Undergraduate Thesis Prospectus

An Optogenetics Approach to Quantifying Ovarian Cancer Cell Migration Due to PTP4A3 Localization

(Technical research project in Biomedical Engineering)

Cause-Marketing and Breast Cancer: The Efficacy of Pinkwashing

(STS research project)

by

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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General Research Problem

How can the incidence of cancer in women be reduced?

Breast cancer is the most common cancer in women following skin cancers. In 2019, approximately 268,600 women in the United States will be diagnosed with invasive breast cancer and 41,760 will die from it. Ovarian cancer is the fifth deadliest cancer in women and is predicted to cause 22,530 new diagnoses and 13,980 deaths in 2019 (American Cancer Society, 2019). Cancer charities raise money to promote awareness and conduct cancer research. Companies can partner with charities and sell pink-colored products to further raise awareness and most donate a portion of revenue to the charity. Cancer has not been cured, and while survival rates have improved, unknown environmental and genetic factors still cause the needless deaths of millions worldwide.

An Optogenetics Approach to Quantifying Ovarian Cancer Cell Migration Due to PTP4A3 Localization

How can metastasis due to PTP4A3 overexpression be quantified in ovarian cancer?

I plan to complete this Biomedical Engineering Capstone project with Sruthi Jayaraman under the supervision of Dr. John Lazo of the Pharmacology Department. We intend to collaborate with Dr. Kristen Naegle of the Biomedical Engineering Department. Our aims for this project are to 1) design and test an optogenetic vector that expresses genes of interest within an ovarian cancer cell line, 2) quantify protein tyrosine phosphatase IVA3 (PTP4A3) localization upon exposure to visible light, and 3) design a novel 3D migration assay utilizing fluorescence to measure cell migration.

PTP4A3 is overexpressed in many forms of cancer, including ovarian. While its direct substrate is unknown, studies support the removal of PTP4A3 hinders cell migration by reducing

extracellular matrix (ECM) protein concentrations (McQueeney et al., 2018). PTP4A3 also localizes in the cell membrane (Zeng et al., 2000). This suggests that PTP4A3 may play a role in secretion of cytokines, likely those involved in cell migration. Optogenetics has been used to measure protein tyrosine kinase activation and identify cellular responses directly downstream of those proteins (Karunarathne et al., 2015). Since PTP4A3 undergoes posttranslational modifications to add a lipid tail, the CAAX box will have to be removed in order to implement an optogenetics construct. CRY2 and CIBN proteins have been chosen since they couple when exposed to blue light in a matter of seconds with an off-rate of minutes, allowing real-time data to be easily collected. Also, fluorescent proteins such as GFP have been tagged to CRY2 allowing for localization to be analyzed via fluorescent imaging (Osswald et al., 2019). This will allow for a unique measurement of cell migration in a 3D environment.

This project hopes to predict the behavior of ovarian cancer cells with upregulated PTP4A3 with the intention of PTP4A3 being a prognostic indicator of cancer. There is currently a focus in the field on developing small molecule inhibitors for PTP4A3 that will one day be used therapeutically. Better understanding of the localization and activation of PTP4A3 will aid in the development of inhibitors that could be used to treat cancers with overexpressed PTP4A3 in the future.

Cause-Marketing and Breast Cancer: The Efficacy of Pinkwashing

How has the "pink product" movement divided advocates from critics?

Companies that sell "pink products," committing a portion of proceeds to cancer funds, often also sell carcinogenic products. Only a small fraction of the money raised goes towards cancer research or treatment. Such cause-marketing is called "pinkwashing" which has grown

more conspicuous over the course of the 21st century. Pink ribbons, an international symbol of breast cancer awareness, were first associated with breast cancer in 1990 when Charlotte Haley distributed peach-colored ribbons attached to note cards to alert citizens that only a small percentage the National Cancer Institute's annual budget went towards cancer prevention (Burke, 1992). *Self* magazine approached Haley about using her ribbons for a breast cancer awareness issue. When she refused on the grounds of commercialism, *Self* switched to pink to avoid legal trouble (National Film Board of Canada, 2011). Pink ribbons were quickly adopted by breast cancer charities and other organizations and are still used today, especially in October, which is National Breast Cancer Awareness Month in the United States. "Pinkwashing" was coined by Breast Cancer Action, an activist organization, in its "Think Before You Pink" campaign in 2002. It claims that pinkwashing is a form of social injustice. Its members consider themselves "watchdogs" for those at risk (Think Before You Pink).

