Crafting with Livings: An Inquiry of Cellular Anthropology Through Laboratory Gestures

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Contents

Pour Comète

Not only can we not predict into the next instant of the future, but, more profoundly, we cannot predict into the next dimension of the microscopic, the astronomically distant, or the geologically ancient. As a method of perception – and that is all science can claim to be – science, like all other methods of perception, is limited in its ability to collect the outward and visible signs of whatever may be truth. Science probes; it does not prove.
-Gregory Bateson, *Mind and Nature*, 1979.

> In the unusual event that a master takes time out to articulate a craft, the result seldom takes a well-established literary form. If a scholar attempts to connect divergent aspects of a fundamental human activity, the result may not adhere to established standards of academic rigor. When such aspects range from the poetic to the technical, the social, and the theoretical, there may be no level at which all of the writing can work for every reader.
> -Malcolm McCullough, *Abstracting Craft,* 1996.

> > Comprendre ici que l'entreprise de connaissance scientifique, dans les conditions même de ses productions comme de ses circulations, reste indissociable de ce que l'on pourrait nommer (mal et trop approximativement malheureusement), une sensibilité, c'est, d'abord, rappeler la pluralité des registres psychogéniques impliqués dans l'élaboration desdites connaissances (fussent-elles scientifiques ou anthropologiques). C'est, ensuite, replacer la question phénoménologique au cœur d'une entreprise épistémique et méthodologique délicate impliquant une pluralité de vivants (appartenant souvent à des espèces animales et végétales distinctes), ainsi qu'à une pluralité de registres affectifs (reposant sur une hybridité des genres et des espèces). C'est, enfin, inviter l'anthropologie à s'intéresser à ce(ux) qui, par-delà la figure de l'Humain, fonde(nt) l'idée même d'être humain.
> > -David Jaclin, “L’écume des mondes”, 2016.

Remerciements

Growing C2C12 cells. Image taken by my phone camera through the eyepiece of a bright field microscope. SymbioticA, July 28th, 2016.

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Abstract|Résumé

This text is the result of a research project which began in summer 2015. I spent the past two years visiting various laboratories concerned with questions of life: the Pelling Lab, SymbioticA, the Chooi Lab and the HumAnimaLab. My methods have been highly immersive and at the edges of autoethnography. I have navigated gestures and a cellular anthropology to gain a better understanding of the relations at play within the laboratories I have grown with and learned from. Interconnected moving livings is what I stumbled upon in these spaces of scientific, artistic and, most importantly, embodied exploration. By characterizing these specific biotechnological relations and mediations which are in processes of articulation, I explore the notion of crafting. I draw from the literatures of the anthropology of life, anthropology of craft as well as from craft theory to speak of concurrent laboratory livings as engaging in a crafting with livings.

Ce texte est le résultat d'un projet de recherche qui a débuté en été 2015. J'ai passé les deux dernières années à visiter divers laboratoires préoccupés par la question de la vie : le Pelling Lab, SymbioticA, le Chooi Lab et le HumAnimaLab. Mes méthodes sont immersives et aux frontières de l'autoethnographie. J'ai navigué des gestes et une anthropologie cellulaire pour mieux comprendre les relations en jeu dans ces laboratoires. *I have grown with and learned from.* Ce sont sur des vivants mouvants et interconnectés que je suis tombé dans ces espaces scientifiques, artistiques et d'exploration incorporée. En caractérisant les relations biotechnologies et les médiations qui sont en articulation, j'explore la notion de *crafting*. J'élabore, depuis les littératures de l'anthropologie de la vie, de l'anthropologie du craft et de la théorie du craft, le *crafting with livings* pour parler des processus en jeu pour des vivants de laboratoires.

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Introduction

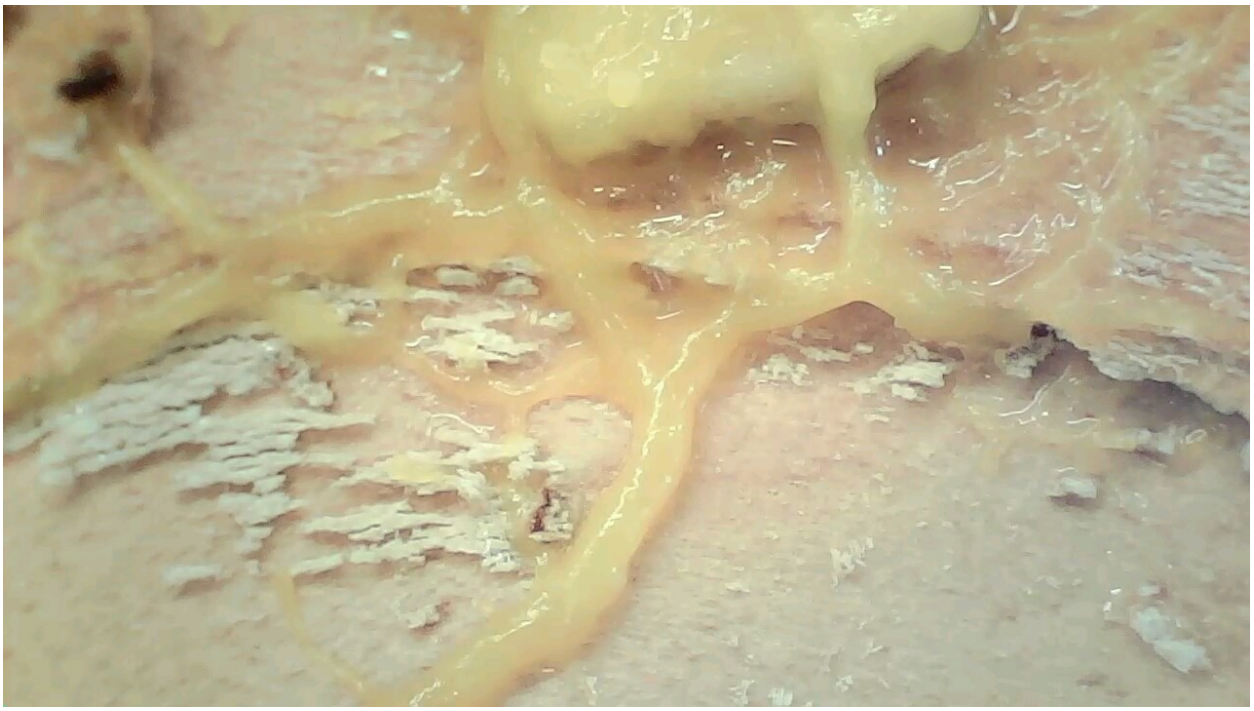

Figure 1: Physarum polycephalum growing with Melaleuca quinquenervia

The first time I saw *Physarum polycephalum*, which means literally many-headed slime mold, was in an art gallery. It was Thursday, June 16th, 2016 and I was in Perth, Australia. In the first week of my residency at SymbioticA, James and I headed to the ArtLAAB, a small gallery of the UWA School of Design. James had the key: as a recent graduate of the Masters in Biological Arts program working teaching assistantship jobs, he was supervising an ongoing exhibition produced by a class of undergrads working at the crossover of art and science. The artworks in the exhibition were varied. Some created closed off systems, living microecologies where slime mold could thrive, others allowed slime mold to grow on glass and used its trails to display shadows on the wall. The piece that grasped most of my attention was simple yet effective: a large and tall log of wood sat on the ground. On the flat top, lay slime mold and different 'foods': oats, rice and cayenne pepper to name a few. A pair of tweezers invited us to 'feed' the slime mold and watch how it would react. An acellular amoeba, slime mold is motile but at different speeds than humans. Over time, you can see if this slimy yellow friend has either avoided the food you gave it or moved towards it: the movements of this large multinucleated mass are oriented through chemically sensed relations in its surrounding environment. This slime mold was growing on a tree! James explained the simple process of cultivating slime mold, a modest and sturdy living who thrives in

warm, moist and dark environments, especially with grains of rice or oats scattered about. “We mostly grow them in our bedside tables at home,” James explained as we walked out of the gallery and headed for lunch.

This vignette about slime mold allows me to bring in the question of cells and living materials. *Physarum polycephalum* is an acellular amoeba. It begins its life as a unicellular amoeba who will mate with another of its kind. These grow into plasmodia: this is a cytoplasmic structure with no cell wall and which contains many nuclei moving around in the living. Slime mold in a plasmodium stage can merge (if two separate samples are added in the same container, for example) but can also be split (for example, a sample can be removed from a healthy culture to start a new subculture) without impact. Working with *Physarum polycephalum* has allowed me to question and challenge the idea of cells as presented to us by cell theory. The slime mold plasmodium also explores its environment by stretching out a network of thin veins and searches for food. We could say that it is a big motile cell that spreads itself out and chemically senses its surroundings. Slime mold can also be found in the wild, which brings into tension from livings growing *in vitro* but also *in vivo*. By navigating human and living gestures, I come to propose a cellular anthropology as a way of educating one’s attention to and learning from the unfolding relations at play *in vitro* (within laboratories) and *in vivo* (beyond). With this, I hope to contribute to our collective understanding the human-cell relationship and to help us think about more than just eukaryotic human cells.

A few weeks after seeing the student art show, I was in the Chooi Lab growing my own slime mold. I ended up talking to Chris, a member of the SymbioticA staff, about growing slime mold around the office or at home and he remembered that one of the residents had worked with fungi before. James had confirmed he could pass along a sample of the protist, but I still wasn’t sure where to grow these. I met Dr. Heng Chooi in his office on June 28th for a short talk which strongly reminded me of my first meeting with Dr. Andrew Pelling in Ottawa, almost one year prior. Heng Chooi runs a fungal research lab: he had no specific expertise in slime mold but was very curious! Having hosted an artist once before, we did a tour of the lab after our little chat and Heng showed me a bench space I could use. I messaged James on my way out. The next day, he arrived at the Symbi office with a box and some slime mold. James explained in detail how he maintained the life of slime mold. The instructions were seemingly as simple as the life sitting in a plastic container. The next day, I took the slime mold to the Chooi Lab and started working on

learning with a new living. All the while, I was perfecting my laboratory skills, continuing to experiment with mammalian cell tissue culture and, unknowingly, preparing to meet fungal bodies.

