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Jewelry Inspired by Stem Cells

A Capstone Project Submitted in Partial Fulfillment of the
Requirements of the Renée Crown University Honors Program at
Syracuse University

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May 2013

Honors Capstone Project in Jewelry and Metalsmithing

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Date: May 7, 2013

Abstract

The representation of living organisms has a long history in jewelry. Since jewelry is intended to be worn on the body, it has the faculty to materialize what typically remains unseen below our skin. Creating this body of work aims to entice public curiosity and educate them in current stem cell research, as it is a promising avenue of medicine that could cure many diseases, rather than treat their symptoms.

The jewelry I made is a glimpse into the body revealing microscopic stem cells, which are essential to our existence. Current research has shown the potential for immense advancement in medicine using stem cells, the body's natural repair system. Scientists are searching for ways to use stem cells to regenerate damaged and lost tissue and to develop personalized drug testing.

The painted cell pins reference images taken of stem cells induced to become heart muscle cells. I allude to their cultivation in vitro by framing them within a petri dish. The pins are worn directly over the heart, invoking thoughts of future strategies to grow heart cells on a base scaffolding for transplantation.

The blastocyst cross section pins show the glorification of the inner cell mass for either its pluripotent cells or potential to give rise to the entirety of the human embryo. By displaying the embryonic stem cells as pearls, their social value is made more evident. The hanging pearls reference their extraction and cultivation in a lab.

The variety of forms that my jewelry materializes in is an echo of the many potential medical applications of stem cells. Through placement in relation to the body and use of materials that hold cultural significance, I strive to evoke the larger context for the public that is not easily deduced from isolated microscopic photographs.

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Acknowledgements

I would like to thank my advisor Barbara Walter for her encouragement and support throughout the capstone process and for all the knowledge she has bestowed upon me through her teaching. I would also like to thank my reader Lori Hawke for not only reading over my essay but also being a wonderful professor. I would like to thank Dr. Ruth Hart and professors John Russel and Melody Sweet for taking the time to speak with me about stem cells and current research. I would like to thank Sally Prasch for teaching me all about glass, her time generosity. I would like to thank Karen Hall for teaching me about writing and keeping an eye out that I completed my civic engagement hours. Lastly I would like to thank my friends and family for providing me with the moral support I needed to complete this project.

Chapter 1

Introduction

Jewelry, although unassuming initially, can be a platform for both the wearer and maker to spark consideration of certain issues. Jewelry can range from sculptural to craft to fashion jewelry to conservative. Its vast demographic and opportune placement on the body heighten the probability of its contemplation.

In the article *Weeds on the Lapel: Biology and Jewelry*, Maura C Flannery, a professor at St. Johns University, identifies the frequent depiction of plants and animals in jewelry as a manifestation of biophilia. Biophilia, a theory presented by Edward O. Wilson, suggests that humans have an instinctual desire to keep a close proximity to the natural world.

My desire to adorn the figure with the natural world, specifically microscopic imagery of the human body is nothing entirely novel. It alludes to a long tradition of biophilia. Throughout the history of body adornment there are many examples of organisms used as motifs. Approximately 33 thousand years ago teeth were extracted from the deceased and worn along with soapstone and mammoth ivory carved to look like seashells. In the early 1900's the designer Rene Lalique created exquisite jewelry using motifs of natural organisms both repulsive and alluring. Stinging nettle, orchids, wasps, cicadas, snakes, and the

metamorphic female figure are but a few of the flora and fauna with which he adorned the body. *Nervous System*, a contemporary jewelry company, derives its ring and bracelet structures from Radiolaria, an amoeboid protozoa that produces microscopic mineral skeletons.

In my project, I concentrated on the beauty and aesthetics of stem cells but also attempted to bring to the surface their significance in terms of their application in medicine. Jewelry's natural disposition to relate to the body makes it the perfect mode through which to reveal the connection between our internal and external systems.

Inspiration

There were several artists that I referenced for guidance in my own work. It is not necessarily their concepts that I admired but the way in which they employed their materials.

