 5 percent of all articles published in the journal”) PMID: 23530051.
   c. Ochoa-Alvarez, J.A., Krishnan, H., Pastorino, J.G., Nevel, E.M., Kephart, D., Lee, J.J., Retzbach, E.P., Shen, Y., Fatahzadeh, M., Baredes, S., Kalyoussef, E., Honma, M., Adelson, M.E., Kaneko, M.K., Kato, Y, Young, M.A., Deluca-Rapone, L., Shienbaum, A.J., Yin, K., Jensen, L.D., and Goldberg, G.S. (2015) Antibody and lectin target podoplanin to inhibit oral squamous carcinoma cell migration and viability by distinct mechanisms. *Oncotarget, 6:* 9045-90604. (highlighted in issue cover art) PMID: 25826087.
   d. Krishnan, H., Retzbach, E.P., Ramirez, M.I., Liu, T., Li, H., Miller, W.T., Goldberg, G.S. (2015) PKA and CDK5 can phosphorylate specific serines on the intracellular domain of podoplanin (PDPN) to inhibit cell motility. *Experimental Cell Research.* 335: 115-122*.* PMID: 25959509.

Complete List of Published Work in Google Scholar and MyBibliography:
https://www.ncbi.nlm.nih.gov/myncbi/1ZQwvlagsgsQT/bibliography/public/
http://scholar.google.com/citations?user=tF9n2o8AAAAJ&hl=en