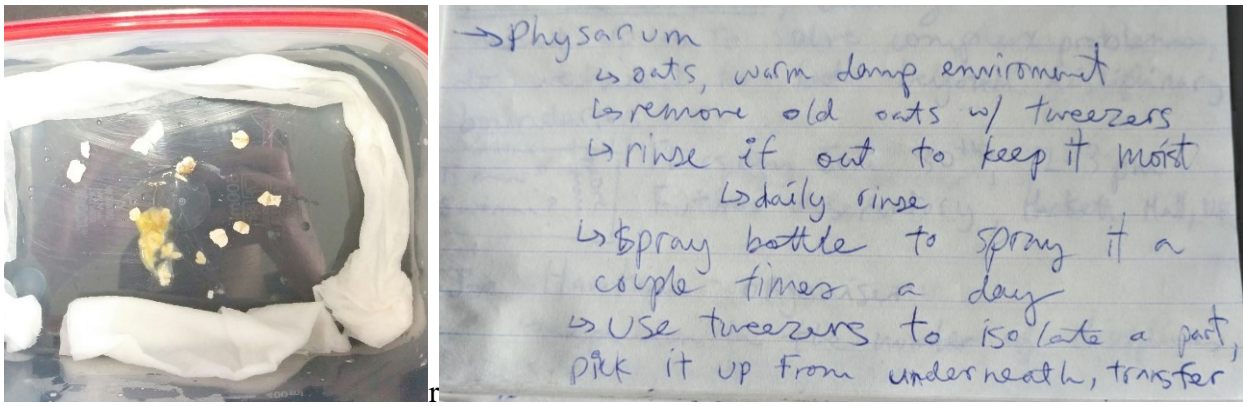

Figure 2: First sample of Physarum polycephalum and protocol for growing

By June 2016, I had spent one year in a biophysics lab in Ottawa where, on a part-time basis, I had learned to grow C2C12 cells and began experimenting with them and following them in the lab. The striking first tension to emerge from this vignette is the question of craft. As such, it was shown that James and a group of students went through a learning phase to maintain the life of slime mold over the course of the semester and even found ways to work with it. James also passed on some of his knowledge to me as he gave me my initial sample of slime mold from the Symbi office. Funnily enough, I managed to kill off this first batch of slime mold and brought James to the Chooi lab to help trouble shoot my protocol. This alludes to many tensions identified by craft theory: sensory and tacit knowledge, 'studio' space, master-apprentice relationships, protocols and recipes, tools and technologies, materials. Craft, described by Paxson (2013) as being at the nexus of art and science, offered me an interesting alternative to bridge experiences and phenomena which unfolded in the various disciplinary and interdisciplinary labs I joined without falling into dualistic accounts of art vs science, Canada vs Australia, human cells vs others, etc. By focusing on craft, I account for the haptic knowledge and the intuition which develops by engaging livings through biolaboratory practice. In the lab just as in wood shops and studios, there is a constant movement between what is practically apprehended and the protocol of practice. Some things just cannot be verbalized and are passed on through bodies, materials or tools and simply need to be known through repetition, experience and time. It is through specific sets of practices and laboratory gestures that a certain crafting takes place. To account for all the beings who take part in laboratory practices and gestures, I propose crafting with livings. This crafting refers to James and his art students learning with slime mold, growing with it and exploring new

possibilities. It also refers to the practice of Tarsh Bates who spends time in a microbiology lab growing mutants of *Candida albicans* for an art show. It speaks of the practice of Daniel Modulevsky at the Pelling Lab, a biology PhD student who brought various fruit, vegetables and flowers into the lab and started growing cells into them to scientifically investigate what was initially just a joke. Again, it is through gestures than we can understand this crafting with. The livings we find in biolaboratories and elsewhere are vigorous physical materials and as such they can join our gestures as they themselves unfold within our shared enmeshments. As such livings can, each in their own ways, (cor)respond. Using the verbal form crafting with living – pluralized as livings – allows me to give primacy to processes and movement which emerge from material engagements. As livings unfold along corresponding lines, some emerging scenarios in biolaboratory settings can be characterized as crafting with livings. That is the thesis I will defend in this text through detailing specific ethnographic and biotechnological entanglements.

Every slime mold knows, every slime mold laughs
Every slime mold grows, every slime mold crafts

Figure 3: Physarum polycephalum growing with Melaleuca quinquenervia

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The fieldwork at the basis of this thesis took place in three wet and one social science labs located in Canada and Australia. These labs are all intimately linked: David Jaclin of HAL pointed me towards the Pelling Lab, these two laboratories naturally led me to SymbioticA through their

shared residents and practices. This research about the human-cell relationship was initiated in summer 2015 when I had the chance to engage with a biophysics laboratory. My methods unfolded as highly immersive participant observation at the edges of autoethnography and multisite research. Embracing living materials, I engaged my fieldwork in a dialogue with the literatures of the anthropology of craft, craft theory and the anthropology of life. In my last chapter, I present a calibration to laboratory gestures and cellular anthropology as a way to gain a better understanding of the relations at play within the laboratories I have grown with and learned from. Interconnected moving livings is what I stumbled upon in these spaces of scientific, artistic and, most importantly, gestural exploration. By characterizing these specific biotechnological relations and mediations as processes in articulation, the unfoldings of my fieldwork present themselves as crafting with livings.

I first set foot in the Pelling Lab for Augmented Biology (at the time, Pelling Lab for Biophysical Manipulation) in July 2015 and worked there until May 2016. The lab was established by Andrew Pelling in 2008 as an experiment to bring creative and curious people together – despite traditional disciplinary boundaries – to see what would happen (Pelling, 2015; Beaudoin & Jaclin, 2016). Experiments generally probed themes of biophysics and cellular mechanics and the lab mostly used immortal mammalian cell lines as their model biological system. The Pelling Lab plays a role in the Canadian scientific world as well as the science literacy scene (Global Young Academy, TED, Phacktory), the biohacking community (Spiderwort, open incubator design) and bioart circles (by creating their own pieces and through an artist-in-residence program). The Pelling Lab is where I first learned the 'craft of mammalian tissue culture', as Andrew and Sophie presented the practice. I mostly worked with C2C12 cells. I also learned many other laboratory techniques which related to my working with biological beings such as completing in-person biosafety and lab safety training, staining and microscopy, use of 3D printers, sterilization. My work centred on trying to grow cells on 3D printed disks of plastic and recycled wood. As a member of the lab, I also got invited to participate in related activities. For example, lab meetings were held once per week. I was also part of the Pelling Lab delegations that attended community events such at the Maker Faire in November 2015 and the 1st Canadian DIYbio Summit hosted by the Public Health Agency of Canada in March 2016. Other students were artists, biologists, physicists, mathematicians, engineers, undergrads or graduates… In the fall 2015, I was also auditing PHY2353, a course on Physics in Biology. In a more informal manner, I was also invited

to attend lab lunches, dinners and barbeques which generally took place for special occasions such as birthdays, welcoming new lab members or wishing farewell to old lab members. I stopped going to the Pelling Lab in May 2016, it was only a few short weeks later that I arrived in Australia and to learn about another space with its own context. With Pelling and Jaclin's recommendations, the plan of my trip to SymbioticA was agreed upon in a prearranged Skype meeting.

Figure 4: Cell culture room

I arrived by plane at SymbioticA in early June 2016 and stayed until early September 2016. The lab was established in 2000 by artists and their scientific allies in a department of the Faculty of Sciences at UWA ("History.", N.d.). When the Tissue Culture and Art Project was formed in 1996 by Oron Catts and Ionat Zurr (later joined by Guy Ben Ari in 1999), the group started working with the School of Anatomy and Human Biology and UWA research centres. In 1999, Oron Catts joined forces with Professor Miranda Grounds and Dr. Stuart Bunt to open a space permanently dedicated for artists to engage with the life sciences and biological systems. SymbioticA hosted their first two residents in 2000 and has since become an official research centre at the university: it runs a residency program for artists, designers, social scientists, philosophers, pretty much anyone who is interested and willing to learn and it hosts graduate studies programs as well as undergraduate courses. They've engaged in numerous collaborations within Australia and beyond, with artists, engineers, scientists… As the first laboratory of its kind – SymbioticA has also

organized conferences and exhibitions. Andrew Pelling himself pursued a residency at SymbioticA in 2014 – which led to his title as honorary research fellow – and Whitefeather Hunter, an artist who was in residence at the Pelling Lab, also visited SymbioticA in 2014. These two laboratories shared, along with the HAL, interests in pushing the boundaries of what we thought possible through curiosity-based research and critical thinking. The Pelling Lab tried to answer funny questions that caught their attention, while SymbioticA director alleged to provoking questions in people's minds, not answering them. The HAL has always been about exposing ourselves and each other to new ways of thinking and being the world.

Figure 5: Office

During my stay at SymbioticA, I had the chance to participate in the Symbi Friday Seminars, artist talks – most notably in the context of the Radical Ecologies, a group exhibition at Perth's Institute of Contemporary Arts (PICA) and the Disrupted Festival of Ideas, a free event held at the State Library of WA in July 2016 –, I also had the chance to lecture one session of Professor Ionat Zurr's VISA2214 Aesthetic Crossovers between art and science, I participated in a reading group with other Symbi students, I participated in a workshop in plant tissue culture, someone helped me build an incubator DIY-style and I visited people's working sites that were off-Symbi grounds. In a more informal manner, I also attended meals and barbeques with Symbi students, staff and residents and we often had lunch either in the Symbi office or at a nearby

restaurant. I also went to Oron and Ionat's house on a couple occasions. One weekend, we all participated in mixing a huge amount of clay with hay and charcoal and proceeded to spread it across a plywood structure built by Mike, a PhD student[1]. Oron introduced me to one of his prized possessions, an exemplary of *The Science of Life* by H. G. Wells, Julian Huxley and G. P. Wells in three volumes dating from 1929-30. He also had an exemplary of *The Uses of Animals in Relation to Industry of Man: Being a Course of Lectures delivered at the South Kensington Museum* by E. Lankester dating from 1876.

At SymbioticA, I had the chance to continue gesturing mammalian tissue culture, as I had learned at the Pelling Lab but with the intricacies of each knot revealing themselves more and more over time through repetitively practicing gestures. I kept working on staining, mounting and microscopy techniques and worked on developing a protocol to grow cells on barks and wood. I had to complete a new set of online trainings in biosafety, lab safety and gene technology. Through reading groups and Friday Seminars, I was able to continue meeting new thoughts and ideas in a way similar to my experiences at the HAL. Through learning to craft with slime mold (*Physarum polycephalum*) and wanting to learn to grow fungal bodies, I ended up spending some time at the Chooi Laboratory for Fungal Chemistry.

The Chooi Lab was yet another point of convergence that revealed itself in the unfolding of my research. Dr. Yit Heng Chooi joined the School of Chemistry and Biology (now School of Molecular Chemistry) of UWA in 2015. I only started working at the Chooi Lab in the last days of June – I specifically brought *Physarum polycephalum* to the lab for the first time on June 30th. The Chooi Lab has focused on investigating secondary metabolites of fungi (the molecules produced by fungi

Figure 6: Door which separates the hallway from the secured biosafety level 2 facility

[1] This was a prototype for what would become the artwork *Vessels of Care and Control: Prototypes of Compostcubator and Hivecubator* (Zurr, Catts & Bianco, 2016)

and the genetic processes by which they are synthesized) and trying to understand their roles and possible application in medicine and agriculture. They engaged in techniques of culture of various fungal strains as well as genetic modifications and sequencing of these strains. The lab meets weekly, but I only attended the lab meeting once. This was to plan the upcoming UWA Open Day where the Chooi Lab had a table; I ended up helping by representing the lab and discussing my work. After the Open Day, we all went out to a nearby pub for snacks and drinks. Unlike with the Pelling Lab and SymbioticA, this was the most I participated in activities of the Chooi Lab. I did not go to the lab every day and mostly centred my efforts on learning how to care for *Physarum polycephalum*, learning how to grow fungi *in vitro* with samples taken *in vivo* from a park and learning to isolate fungal DNA to send for sequencing and identification.