Luke Jerram created a series of glass microbiology sculptures based on the structures of viruses. Although not a glassblower himself, he commissioned an artist to create his designs based on medical illustrations and microscopic photos. The sculptures were designed to hold and contemplate the impact of disease upon humanity. Jerram is particularly concerned with the way that the public has perceived scientific images. Even though, viruses are transparent microscopic images they are artificially colored to aid with their analysis and understanding in science. This particular method distorts and skews the way that the imagery is interpreted. Jerram admits that his sculptures create a paradox because of the

discrepancy between the beauty of the glass objects and the deadly virus that they represent. I appreciate the way that Jerram attempts to bridge the gap between scientific imagery and the public's perception of it.

Klari Reis uses her *Daily Dish* project to explore our relationship with the local San Francisco biotech industry. With vibrant reflective epoxy polymers (a liquid plastic that solidifies when mixed with a catalyst), she creates cellular and natural reaction inspired three-dimensional paintings contained within Petri dishes. Her use of the Petri dish to frame her work is well devised since it immediately suggests to the viewer a context of scientific research. By repurposing a scientific apparatus as her canvas, Reis was able to maintain a conceptual link between her work and the research of the biotech industry.

Lauren Kalman's work is fleeting and not necessarily wearable in the typical sense of jewelry. Kalman does not follow the conventional archetypes of rings, necklaces, earrings or bracelets but instead creates wearable sculptures that she documents through with photography or videos. She draws upon the relationship between jewelry and the presence of a wearer to investigate themes of consumer goods, illness, and the body in contemporary and nineteenth century culture. In her series *Hard Wear* created in 2006, she recorded her tongue covered in gold leaf and salivating. She provides material evidence of the performance by collecting the gold leaf and saliva in a jar displayed with the video. Other devices both conform to and restrict the body. Kalman wears metal denture like pieces that conform to her gums, and inserts metal pieces that fit into the nose and ear cavities. She explores cavities of the body not normally identified with wearable

jewelry. It is not so much the content of her pieces but her refusal to fit into traditional ideas of wearable jewelry that I admire. Without the human body the pieces would remain inactivated and motionless. She exploits the human figure's ability to reference culture to its fullest extent by not arbitrarily defining her work to fit into a pre-established social construct.

Research and Creation

With all of these artists in mind, I decided on a scientific subject for my project. I fell upon the subject of stem cells rather coincidentally. My professor Barbara Walter, put me in contact with Dr. Ruth Hart because I had expressed interest in cellular imagery. Dr Hart is a practicing physician and professor at Upstate Medical University. Part of the attraction was the repetition of pattern and level of detail in microscopic histological images. I decided to concentrate on human anatomy but this is far too broad of a subject to cover in merely one body work so Dr. Hart suggested that I look into stem cells, because there is still much to be learned about them, and it is a popular topic of scientific research.

I began by listening to TED talks on the future of stem cell medicine. The current innovations and possibilities of the field are astounding. Susan Solomon proposed that stem cells should be used initially to test drugs in vitro rather than risking the health of a patient in clinical trials right away. She argued that drugs are not one size fits all. Stem cells are the key to personalized medicine. Each

individual could see the effects of certain drugs on their own cells by reprogramming cells into induced pluripotent stem cells, and then inducing them to differentiate into specific cells. Scientists are able to view directly in real-time how a disease unfolds in a cell rather than waiting for the symptoms to take effect in a human.

Another scientist in this field is Susan Lim who works to reprogram fat derived adult cells back into embryonic-like cells (iPS). Lim hopes that stem cells will be used to repair rather than replace organs because donor organs are in short supply. There are many diseases such as heart disease, liver disease, and blindness that could be cured by stem cell therapies.

Dr. Doris Taylor, also a stem cell researcher has built a beating heart by using the scaffold of a mouse heart upon which mouse stem cell were grown. A culture of heart cells does not make a heart; the cells need structure. In the lab they were able to remove the previous cells from the extracellular matrix protein scaffold with a mild detergent. She hopes to upscale the size to use a pig's heart scaffold, which would be more comparable for use in human heart transplant. In essence this innovation would allow people with heart problems to create a new heart using their very own stem cells, so there would be no need for harsh anti-rejection drugs.

As shown by these scientific breakthroughs, Stem cells are unique because of their ability to give rise to divide indefinitely and specialize (known as differentiation) into specific tissues. We begin our life as embryonic stem cells and continue to maintain them throughout our life within each tissue as

somatic/adult stem cells. The ability to multiply and specialize makes stem cells the repair kit of the body. Adult stem cells maintain and repair organs throughout one's life. When a stem cell differentiates it divides into a copy of itself and a differentiated cell.