Corporations

There are countless examples of pinkwashing beginning with the establishment of the pink ribbon as a symbol of breast cancer awareness. Beginning in 1998 in its "Save Lids to Save Lives" campaign, Yoplait urged customers to mail in pink yogurt lids to donate 10 cents to the Susan G. Komen Breast Cancer Foundation. It advertised the campaign on television, in print, and on other General Mills products (Dahlsad, 2017; Display Ad 482, 1999). Many were angry that their yogurt was made with milk containing recombinant bovine growth hormone (rBGH) (General Mills, 2009). Kentucky Fried Chicken sold chicken in pink buckets, donating 50 cents per sale to Susan G. Komen For a Cure in 2010 (KFC, 2010). A healthy diet is key in preventing cancer, so a fast food chain selling deep fried food high in calories and sodium might be

hypocritical. Studies show that “the average firm does not risk a loss of public goodwill” in cause-related marketing (Dean, 2003).

Charities

The most notable charity connected to the pink ribbon is Susan G. Komen Foundation, raising 988 million dollars for breast cancer research and 2.2 billion dollars for breast health education since 1982 (Susan G. Komen, n.d.-b). However, its claims that only 2 percent of its budget funds breast cancer prevention, while 56 percent improves existing treatments (Susan G. Komen, n.d.-a). Its corporate partners include Ford and Mohawk, which both have come under fire for carcinogens in their products. Automobiles combust gasoline which release volatile products such as such as benzene ad aromatic hydrocarbons, while laminate flooring contains PVC which is a contributor to indoor air pollution (Hansen, 2000; Lent et al., 2010). Susan G. Komen Foundation also pinkwashes by selling its own merchandise including clothing, tote bags, tumblers, and books (ShopKomen.com).

Doctors and Medical Associations

Many medical professionals have criticized breast cancer cause-marketing. At an OncLive Conference, Patrick Borgen, MD, said: “The downside of pinkwashing is that it perpetuates a number of myths about how common breast cancer is, how curable it is,” which can weaken breast cancer campaigns (OncLive, 2012). Breast cancer kills tens of thousands of women every year and chemotherapy and surgery leave women feeling extreme pain and discomfort. Meanwhile, many advertising campaigns with bright pink colors and smiling, youthful actors imply that cancer is not as threatening as it is. While individuals may have no impact on multimillion-dollar corporations and their marketing tactics, medical associations are more influential. The American Society of Clinical Oncology (ASCO) condemned pinkwashing

in its 2018 alcohol and cancer statement, and urged beverage companies to refrain from using breast cancer symbols to market their products (LoConte, 2018). In an interview, LoConte said "It's sort of like selling cigarettes to raise lung cancer awareness—it just doesn't make a lot of sense" (Chahal, 2018).

Advocacies

Breast Cancer Action (BCA) coined the term "pinkwashing" and is always alert to cases of irresponsible cause-marketing. Its blogs warn followers of the health risks of pink products and urge them to contact the companies with their concerns. For instance, BCA members publicized Yoplait's use of rBGH and were a driving force in its elimination from Yoplait products in 2009 (Ojea, 2008). While BCA accepts donations, it does not use pink logos or ribbons and refuses gifts from some donors including the automotive, pharmaceutical, tobacco, and alcohol companies (Breast Cancer Action, 2017). Other professionals have criticized pinkwashing. Gayle Sulik, sociologist and author of "Pink Ribbon Blues," contends: "There are those with good intentions. But in this industry, it's not about intentions; it's about following the money and seeing where it lands" (Lieber, 2018). Companies generally do not disclose the share of funds they commit to cancer causes.

Breast Cancer Patients

Breast cancer patients and survivors are reminded every day of their disease when they take their medication or look in the mirror. They are also reminded every time they see a pink ribbon at the grocery store or the mall. Marie Arsenault, a music promoter and victim of metastatic breast cancer, said "I think everybody is aware of what breast cancer is now, and I think that the money doesn't need to go to awareness, the money needs to go to research, because we still don't have a cure" (DePolo, 2015). Nearly thirty years ago when the breast cancer

awareness movement began, the attention was desperately needed. Today, women with cancer "don't want to be wearing that logo everywhere" (Harvey & Strahilevitz, 2009).

Consumers of Pink Products

Consumers of pink products may be unaware of such matters. The products typically lack warnings and further information is difficult to find. More people are turning to social media platforms to learn about public health matters (Diddi & Lundy, 2017). Companies and charities can reach wide target audiences through posts and ads on Facebook and Twitter. Likely donors typically have sufficient income and trust the charity (Cheung & Chan, 2000). However, researchers have shown that pinkwashing is not effective on women at risk. One study comparing mammogram advertisements showed "gender-salient ads featuring the Susan G. Komen logo and images focusing on women's identity decreased health perceptions, whereas gender-neutral themed ads increased risk perception and preventative behavior intentions" (Devlin & Dillard, 2016).

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