The HumAnimaLab (HAL), which I joined when I arrived in anthropology, is formed mostly of undergraduate and masters' anthropology students, anthropology professors as well as students and professors from other disciplines (sociology, criminology, feminist studies to name a few). The HAL is also a host to visitors from Canada but also from abroad (to name a few Natasha Meyers, York University; Noémie-Merleau Ponty, University of Cambridge; Jérôme Michalon, CNRS). The HAL was established by anthropology professor David Jaclin at the University of Ottawa in 2014-2015. I joined the group in summer 2015; it was not until September that we started holding biweekly meetings. The following year, we started holding meetings every week. At first, we mostly discussed readings or held presentations on members' research. In the second year I participated in HAL activities, screening of ethnographic films and documentaries entered the rotation of activities. This year, the lab has also started organizing fieldwork excursions to a nearby park, Gatineau Park. In doing so, HAL is developing crafty practices with livings *in vivo* instead of *in vitro* like the biolaboratories. It may seem bizarre to study cells anthropologically, but HAL is a strange creature in its own respect. Companions vary week by week and – not being grounded in specific spatiotemporal boundaries – the lab in a constant mutative state of becoming. Though I did not attend every session held by HAL, this lab has greatly contributed to my thinking and approaches which have been developed for this thesis. Participating in the HAL and has also led to encounters which have played significant roles in my research trajectory. In an effort to extend our notion of fieldwork, I also which to account for the role of my own anthropological training.

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In the first chapter of this thesis, I present the context of biolaboratories. By retracing the crafty practices of biohacking and bioart, I arrive at my research question: **how do humans and cells correspond?** I then expose my proposition of crafting with livings through three empirical examples.

The second chapter of this thesis will address the question of methodology. To tackle methodology, I describe my research trajectory and my harnessing of the classic approach of participant observation. Additionally, I pose some methodological questions relevant to anthropology which emerged from my fieldwork: autoethnography, multisite ethnography and multispecies ethnography. Finally, I address the question of politeness.

The third chapter of this thesis presents a bridging of the literature concerning life and craft. In this chapter, some fieldwork experiences enter in a dialogue with craft theory and the anthropology of craft as well as the anthropology of life. Relevant tensions in the literature are identified and it is shown how my fieldwork can help shed some light on some of these tensions.

The fourth and final chapter of this thesis presents a calibration of my research. By calibrating scales of relationality, this analytical chapter serves to the present the realm of gestures and cells. Broadly, gestures allow us to focus this mode of attention on the biotechnological mediated complex of livings in a way that account for the synesthetic experience of engaging (mammalian, plant, fungal, amoebic) cells seriously. Cellular anthropology is presented as a specific mode of attention which can be helpful when working with cells.

1 Crafting with Livings

This first chapter outlines the context of biolaboratories within which this research unfolded. It also presents the research questions and the proposition of crafting with livings through three concrete, empirical examples.

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1.1 Biolaboratories

In recent years, there has been a massive reduction in costs associated with conducting research within the life sciences. For example, the cost of DNA sequencing has dropped from $100,000 to ten cents (Wall, 2015). This reduction in cost in recent years has led to the rise of do-it-yourself biology and biohacking within and beyond academia and industries. Citizen science and open source movements are recognized as a way for scientists to collaborate with the public and give them access to research and biotechnological tools which have been kept locked behind lab and library doors as well as scientific journal pay walls. As a response, DIYbio – which aims for public access to biotechnologies – has emerged as a global movement which articulates itself in small groups (Park, 2013:120). Bio-art has also emerged, since the 1980s, as a new field where biological/biotechnological systems and/or processes serve as a medium for artistic practice (Abergel, 2011; Byerley, 2015; Damm, 2013; Kac, 2006; Lapworth, 2015, Uhl, 2011). It can be argued that the rise in usage of biotechnologies is an artefact of the much-debated Anthropo(s)cene[2]. One thing remains clear: humans have been interacting with earthly livelihoods in seemingly new ways, shaping ecologies all over the planet at scales and speeds not yet experienced by anthropological sensoriums (Carpenter & McLuhan, 1960; McLuhan, 1994 [1964]; Ong, 1991)[3]. Laboratory ecologies of isolation and control are part of this a romantic

[2]There has been a working group on the Anthropocene since 2009 as part of the Subcommission on Quaternary Stratigraphy (http://quaternary.stratigraphy.org/workinggroups/anthropocene/). They have since been working on clarifying the term coined in 2000 by Paul Crutzen and Eugene Stoermer in No. 41 of the IGBP Newsletter. The Anthropocene generally "denote(s) the present time interval, in which many geologically significant conditions and processes are profoundly altered by human activities." For alternatives to the idea of the Anthropocene, see LeCain (2015), Haraway (2015a), Haraway (2016). The idea of the Anthrpo(s)cene was discussed many times within activities of the HAL where we have shed a critical anthropological outlook on the question.

[3] Sensorium is a concept that refers to "the entire sensory apparatus as an operational complex" (Ong, 1991:28). In other words, it is the sum of perceptions of a living being, usually organisms. This concept took an important role in theories of communication in the 20th century as new media and mass media were in emergence. McLuhan studied new media and paid attention to the ways in which they modulate human sensorium. As such, sensorium is a useful conceptual tool to study how different conditions allow for different modes of attention depending on the ways in which senses are developed. We are constantly under the influence of our perceptions which are fluid and multiple, and sociocultural contexts "organize [the] sensorium by attending to some types of perception more than others."

narrative, at once utopian and dystopian, of 'human domination over nature'. As a set of practices and gestures which establish relationships with various (forms of) life (forms), techniques involved in work with biological entities – whether they be organisms, systems, fragments – rely on biotechnological (re)mediations. These are rapidly shifting under constant ecological and anthropological pressures. The proliferation of access to biology and the multiplicity of livings involved – within industry, academic and community or home labs – brings urgency to the idea of problematizing these relationships.

The DIYbio movement entails the use of hacking practices which stems, at least in part, from the culture of computer hacking. An analogy, of cybernetic influence, is often made between organisms and machines: "If computers can be programmed, and living things are not so different from computers, […] life too can be programmed." (Wohlsen, 2011:5) Biohacking and DIYbio refer to the creativity and self-reliance of individuals carrying out biotechnological and crafty laboratory practices outside of institutions. On the one hand, open-source publishing and the internet provide great sources of information; platforms such a Google Scholar and Wikipedia facilitate access to relevant knowledge. For example, there is an open wiki for the Pelling Lab[4]. What is often lacking is the equipment. Notably, there are more and more DIYbio kits which you can order online, in a way reminiscent of DIY computers such as the Raspberry Pi and Arduino micro-controller. It is becoming easier to access bacteria culture kits, biomaterials and DNA modification sets. Once the tools and knowledge are there, "the solution is the hack" (Wohlsen, 2011:5). Just like computer hackers have often built revolutionary innovations out of garbage (Wohlsen, 2011:6), biohackers are also repurposing. Andrew Pelling's design for an open-source CO2 incubator that supports mammalian cell culture is a prime example: Andrew used trash and electronic scraps gathered here and there at SymbioticA while he was completing a residency. This kind of approach entails a massive attempt at deinstitutionalization of biotechnological practices to bring them into new contexts. I call this an attempt because it remains that most DIYbio communities and biohackers are privileged. There needs to be access to- and knowledge of- biotechnologies and various livings to trigger potentials which can be actualized, over time, in

(Ong, 1991:28) Biolaboratories, seen as emerging sociocultural contexts, lead to the calibration of a specific kind of sensorium and attention of the livings who spend long periods of time there.

[4] (Last accessed January 7th, 2018) Pelling Lab Wiki https://openwetware.org/wiki/Pelling ; Protocols https://openwetware.org/wiki/Pelling:Protocols ; Lab supplies https://openwetware.org/wiki/Pelling:Lab_Supplies ; Lab safety https://openwetware.org/wiki/Pelling:Lab_Safety

these rogue spaces; additionally, access to expensive laboratory equipment and reagents remains a luxury which is inaccessible to most humans of our connected meshwork. On another note, Andrew Pelling has shared that his physical biohacker stance is rooted in curiosity-driven research; most often concrete applications arise from emergent scientific discoveries and not from trying to solve applied problems (Beaudoin & Jaclin, 2016). Meanwhile, we must acknowledge some liberation of knowledge and tools for and by biohackers and DIYbio enthusiasts. This allows more people to immerse themselves in the plural practices of biotechnology and brings a growing heterogeneity of practices and laboratory gestures. Within and beyond the academic world, more and more humans are engaging with bio(techno)logical practices and I hope to contribute to the works of my predecessors, researchers in the social sciences and sciences and technology studies who have also engaged in (bio)laboratory practices in hopes of better understanding them.

The logic of DIYbio and biohacking was most strongly present at the Pelling Lab. Andrew Pelling started a biotech company, Spiderwort Inc.[5]. This company – the combined efforts of post-doc Charles Currier, biology PhD student Daniel Modulevsky and Andrew Pelling – aims to develop and provide low-cost kits for key scientific equipment specifically related to biology and tissue engineering. In this mandate is the idea that providing tools enables one to do science in universities but also in other spaces such as garages, makerspaces, biohacking labs, artist studios, schools. From my discussions with the founders, the low cost is also an attempt to provide colleagues with different economies and funding structures with access to equipment that may be too expensive to purchase otherwise. This company is a manifestation of the aim of biohacking and DIYbio movement to facilitate access to biotechnologies. Throughout my time in the Pelling Lab, I have seen the development of the incubator kit in preparation for sales, the testing of various potential biomaterials and talks about inspiring computer hacking communities. Where biohacking often refers to genetic modifications (a DNA sequence is viewed as an analogue to computer code), Pelling speaks of physical biohacking: it is the physical parts of organisms that are hacked, and not the genome. Such an approach allows one to work outside of the omnipresent genetic paradigm of our day and age. It also encourages students in the lab to 'hack' their own biological systems and scientific tools. As became evident throughout my time in laboratories, scientists have been building their own lab equipment for centuries before biotech companies started standardizing the

[5] Visit Spiderwortbio.com for more information.

equipment and charging high fees for parts that are near costless. As such, I've seen the device that Sophie, a physics PhD student, built herself by combining methods of microfabrication, making and software development. The chamber that Sophie created became a new specialized milieu for the human foreskin fibroblast cells to inhabit while she could test their responses to various drugs. The lab enabled her to design the tools to experiment with her cells and gave her room to ask questions, instead of basing her data collection in available equipment and technologies. Matthew, a biology PhD student, built himself a cell stretcher to investigate the effects of stretching tissue on cell shape, health and metabolism. Beyond the graduate students, this approach has served WhiteFeather Hunter, artist-in-residence of the Pelling Lab. She used Andrew's CO2 incubator design to build her own portable incubator that has toured galleries and exposed her living art and craftworks to the public.

These logics of building your own equipment were also present at SymbioticA, it is no surprise since the two labs have developed close ties over the years. When I was at SymbioticA, I worked closely with James to build an incubator using Andrew's design. SymbioticA itself has been established to support access to biological systems beyond strictly scientific endeavours. Their residency program offers artists and other humanities or social sciences scholars, with or without biology background, access to their lab and to their tissue culture expertise. At the Chooi Lab, I was not the only one benefiting from an arrangement to get bench space: Dr. Chooi allowed other graduates or curious humans to get lab access in order to continue developing ideas or get preliminary results. As this demonstrates, these three sites are not in opposition but in continuity as part of the wider global community promoting access to biological systems and biotechnologies. This maker element is a line which has unfolded throughout all the laboratories I have visited. Work in the realm of DIYbio and biohacking is closely linked to bioart, as more and more "have brought Petri dishes out of the lab and into the museum." (Wohlsen, 2011:201).