Stem cells have varying degrees of differentiation potential known as potency. In order from least to most specialized, stem cells are totipotent (zygote), pluripotent (blastocyst), multipotent (adult stem cell), oligopotent, and unipotent.

If a cell is totipotent it has the ability to give rise to any cell type. A zygote begins to divide and proliferate, the cells have the ability to become not only the fetus but also the placenta and outer membrane. The cells then continue to divide and form a hollow sphere with an inner cell mass called a blastula. The embryonic stem cells of the inner cell mass have the ability to become all three germ layers of the fetus (mesoderm, ectoderm or endoderm). Embryonic stem cells are therefore pluripotent because they can become any tissue of the body. It is during this five to seven day time frame that they are extracted for the culture of stem cell lines. Embryonic stem cells removed from the blastocyst have stirred great ethical controversy because they require the destruction of a potential fetus.

The two cast bronze pins (figure 1) are cross sections of a blastocyst. The inner cell mass is represented by a cluster of pearls. Both pins are worn so that the inner cell mass is hidden inside against the wearer's body. The hanging cluster of pearls at the bottom of the chain alludes to the extraction of embryonic stem cells for culture. I chose pearls in contrast to the bronze outer shell of the blastocyst because pearls are historically coveted as a precious material. Irregularly shaped

pearls during the Age of Discovery were used as the body of organic forms in combination with metal work. A late 16th century pendant uses an elongated Baroque pearl as the body of a salamander filling in the head, limbs and tail with gold and enamelwork. An early 17th century German brooch uses a clump of deformed pearls as the bunch of grapes topped with gold and enameled leaves. Although inadvertent, the combination of natural materials and manmade craftsmanship draws a parallel with modern scientist's attempt to harness our innate natural ability to regenerate lost tissue with new technologies. In traditional Chinese medicine crushed pearls have also been used to treat skin conditions and other ailments. My intent was to reference the importance of embryonic stem cells in scientific research as well as their value associated with their potential to become a child.

Astoundingly every cell in the one's body contains the exact same DNA. The difference between a muscle and nerve cell is merely what genes of the DNA are expressed and which are turned off. Shinya Yamanaka and James Thomson in 2007 discovered that adult skin cells can be reprogrammed with viruses to become induced pluripotent stem cells also known as iPS cells. Induced pluripotent stem cells bypass much of the controversy associated with destruction of an embryo because they are derived from adult cells.

Syracuse biology Professor John Russel, who teaches a class on stem cells in society, expressed concerns over the perception of stem cell research in the public. He perceives that the media has stirred excitement over the promise of stem cells but not clarified that the time frame is not immediate. There are many

technical issues, which must be sorted out before human clinical trials could even begin. Professor Russel is weary to say that induced pluripotent stem cells are exactly the same as embryonic stem cells, because it may be possible that they 'remember' somewhat of their previous cell structures function. There are also issues of how the stem cells will be delivered to the correct tissue and the reaction after implantation.

I was fortunate to speak with another honors student, Anna Kahkoska, who had done summer research culturing umbilical cord stem cells at the Fred Hutchinson Cancer Research Center. Umbilical chord stem cells are promising because they are less specific than the stem cells of bone marrow transplants. Therefore, there no risk of rejection as there is in bone marrow transplants. It is hoped that after treatment of leukemia (cancer of the blood) they may be able to use umbilical chord stem cells to rebuild the immune system.

Along with explaining umbilical cord stem cells, Anna was able to describe the sort of equipment that was used to culture the cells. One of the processes they use to determine the success of a cell culture is the Trypan blue cell count. A sample of the stem cell culture, stained with Trypan Blue dye, is put on a hemocytometer slide that contains a transparent grid and counts the cells of a specific volume under the microscope. A dead cell has a damaged membrane, so it allows the dye to flow through and stains blue. These sample percentages indicate the amount of viable cells cultured. Anna explained that cells have to be extracted every so often to avoid overcrowding of the culture container. Her research included testing a new fibrous material upon which to culture cells that

may simulate a more porous and three-dimensional environment. A nanofiber matrix would increase the viability of a cell culture since a three-dimensional form is more similar than a flat dish to the environment found within the body. The fiber is so closely woven however once cultured it was difficult to extract the cells from the fiber.