Simply put, bioart is using life and its processes as an artistic medium. Some speak of bioart, bio-art, biological art or biotechnological art. Bioart can be conceptualized as opening the doors to a new imaginary to move beyond classic dualisms of mind and body, nature and culture (Uhl, 2011). It can be seen as a transgression of the body (human or not) by technology which leads to a blurring of many lines that have been so strictly established by the sciences. In this

conceptualization of bioart, many notions are put in tension such as bodies, incorporation, species, animality, humanity, ethics.

Ultimately, bioart also brings us back to the question of life. In the words of Eduardo Kac, “il s’agit […] d’un principe général de création littéralement basé sur la vie ” (2006:313). The fusional character of bioart breaches disciplinary boundaries: this kind of investigation situates itself in at the boundary of arts and sciences (Uhl, 2011; Abergel, 2011; Kac, 2006; Catts & Zurr, 2006). It is by playing with the autonomy of living things (Landecker, 2007) that bioartists can attempt to expose different aspects of our relationships with these life forms. Bioarting practices do unfold as a common practice in the scientific Pelling Lab through an artist-in-residency program. At SymbioticA, I was surrounded by numerous artists, bio or not, who developed relationships with laboratory livings. Humans, bees, mammalian cell lines, yeast, fungi, amoebas, plastics, electronics, glass, metals, hair, liquids, solids, gases, fluids, visible, invisible. Though motivations behind – and methods of – bioartistic production vary, the unanimity of bioartists rests in the creative use of biotechnologies and “new ways of exploring the living and the partially living.” (Byerley, 2015:213)

The transgenic organism, hybrids, fragments which emerge from bioart and biohacks can pose an ontological problem. It is easy to wonder is these are ‘normal’ beings (dare we say natural), or ‘fantastical’ beings (dare we say cultural) (Abergel, 2011)? In contrast, I prefer to avoid dualisms when I raise questions. Rather, it is possible to problematize bioarting as a process of becoming with others form of life, akin to “making-in-growing, or growing-inmaking” (Ingold & Hallam, 2014:5). In line with my chosen framework, I understand the gestures which unfolded in bioart spaces as crafting with livings through movement and relationality. Gestures are seen here as events of the meshwork which unfold materially between ‘humans’ and ‘*in vitro* cell’ which correspond in biolaboratories. Crafting is but one possible set of biolaboratory gestures.

This has directed my inquiry: rather than fixing it in categories and ontologies, rather than identifying (forms of) life (forms), could we understand *bios* as a verb (Ingold, 2013b)? To be precise, I am interested not in what is laboratory life but rather what does laboratory life do. To address this active, processual and relational character of co-constitutive biological and extra-biological systems of matter, I started conceptualizing laboratory livings. For Lapworth (2015), the relationship which establishes itself between art piece, artists and spectators is not one of

domination but of affect which could have the possibility of generating ontological (re)conceptualization. This change would emerge from the artistic encounter which leads to new ways of thinking and feeling: it is the establishment of a dialogue with other life forms, of a becoming together (Deleuze & Guattari, 1980; Lapworth, 2015). Lapworth (2015) argues that bioart could lead to a new relational ontogenesis (*becoming together* rather than *being alone*), a way of engaging the world which relies on rhizomatic processes, not hierarchical arborescence (Deleuze & Guattari, 1980; Ingold, 2017).

Tim Ingold refers to he idea of ontogenesis as "the fluxes and flows of materials entailed in making and growing" (Ingold & Palsson, 2013: 7). In opposition to Latourian approaches, Ingold speaks "not a network of connections but a meshwork of interwoven lines of growth and movement." (Ingold, 2010: 3) Things are not fixed forms of matter but unfold in relational and processual ways (Ingold, 2007a). In this sense, Ingold argues that relationality can take two forms: staying within the maze of intention, agency, humans and nonhumans OR entering the labyrinth of attention, animacy, growth and becoming (Ingold, 2013c: 248). He identifies the later as more fitting to understand the world emerging as "living, breathing beings." (2013c: 249). This can lead us to ontoepistemology in a move beyond the boundary between being and knowing: if things are always in the process of becoming and we grow with them, then our knowledge also grows along with them. Therefore, being and knowing is movement. "To know things you have to grow into them, and let them grow in you, so that they become a part of who you are." (Ingold, 2013a: 1) Here, knowing is not reduced to exact knowledge of things that can be predicted. Rather, it involves the act of comprehension – *de prendre avec soi* – which trans(forms) potential relational emergences.

As such, I am adopting for this project a framework of material and relational ontogenesis. As Jaclin states, we may want to move away from a "naturalist, essentialist and rational" ontology towards one that is "relational, processual and affective" (Jaclin, 2016b: 8, my translation). I am according primacy to the movement and material relations at play in the world; I am attending to the way in which they are unfolding and emerging. This has ontoepistemological implications: knowledge is generated by being in the world and paying attention to its becomings. In this sense, the anthropological experience is itself transformative and this results in knowledge-generating experiments (Ingold, 2014). Knowledge, in this case, is generated by adopting specific modes of

attention, some of which I have outlined as the different scales of relationality which will be outlined in the final chapter of this thesis.

At the centre of the ontogenesis, emerges the question of material practice. As previously reported, not all researchers (let alone humans) engage livings in the same way, nor do they all engage livings of the same specie, form nor liveliness. At the Pelling Lab, most researchers engaged in the practice of mammalian cell culture – but this is not a homogenous group of livings! Different cell lines warrant specialized care; the differences are especially pronounced when one compares differentiated mammalian cells and undifferentiated stem cells. I experienced plural modes of becoming with livings by multiplying the types of liveliness encountered[6]. In turn, this extended the reach of my fieldwork. As such, I was lucky enough to have a prolonged immersion in the practice of cell culture between the Pelling Lab and SymbioticA, but I also found, at the Chooi Lab, slime mold and various fungi as well as numerous biotechnological mediations that I had yet to experience. It is on these ever-changing haptic contacts, hosted within laboratory walls and upheld biotechnologically, that I have focused my analytical efforts for this thesis. Since my fieldwork is artificially bounded to the laboratories I visited, it is important to finally unpack this idea of laboratories.

Livings, especially *anthropos*, are curious beings who love to explore and experiment. As David A. Edwards states (2010), laboratories are prime examples of spaces of experimentation. These spaces generally contribute to knowledge production – both today and historically – yet there are significant variations regarding their forms, subjects of explorations, methods and roles in the broader sociocultural context. Some laboratories end up being the object of interest: anthropologists, sociologists and other scholars have turned their attention to the idea of the laboratory and scientific spaces in the last few decades. Others are spaces which allow controlled manipulations of materials, such as in chemistry, physics or biology.[7] Some laboratories work on the manipulation of datasets, concepts or ideas. Other labs can hold the simple role of title which contributes to the legitimization of one's work. This heterogeneity in the roles of the laboratory relates to the initial idea of the laboratory which has evolved through time and space. Not only do

[6] "Un des enjeux de ma recherche consista donc à démultiplier au maximum les postures en espérant couvrir le plus largement possible les champs de rapports humains/animaux." Jaclin, 2013: 181

[7] It is interesting to note that "spaces which allow controlled manipulation of materials" could also describe artist studios and workshops.

these physical spaces vary, but the modes of attention we cultivate by spending time there lend themselves to the making of different world lenses. In this sense, laboratories lead to the development of various specialized sensorium, specific ways of being in the world which manifest themselves, in part, through gestures.

"That laboratories are now fundamental to the practice of science is commonplace" (James, 1989: 1). James has insisted on the multiplicity of laboratories: teaching, applied or experimental research, development of norms for new technologies and products, laboratories can take chemical, physical, biological and interdisciplinary approaches. Many disciplines have since tried to apprehend the laboratory in their own way. Some take up the question through education, like Perkins-Gough (2006). For Perkins-Gough, lab work is essential for students to develop a practice informed by the scientific process of experimenting and trying to explain observed phenomena. This practical experience where empirical world is tied to theory is essential in some professions, such as engineering (Feisel & Rosa, 2005). Despite the control of variables through which labs are usually perceived, labs can take on a role beyond data gathering: labs become a place to learn to experiment. This is in line with Tim Ingold's (2014) idea that research is an education of attention. Studying, working, experimenting in a lab space allows one to attune their attention to ideas and materials that they encounter. Labs are a place of learning, of development and of research (Gooday, 2008).

Often referring to a specific building or room, laboratory does not always refer to a specific room: contemporary research groups within the social sciences and humanities are often formed as intellectual 'laboratories'. It is thoughts, ideas and concepts, – not materials – that are isolated, explored and transformed. This is the case of the HumAnimaLab which is not bounded by walls but unfolds around the relations at play between those who participate, texts we read, images we look at, videos we watch, sounds we listen to and finally our respective and common fieldsites and topics of investigation. The rapport to livings has been the most distinct from other fieldsites at the HAL, where most often it was ideas, words or images that were exchanged or experimented.

Coming back to the maker community, could someone build their own laboratory from scratch? Some (Baden et al., 2015) argue that yes, and provide lists of open access design for lab equipment that can be 3D printed. Through the Pelling Lab, I was able to attend the 1st Canadian Do It Yourself Bio Summit, organized by the Public Health Agency of Canada. With more and

more groups establishing themselves in Canada[8] and globally[9], there is a clear effort towards easing access to biotechnologies, lab spaces and living systems. The notion of community is immanent to this approach and revolves around the idea that anyone can participate in the scientific world (Wohlsen, 2011). Without having to rely on institutions for funding – whether university or industries – DIYbio enthusiasts have the liberty to choose the direction of their own research. This emphasizes the role of curiosity in research present at the Pelling Lab, SymbioticA, the Chooi Lab as well as the HAL. Some of the researchers, DIYbio enthusiasts and biohackers I met often end up doing 'laboratory' work in their kitchen or garage, outside of institutions and accredited lab spaces.[10] James grew slime mold in his nightstand at home, WhiteFeather Hunter built an enclosed mammalian tissue culture incubator to expose livings work in galleries, Mike Bianco built his wooden bee bed with carpentry spaces, tools and skills, Andrew Pelling and his team gave us protocols to decellularize apples in our kitchens and built a microscope in their lab that was controlled through Tweets! (Bio)laboratory crafts often require (extra)cellular apparatus, especially if it is to survive, leak beyond (bio)laboratory boundaries and engage, across scales, *in vivo*.