The silver locket with a glass cover (figure 2) references the hemacytometer grid. Inside the locket seven embryonic stem cells are visible in bronze, however one of them has a black patina to signify the Trypan blue stain. The black cell is based on an image of a stem cell undergoing apoptosis; programmed cell death. It has been proven that as we age our adult stem cells lose the ability to divide, and stress can shorten the life of stem cells. My pieces strive to convey the effect of environmental factors and passage of time on our adult stem cells proliferation.

My Petri dish paintings (figure 3) are based on fluorescent micrographs of cardiac cells, cardiac cells differentiating, and cardiac cells derived from induced pluripotent stem cells from the skin. Some of the images I referenced were from the annual Reflections of Research competition sponsored by the British Heart foundation. Awards are given to the most striking and beautiful images from scientists working with heart disease. The vibrant colors of the micrographs are not natural; fluorescent genes from jellyfish are incorporated into the genome of the cells so that their parts (nuclei, cytoplasm etc.) can be easily labeled. I chose to continue the use of fluorescent colors in my depictions because I felt it would allow the viewer to recall that these images are perceived through a microscope.

The color is significant of the scientist's work of understanding stem cells and I wanted to relay that to the viewer.

After each layer of clear resin hardened I painted a part of the cell, this gave the effect of three-dimensionality even though I had been referencing a flat photograph. I hope to make these Petri dish paintings into pins to be worn over the heart. Their placement over the heart would be similar to a mock transplant and signify hope for future advancement in stem cells to regenerate and replace organ donations. The Petri dish frame suggests the cultivation of these cells in the lab and provides an external window into the microscopic workings of the body.

The cast bronze pin (figure 4) that sits in a Petri dish is referenced from a scanning electron micrograph image of a pluripotent stem cell derived from a white blood cell. Electron scanning micrographs allow one to imagine how the form looks three-dimensionally. Professor Melody Sweet, who specializes in cell physiology, explained to me that the tentacle like arms are called sudopods. They grow towards a chemical stimulus. This stem cell is likely growing flat because it is growing directly on the culture dish rather than on top of the nutrient layer typically in a culture dish.

The glass necklace (figure 5) is made up of a cluster of stem cells residing in the bone marrow. These cells are destined to become blood cells; they develop through a process known as haemopoiesis. The necklace consists of a whole grouping of stem cells because blood cells are in constant turnover since they have a short lifespan. I chose a finish of both shiny and matte. This was based on my conversation with professor John Russel because he explained that stem cells

are actually not that visually extraordinary in comparison with normal cells. Within the body it is difficult to visually identify adult stem cells amongst other cell types. Scientists are only able to observe them once they have been genetically marked and isolated outside the body. Based on the idea that stem cells are obscured within the body I created the grouping of shiny transparent stem cells dispersed amongst normal cells, which were frosted.

In contrast to most stem cells, which are not easily identified in the body's tissues, there are a few stem cells whose existence has long been apparent to scientists. In the intestinal lining the villi are finger-like protrusions that aid with the absorption of nutrition. The lining of the small intestine is constantly being shed off so new cells are continuously being created. The cells over time move upwards from the bottom of the villi to the top and then are shed off. Because of the direction of movement, it is understood that the stem cells are located at the bottom of the villi in a cavity called the crypts of lieberkuhn. I chose to depict the intestine in borosilicate glass so the viewer could see the villi lining. The pendant (figure 6) rests on the body at a similar height to the intestines as a window to the inside.

Exhibition

I chose to exhibit my work with my classmate, Samantha Laddin, who also studies jewelry and metalsmithing. Our work is complementary in their organic inspirations but also different. Her work tends to be more abstract in

contrast to my own. She has the ability to create subtle conversation between her materials. Her jewelry explores plants and seeds as both a means to provide daily interaction with nature and as a metaphor for purity, young love and innocence. For this show, entitled *Yet* our themes overlapped in certain ways. To quote our collaborated artist statement,

Through making jewelry we explore alternative ways of expressing what is unseen and enigmatic. Our emotions and microscopic organisms that make up our physical presence captivate us to craft the unseen. Both seeds and stem cells are the starting point of new life.