As such, it is difficult to precisely say what is a laboratory, since laboratories can be many things. One thing remains clear: the way we think about labs, and their associated practices, is always changing. Since the 1990s, many anthropologists and sociologists of science have looked at the question of the laboratory without reaching consensus (Franklin, 1995). Latour and Woolgar's Laboratory Life (1986 [1979]) studied the social construction of scientific facts and came to understand labs as cultural spaces. This, according to Van Damme (2008), is what started the trend of 'laboratory ethnographies'. Labs, then, were a place where social scientists can have their subjects (natural scientists instead of cells) with their own myths (scientific papers) and tribal hierarchy (professor, post doc, principal investigator, student). This work kicked off a series of research concerned by the construction of scientific facts (Roepstorff, 2002; Nersesian, 2006). This was critiqued by scientists themselves, as exemplified by the Sokal controversy (Sokal, 1996a;

[8] DIYbio Toronto, Biotown, brico.bio, the Open Science Network to name a few.
[9] Visit www.diybio.org for a geographical list.
[10] Interestingly, this comes into tension with the history of laboratories. Initially hidden away in researchers' basements, then institutionalized by academia and industries (James, 1989), laboratories – with their equipment and practices – are now finding themselves back in peoples' homes. Even Gregory Bateson and his wife had, for over a year, octopus in their living room (Bateson, 1987 [1972]: xii). The once clearly defined boundaries between lab, kitchen and garage are put into question (Gooday, 2008; Kelley, 2016).

1996b). Ian Hacking provided a useful critique of Latour's constructivism (Hacking, 1999; Kirksey, 2015): he opposes hyper-constructivism by affirming that reality exists even if it is mouldable by humans. As such, it would be possible to consider laboratories as more than just social constructs. Moving beyond the strict realm of sociocultural construction has allowed new theories to emerge. Over time, the questions that social scientists and humanities researchers can ask about, from or within laboratories have shifted. For example, epistemological questions brought cognition in the discussion about laboratories (Firmino da Costa et al., 2000). Ultimately, many social scholars have used the tools of anthropology and sociology to see not only the cultures of science, but science as culture (Franklin, 1995). Feminist anthropologists have explored the scientific and ethical questions emerging from new reproductive biotechnologies (Franklin, 1995). Latour went on to devise the Actor-Network Theory with Callon and Law which enabled researchers to give back some agency to nonhuman actors; this theory was particularly useful to researchers doing lab ethnographies. Haraway contributed largely to this literature, starting with her deconstruction of boundaries between humans and nonhumans, livings and machines stemming from her now classic Cyborg Manifesto (2013 [1985]).

1.2 Correspondence

What lab ethnographies have shown us is that it's not the notion of laboratory that is most important – because that changes anyway! –, but rather what happens within these complex spaces, assemblages of practices, gestures, materials and ideas where multiple (forms of) life (forms) become entangled. It is also interesting to consider how different labs are tied to broader socioculturaleconopolitical contexts. Theorists like Latour, Haraway and the emergence of Science and Technology Studies have been important "in pushing ethnographic dimensions of this field beyond pioneering lab studies to more complex (and multi-sited) social and cultural time-spaces." (Marcus, 1995:104) Like those who have laid the ground before me, my question is not to find out what a lab is. Within my research, the laboratory has allowed me to easily refer to the places, the literal fieldsites, where I've met and explored with various livings. Pragmatically, the concept of the lab has helped me to identify the artificial and porous boundaries of my fieldwork. Restraining myself to biological laboratories who share a lineage allowed me to focus my research in spaces that embody a certain continuity in approaches. Unfolding in these spaces is always *en débordement*. It is on some of these situated yet leaky gestures and practices that I have focused my attention to answer a classically anthropological question: how do we, humans, come to

establish relationships with other livings? In other words, the question guiding this inquiry has been: **how do human and *in vitro* cells correspond?**

As Sophia Roosth argues, those engaging biotechnologies are making and as such "they destabilize life as an object of investigation." (2013:168) This is what leads me to propose crafting with livings, which can help anthropology account for livings who are constantly leaking from their own cellular membrane, in the world with us researchers, unfolding along corresponding lines. By understanding crafting as a series of material and gestural events, I can extend the notion of crafting beyond human control. Roosth's inquiry leads her to state that "[b]iology is always something that is made, but more important, it is always something in the making." (2012:32) By developing a cellular angle to anthropology, the scales of relationality which are put in tension can serve as conceptual probes to guide one's attention on the field. The aim is an account where cells are becoming-human and where humans are becoming-cell. The analysis of my fieldwork to address the correspondence of humans and *in vitro* cells, essentially the question of the human-cell relationship, will pass through the lens of crafting which allows not only to broaden our notion of living materials but also to account for the numerous (bio)technological (re)mediations at play.

Crafting, as a way of being amongst others in the worlds, can install itself in the fluid, plastic and inherently multiple milieu that is a living (bio)laboratory. The aesthetic and scientific logics I saw at play respectively coming from the arts and from biology are one way of considering the co-evolving relations at play in a bio lab. Crafting offers us an alternative, a synesthetic one, where what we pay attention to is not particularly the aesthetics that go into creating a final art piece or the empirical logics of a scientific paper. Rather, this attention educates itself, it is an education attentive to the haptic epistemologies at play when we establish and maintain a relationship with other livings which is grounded in reciprocal exchange and concurrent unfolding of materials.

The idea of crafting with livings, which is the sum of my thesis, is quite simple: it refers to the gestures which are carried out in correspondence by various human and nonhuman livings in biolaboratories. I harness the verbal form of crafting over craft to emphasize my focus on processes. In a similar fashion, I did not study life in the lab, rather I unfolded along with other livings. The plural form allows me to account for a wide variety of (forms of) life (forms) in movement in the lab from human bodies to fragments of living tissue to amoebic slimy veins. As

such, the craft of mammalian tissue culture refers to the cycle of passaging cells and growing experiments. The craft of growing fungi refers to the seeding of fungal cells on your favourite nutrient agar and incubating them in the dark at room temperatures for a few days, as well as to manipulations of the resulting bodies. The craft of growing *Physarum polycephalum* refers to the rinsing out of plastic containers, replacing the humid paper towels which maintained the humidity favoured by this yellow amoeba, leaving oats for them to eat and placing them in a dark cupboard. Mike engaged in beekeeping. Tarsh grew *Candida albicans,* a yeast which required similar crafting gestures as fungi. Others I met grew neurons, stem cells and other tissues, fragments, livings. Once the most basic gestures of crafting with livings – maintaining life – can be accomplished with a certain level of stability (though instability remains as a main aspect of both crafting and livings due to their improvisatory natures), different potentials arise and lead to sharing playful improvisation, performances and experimentations. As such, one can then pursue the creation of a protocol to collect data to test a specific hypothesis within a scientific context, one can also develop living artworks by harnessing crafting with livings. As I have done, it is also possible to simply pursue different trials and investigations in the lab for exploratory research purposes.

This rest of this first chapter presents analysis of different lines of crafting with livings which unfolded during my fieldwork. In doing so, I harness wood as an axis of analysis and unpack specific laboratory gestures which can be characterized as crafting with livings. Cellular anthropology serves as a useful tool in this section to display my perspective as educated through my fieldwork where I learned to pay attention to the ways in which I could connect with various cells through my gestures if I was polite and calibrated myself to their scale, in order to give them a place in my research. In doing so, I wish to avoid anthropomorphizing descriptions and account for the ways in which material, physical, gestural and sensorial unfoldings in the meshwork of biolaboratories can be considered as a crafting with livings. I will now present three examples of crafting with livings: transparent wood, *physarum polycephalum* overrunning wooden houses and unidentified fungal bodies.

Transparent Wood

From samples that were collected in King's Park, I proceeded to unpack a protocol to render wood transparent. This experiment came about when fellow SymbioticA resident Nathan Thompson, artist and musician, heard I was working with wood and sent me an article about how

to make wood transparent (Zhu et al., 2016). The protocol was pretty simple and was inspired by procedures involved in the process of pulping wood to make paper. First, Nathan and I had to gather some of the necessary chemicals by making runs to the Cell Central histology lab and the chemistry store since not everything was available at the Symbi lab. We experimented with different ways of keeping the samples warm in order to get a more effective bleaching of the wood, as was mentioned in the protocol. In the meantime, Nathan had a friend whom he was chatting up on Facebook who was trying out the same process. As such, we were able to send each other some feedback about which aspects of the protocol could be adjusted for optimal results. There were two steps to this protocol. First, the wood had to be soaked in a warm or boiling solution containing sodium hydroxide and sodium sulfite. From carrying out this experiment a few times, I guessed that this step used this corrosive solution to loosen up the lignin. The second step, transferring the samples to a solution of hydrogen peroxide, caused a foamy bubbling to erupt from the solution. This lasted hours and I guessed that the hydrogen peroxide served to remove the lignin from the wood, bringing to it transparency or at least a loss of colour. Though some of these harsh chemicals required the use of gloves, we were able to carry out these laboratory gestures in the Symbi main lab without much protective equipment. This space was much different than other biolaboratories I had visited and reminded me of a messy artist's studio or an archeologists' lab full of odd artefacts. The contrast of sterility and controlled organization between this space and shared tissue culture rooms was significant and attested to the various kinds of practices which can unfold in different biolaboratories. This protocol aligned itself with the of the approach of the Pelling Lab to decellularize plants and use new materials in preparation for mammalian tissue culture. Ultimately, I took some of the pieces of wood and veneer treated with this protocol to make wood transparent and I used them to grow C2C12 cells. I did obtain nice results under the microscope! I also applied this process to gumnuts and branches which I found along the bike path on my way to and from the university. I did autoclave gumnuts halves and placed C2C12 cells inside the hollow half. However, I had no means to image this concave shape and the results of this trial remain unknown and invisible to this day.

Figure 7: First step of the transparent wood protocol

Figure 8: Wood and gumnut slices soaked in hydrogen peroxide solution for the second step of the transparent wood protocol and left to dry

Physarum polycephalum overruns wooden houses

When I crafted with the living *Physarum polycephalum*, I grew them simply on bare plastic containers that I had received from James. On the plastic, they grew quite slowly. When I started spending time at Chooi Lab, I researched the internet to see what kind of nutrient agar slime mold

preferred: turns out this little yellow guy is quite sturdy and requires non-nutrient agar at 2%. Since I was bringing in my samples of wood from King's Park to grow fungi, I decided to try laying pieces of wood inside of some Petri dishes of non-nutrient agar along with some slime mold and, of course, some oats for the slime mold to thrive and feed along. I placed each item in the Petri dishes by blue-gloved hand, gently placing the wood on the agar, laying out oats randomly or in precise patterns. What I noticed over time is that slime mold seemed to explore the Petri dish with increasing levels of creativity when there were pieces of wood, rather than just oats. When I placed fragments of slime mold on non-nutrient agar with oats, most of the veins concentrated and simply moved on from one oat to the next as time passed on, in a testament to the effectiveness of their chemotaxis sensitivities. When I added pieces of wood, the slime mold's veins branched out thinly, mapping multiple directions, making and quite literally crafting its way through the Petri dish I had myself crafted for this living. I decided to build wood houses for *Physarum polycephalum* to see what how the slime mold would unfold… Many of these moments cannot be described by words, images here play the role of accounting for moments of crafting with livings in the lab.

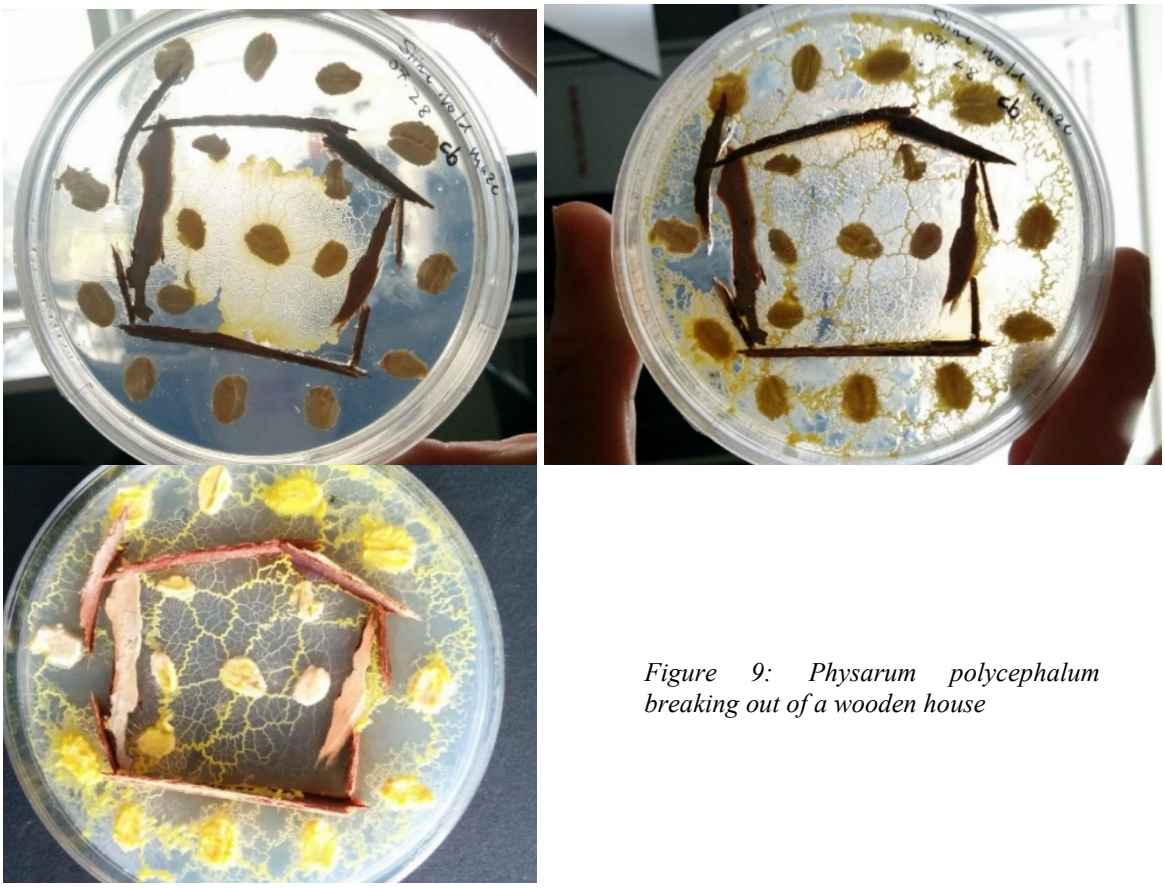

Figure 9: Physarum polycephalum breaking out of a wooden house

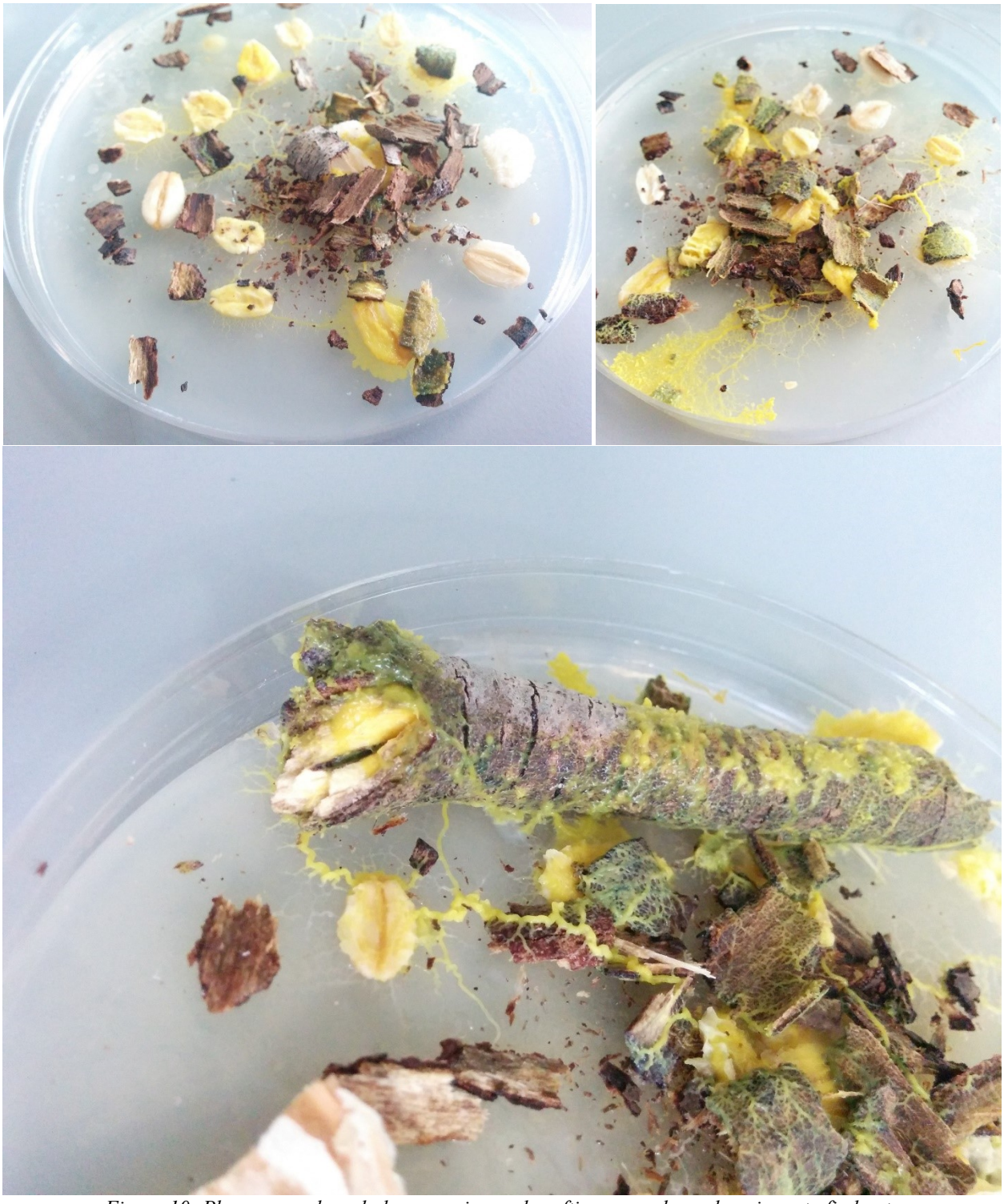

Figure 10: Physarum polycephalum growing and crafting around wooden pieces to find oats

Unidentified fungal bodies

I had plenty of small wood samples collected from King's Park public bike path. I used some of these to experiment with transparent wood, to grow mammalian tissues and to explore

durations of slime mold. I also brought these samples into the Chooi Lab: what I really wanted to try was to grow fungi from the samples all by themcellves. When I found out that Heng Chooi had plenty of experience growing various species of fungi out of wooden and soil samples, I began a process to track the gradual growth and crafting of fungi which emerge from wood samples in Petri dishes with different recipes of agar. These were all incubated in a drawer that was below the bench space I used at the Chooi Lab. Growing fungi was quite simple, it simply required placing a sample inside a Petri dish prepared with nutrient agar, sealing the dish with parafilm to prevent contamination from the unknown fungi and placing it in the dark. For my first trial, I seeded different pieces of wood on July 5th, 2016. I tested out surface sterilization with ethanol against a simple water wash of the samples and I also wanted to compare two kinds of woods: *Melaleuca quinquenervia* or paperbark and some unknown bark, both which I also used with C2C12s and slime mold. I began tracking the visual changes by taking pictures but also by taking notes in my lab book. On July 6th, there were no visual changes. On July 7th and July 8th, I tracked changes through written description hand but began drawing on the 8th. The emergence of drawing my visual observation came as I realized the camera could not capture all the nuances of the crafting unfolding *in vitro*. In this drawing, a new kind of growing along lines joined into the unfolding of livings.