When searching for a venue to exhibit our artwork, both Samantha and I had reservations on using the typical white walled gallery. Since most of the galleries on campus typically have an audience mainly among students, we thought it would be more beneficial to exhibit our work in a more accessible place to the general public so we could increase the range of our audience. We had the idea to display our work among plants because Samantha's themes involved seed imagery, and both of our work has organic and natural structures. I think that the union of our work and the greenhouse environment when better than I expected. Sunlight and plants have the ability to calm and parallels could be drawn between our own health, plants and art.

Conclusion

After exhibiting my work, my perception of articulating inspiration for ones artwork has changed. Speaking to visitors about my jewelry enabled me the opportunity to act as a liaison between the general public and modern scientific research. Although I am definitely not an expert on stem cells, I hope that my work will foster curiosity of current research that will spark interest and contemplation of stem cell research in the public. I hope that more researchers in the field of stem cells can also view my work, so that they might be able to discuss with me other important innovations. My jewelry may also provide researchers with an opportunity to connect with and educate the public in a form that is more easily grasped.

Before doing this project I had been under the impression that art should stand-alone and speak for itself; the ability to visually express what words are unable to capture is essential. I thought that if an artist needs to clarify their intent to the viewer, then the embodiment of their concept is insufficient or poorly executed. This belief does not allow for the ambiguity that follows the creation of a piece. If a work is to gain appreciation, it must stimulate questions and open discourse between the public and artist, not provide definitive answers. My ego may have been under the false impression that my jewelry objects could stand alone; however, in reality they are not all encompassing finite works. Creation occurs within the context of culture, not an isolated bubble. What I produce is reinterpreted and filtered through the viewer's own personal experience. We do not all understand the world in the same way therefore the dialogue and conversation never ceases. As an artist I have never felt the sense of relief that I

am finished; the creation of each work simultaneously answers and creates new questions motivating me to keep making as a means to discover and learn.