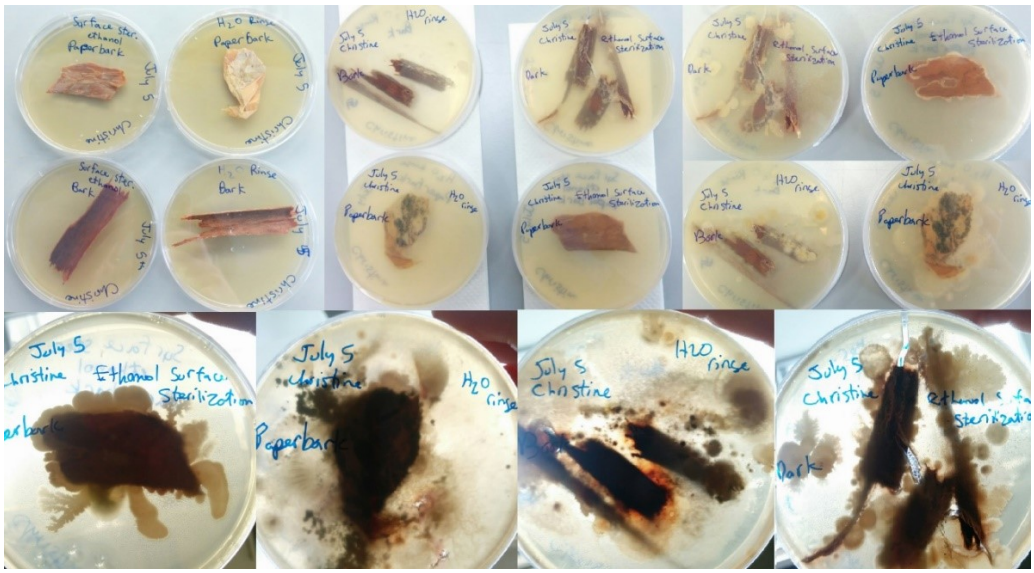

Figure 11: Crafting of fungal growth from wood samples

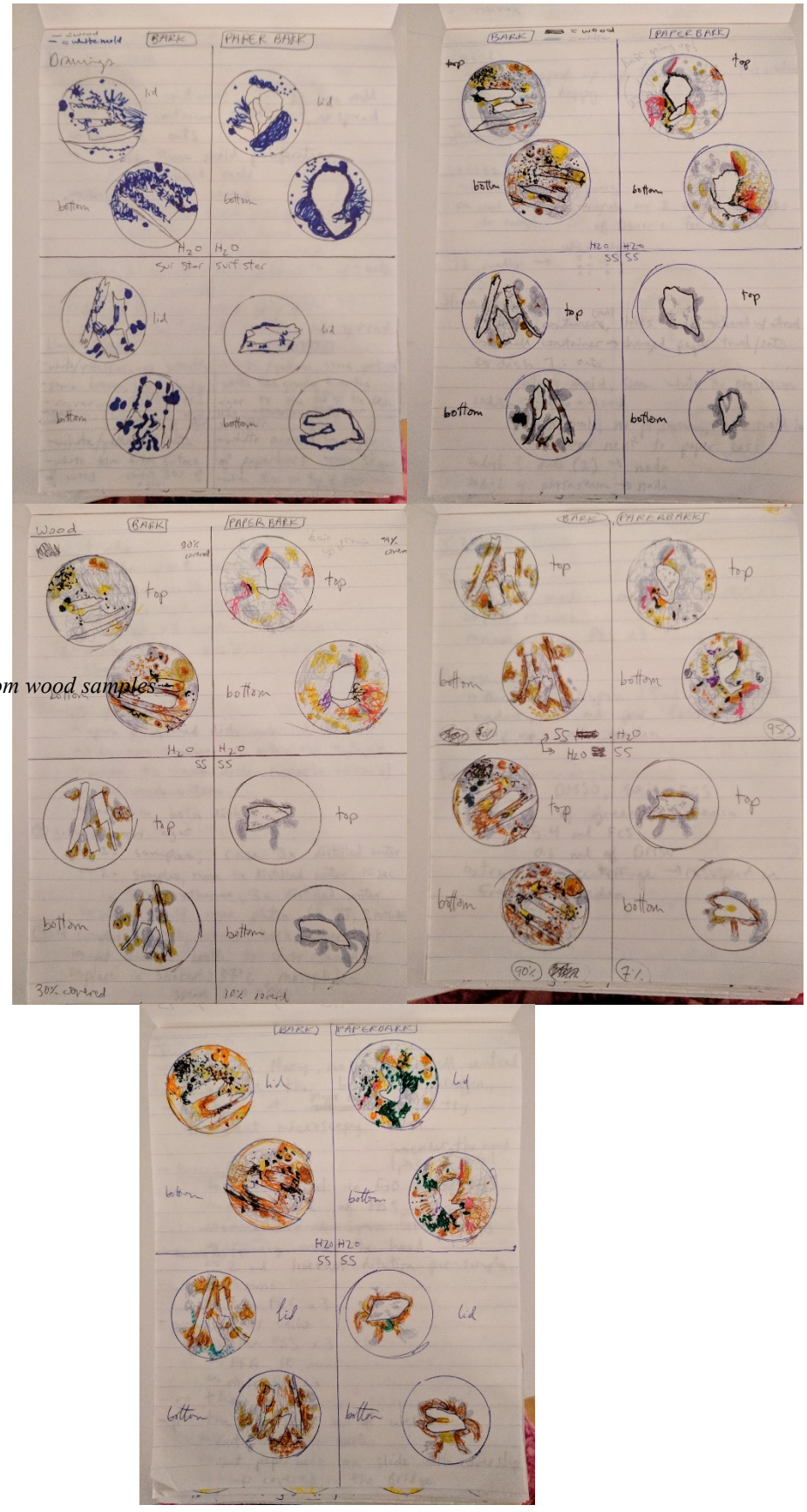

Figure 12: Drawings of fungal growth from wood samples

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This first chapter served to problematize the idea of biolaboratories and present my research question. It also served to present the first empirical examples which support my proposition of crafting with livings. The following chapter will serve to clarify methodological and ethical concerns.

2 Gesturing in the Field

This second chapter addresses the question of methodology. I will first present the research trajectory which emerged from unfolding laboratory gestures. Methodological questions aim to problematize points of anthropological tension I encountered on the field: participant observation, autoethnography, multisite ethnography and multispecies ethnography. Finally, I propose some ethical considerations articulated around polite inquiry.

***

2.1 Research trajectory

I followed two main trajectories while doing fieldwork. Using experience and experimentation as a knowledge-generating experience, I wanted to immerse myself in new contexts. Hand in hand with some of my colleagues, I ended up pursuing speculative questions about livings which led to open ended explorations and the idea of crafting with livings.

As such, my first trajectory emerged around wood, which became for me an axis of interaction between various forms of livings. What enabled me to follow the paths that lead from the Pelling Lab to SymbioticA to the Chooi Lab was specifically the wood I had followed. A few months after my arrival at the Pelling Lab, I was getting more confident in my practice of the craft of tissue culture and Dan approached me. He said if I was interested, there was a "cellulose 3D printer filament" that the lab had received but no one had the chance to play with it yet. Himself working with cellulose scaffolds for mammalian tissue culture (Modulevsky et al., 2014; & Pelling, 2015; & Cuerrier & Pelling, 2015, 2016), he offered to help me design some experiments. I quickly got a crash course in 3D printing from undergrad physics student Max and started printing out circles and squares to insert in Petri dishes. Surprise, this filament was not actually made of pure cellulose but rather composed at 40% of recycled wood and 60% of binding polymers like PLA or other common plastic filaments used for 3D printers. The filament was beige in colour and, as the manufacturer website advertised, and online forums reported, printing at different temperatures altered the colour of the end product. The prints even smelled like wood. We were all suspicious that cells would be able to proliferate on this surface, but I wasn't in it for the scientific discovery rather to learn about the practices of this lab. If that was the kind of project they indulged in, I was there to follow. Part of the challenge was determining a protocol to assess

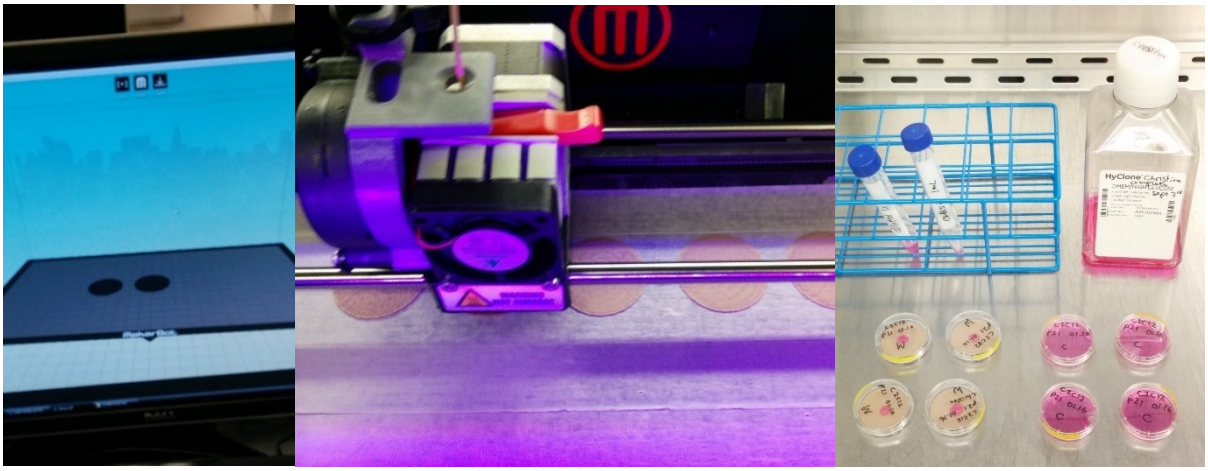

Figure 13: 3D printing wood for tissue culture and seeding C2C12 cells on wood disks

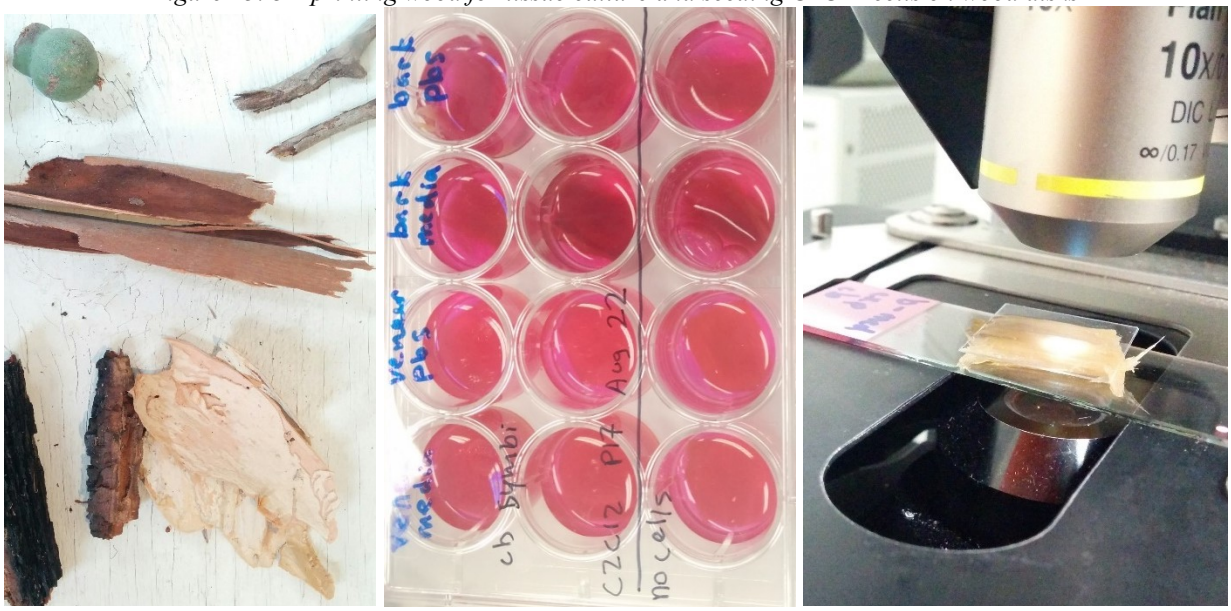

Figure 14: Collection of wood samples from King's Park; seeding C2C12 cells; wood on a microscope slide

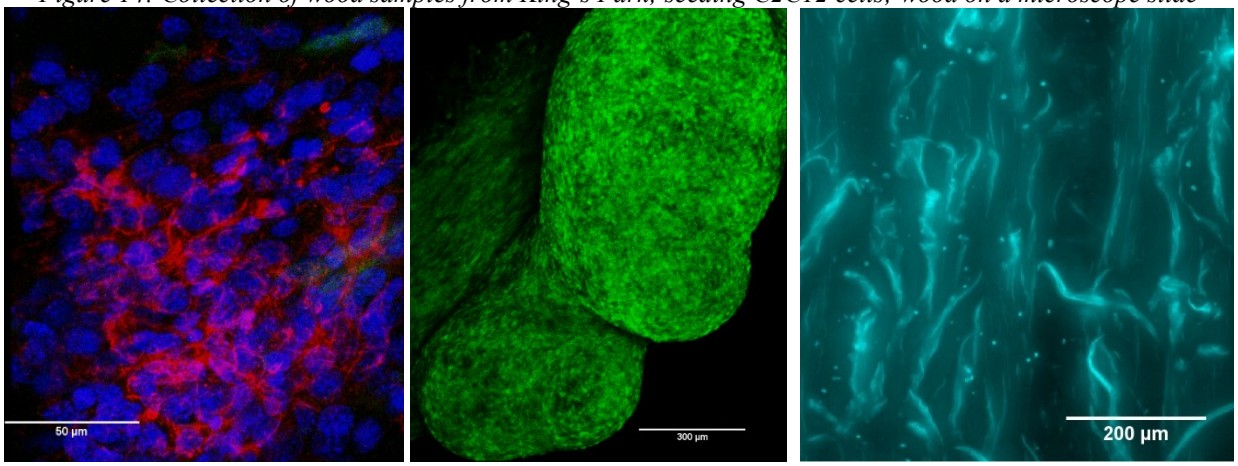

Figure 15: C2C12 cells stained with DAPI & Alexa Fluor 546 (actin filaments); 3T3 cells genetically modified to express GFP seeded on 3D printed wooden disks; C2C12 stained with Hoechst seeded on Melaleuca quinquenervia

the state of cells on the inserts (wood being opaque, light could no longer get through the clear Petri dish and we had to resort to staining of the cells and fluorescent microscopy to get results). I remember the first time I saw blue spots scattered on the computer screen in the microscope room. “Those are cell nuclei stained with Hoechst” said Dan, who was training me on the microscope. My heart dropped: could cells really be sustained on wooden structures? This experience at the Pelling Lab informed the inquiry I led in the lab at SymbioticA: keeping with a similar protocol, I set out to collect samples of branches, pieces of woods, barks from nearby King’s Park which I crossed everyday as part of my bike path to get to the Symbi lab. Collecting these samples, I was confronted with the reality of finding a way of bringing ‘contaminants’ in the ‘contaminant-free’ zones that are mammalian tissue culture labs. Harsh sterilization techniques, both by liquid ethanol and autoclave, made me realize I must be killing many livings in the process. While I was blasting pieces of barks with heat and pressure to sterilize everything in the APHB building where Symbi’s lab stands, I followed the thread of these livings lost through sterilization and ended up in a fungal biology and biochemistry lab, the Chooi Lab. There, I learn naturalistic techniques to grow various species out of soil samples and to isolate species, then to process them for the synthetic biology practices of playing with their DNA.