Figure 1

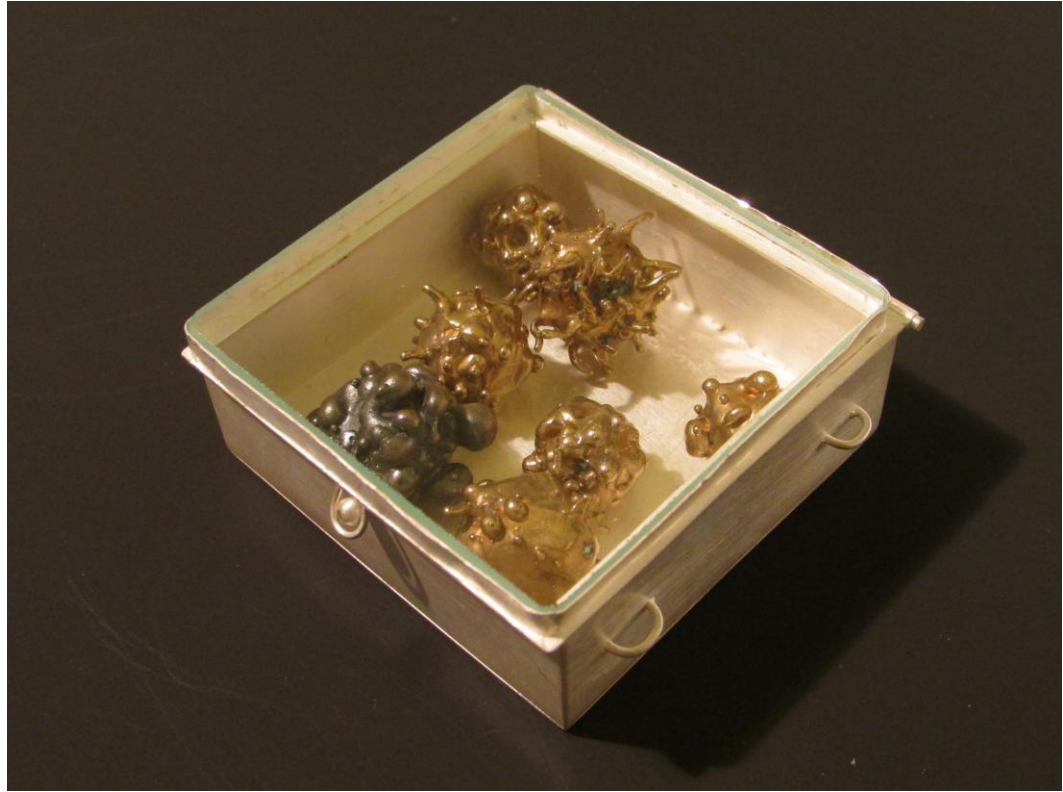


Figure 2



Figure 3







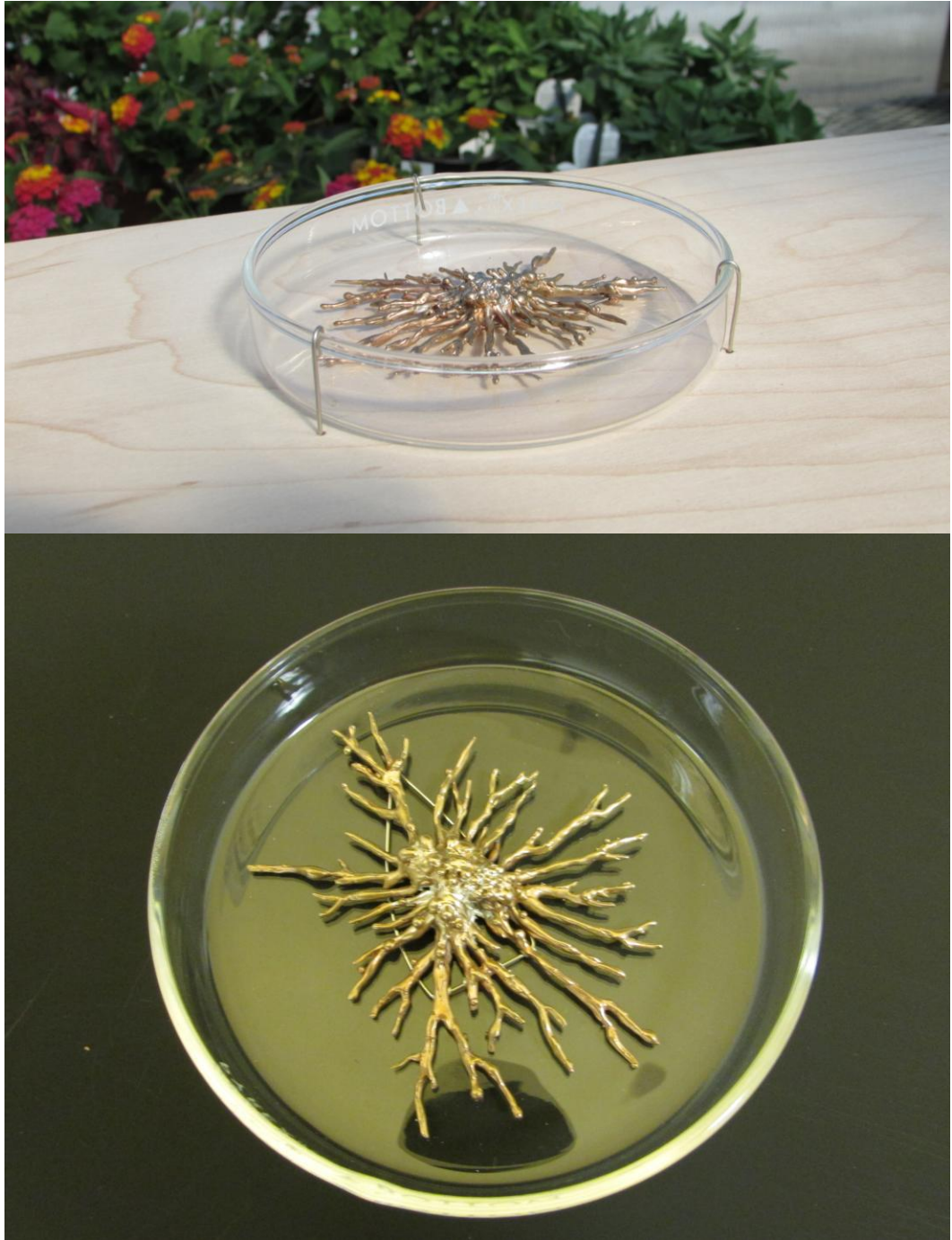


Figure4



Figure

5



Figure 6





Figure 8. (from right to left) Sam and I in front of our artist statement

(7 Chapters have been redacted)

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