Working with this lab also allowed me to bring *Physarum polycephalum* into play which I did quite happily as I, again, used wood to guide our concurrent movements. Slime mold is usually grown in agar when kept in laboratories, but it thrives in warm damp environments in the wild where it can be found creeping and crawling on moist trunks and wet pieces of wood. Building wooden structures for the slime mold to crawl onto showed me another aspect of this little amoeba which seems to have different responses to their surroundings: my mazes of wood seemingly provoked a more complex path of movement from the slime mold than the agar. Slime mold uses chemotaxis to orient its movement in the search for food – it can easily sense chemical signals through agar but less so in plastic containers (which I used to cultivate the slime mold at a slower rate) and wood. In sum, not only did the notion of connected laboratory spaces impact the development of my fieldwork, so did wood which served to guide my research within and beyond the labs.

The second trajectory which I followed during fieldwork, beyond my own laboratory experiments and speculations, concerned the works of fellow human-scaled livings. I spent time

developing my own project, but I also attended lab meetings, paying attention to different individuals' lab practices but also to the research that contextualized these practices, attending SymbioticA Friday Seminars to learn about the various inputs that can serve speculative and artistic research, working through some of Timothy Morton's work (2007) in a reading group, participating in community events both in Ottawa and Australia, etc. Most of these moments, as you can guess, took place outside of the labs themselves, in hallways or meetings rooms, libraries or event halls. As such, the artificially bounded spaces of laboratories showed themselves to be constantly overflowing and I had to learn to choose my spills and follow where they leaked. My research also led me to visit the work settings of researchers, technicians, artists, scientists who did not always operate in the same physical spaces as I did. For example, I had to use the Maker Space at the University of Ottawa when the Pelling Lab 3D printer broke down, I visited Tarsh's lab within the Faculty of Medicine and followed the artworks of Mike Bianco all the way to the PICA gallery in downtown Perth, miles away from the UWA Campus.

In sum, both emerging research trajectories highlight the autoethnographic, multisited and multispecies aspects of my fieldwork all the while showing the pluridisciplinary nature of the settings in which I immersed myself, joining livings in meshworks. They also helped orient the daily grind of fieldwork with laboratory projects and out-of-the-lab activities. By keeping busy in the lab, I opened myself up to new experiences and spent much of my time on the field learning by articulating my own project and engaging productively in the transformative experience of fieldwork.

2.2 Methodological questions

I have harnessed participant observation as my method during a year-long period of fieldwork. I completely immersed myself in lab practices. As such, I set out to contribute a sensitive and creative viewpoint about living with cultured, *in vitro* cells – and other laboratory livings – in specific spaces. What brought these spaces together was genealogical ties as well as an openness about the use of biotechnology and the interest for curiosity-driven inquiries in biolaboratories. This investigation implied learning bioartistic and biohacking crafts to discover a specific way of being in the lab with livings. The main sites of my fieldwork and the activities that I carried out are detailed in the introduction. Most of my research time was spent in or between laboratories, engaging livings directly through various protocols, techniques and experimentations.

As an anthropologist, my greatest tool ended up being my notes! Scattered across a lab book and notebook, a paper journal and a couple Android/Microsoft applications, I collected words, thoughts, ideas, numbers, static and moving images, voices. Some of these renderings tiptoe between qualitative ethnographic accounts, muscle memory of a learned craft, necessary calculations and an attempt at collecting biophysically quantifiable data. In addition to my notes, I brought back a few artefacts from my laboratory fieldworks. Some fusional conversations were recorded near the end of my research stay at SymbioticA to facilitate the use of exact quotation. For analysis, I follow the qualitative, anthropological tradition of evocative ethnographic accounts. The anthropological narrative in itself is a craft that requires practice before being mastered. Experiences from my fieldwork journals and the few recorded conversations which I pursed have not been analyzed in a formal manner: no statistical work, no thematic analysis with nVivo, no discourse analysis, no testing of hypothesis. Rather, the approach has been inductive and autoethnographic in that the concepts put forward in this thesis emerge from my fieldwork experiences. As such, this thesis is a very small contribution to our understanding of some specific sociocultural phenomena through its unfolding movements. The audio recording of conversations has been partially transcribed to facilitate the navigation of the material. By basing my methods in hands-on experimentation and exploration, this thesis stands as an attempt to render some of the particularities which emerged from my fieldwork.

Figure 16: Day 2, Quick oats VS rolled honey oats in a Petri dish for a slime mold challenge

Tim Ingold has said it and multiple times: anthropology is not ethnography (2013a; 2013b; 2011). Viewing ethnography as a descriptive inquiry distinct from anthropology is for Ingold a way to explore the sensitive possibilities of participant observation. He distinguishes theorist and craftsman as “the one [that] makes through thinking and the other [that] thinks through making” (2013b:6). By

considering anthropology and thinking about the human condition as an art of inquiry, Ingold critiques anthropologists who turn encountered alterity into a static object (2013b:8); in coherence with this thinking, I am not doing an anthropology of the human-cell relationship nor an anthropology of bioart and biohacking. Instead, I have used bioarting and biohacking practices to learn from and with the cells, artists and scientists I have encountered: this is how I have thought through the human-cell relationship. As stated by Jaclin (2016a:17) "Thinking such individuation complexes and emergent relationalities conjointly opens space for creative modes of attentiveness to every researcher concerned with processes by which an entity actually becomes (and transforms)." By entering in a relation of correspondence with the world (Ingold 2013a; 2013b; 2011), I enable myself to be attentive to becomings – the flux, the movements – and to our concurrent unfolding paths. Participant observation is, after all, a practice of correspondence (Ingold, 2015: 157).

In this sense, Ingold (2011) and Biehl (2013) view anthropology as an inquiry into the curious, uncertain, open and precarious relations that lay between forces. An approach of this kind enables me to bring life back into the equation. Life can be seen as a process of growing together (Ingold & Hallam, 2014), but the sciences have long preferred to conceptualize natural life as something to isolate, to control, to domesticate. As a result, scientists "make ["it"] do what it will not of itself" through scrutiny, pressure, formality (Ingold & Hallam, 2014: 6). This positivist conception is being increasingly challenged as contemporary practices of biotechnologies are spreading to the arts and to biomedicine; uses of biotechnologies are morphing and moving beyond scientific traditions. The traditional boundaries between human and nonhuman life forms (as well as disciplines) are literally being redefined through these practices. As Eduardo Kac claims, bioartists are creating new entities and relationships (Kac, 2006). By engaging bioartistic and biohacking practices to investigate meshworks, I have directly participated in this breaking down of boundaries, finding myself in fluid processes where I was not simply making an artefact but rather growing alongside scientists, artists and mammalian cells, fungal bodies, protist veins...

The intimate aspect of my research begs me to address the influence of autoethnographical methods in my research. Autoethnography is an approach which attempts, via description and reflexive analysis, to account for one's own experience in the hopes of obtaining a deeper knowledge of the problems raised on the field. A combination of ethnographic and autobiographic

methods, authoethnography is at once process and product (Ellis, 2011). Conceptualizations of autoethnography as a research method vary greatly amongst author (see Denzin, 2006). Anderson (2006) argues that analytical ethnography takes place when a member of a research group uses reflexive analysis, has a strong presence in the narrative, engages in a dialogue beyond the self and focuses on bettering theoretical understandings. Anderson also critiques an autoethnography which would be solely evocative, while underlining that "caring and theorizing are not mutually exclusive" (2006.:461). Evocative or interpretative autoethnography stems from the Creative Analytical Practices movement (CAP) which attempts to account for the leaky boundaries between fact and fiction, between objective and subjective, between subject and author (Richardson, 2004). Denzin (2006, 2014) views autoethnography as a performance assembled by the author who holds the power of shedding light on new realities. Ellis supports an evocative ethnography and insists on the role of emotions and introspection to link individual experience to broader sociocultural logics (2011). In contrast with other anthropological methods, the angle of autoethnography brings a larger focus on the relevance and distinctiveness of the first-hand experience of the author in order to better understand certain phenomena.

In my research, autoethnography plays a role that is tied to my harnessing of immersive participant observation as a method. By going on the field and engaging into laboratory gestures and practices myself, my text will – at times – be autoethnographic. I will be relating my own experience in laboratories through evocative accounts. As a research method, autoethnography is still widely critique. Perceived as either too much or too little of both the arts or the sciences, autoethnography seems doomed to be either too analytical or too aesthetic (Ellis, 2011). While many ethical problems may arise using this research method, consent, external consultations and a recognition of the vulnerability of the researcher can help mitigate these issues (Tolich, 2010). While attempting to break down boundaries, autoethnography can be seen as an attack on the dualism of science and art and as an attempt to craft a research methodology that is rigorous, theoretical, analytical, evocative, therapeutic and inclusive (Ellis, 2011). As Denzin claims (2006:423): "In writing from the heart, we learn how to love, to forgive, to heal, and to move forward." In sum, I see evocative and analytical ethnography as two ways of being which instead of being opposed, can fold into each other: by incorporating not only conceptual and theoretical baggage but also personal experiences and reflections, I seek to provide a sensible and original

account by focusing to a large degree on my own experience of the multidimensional interplays I uncovered during fieldwork.

Central in my research project, and therefore methodology, was the exploration of multiple field sites. Not only did I navigate two cities in two countries halfway around the world from each other, I also had to learn to navigate the different labs within university campuses and the various offices and spaces of each lab which were sometimes scattered across campus. In this sense, my research could be defined as 'multisite ethnography'. Conceptions of multisite ethnography have not yet been clarified since gaining traction when the term got coined by Marcus in 1995. As he notes, "this requires a more literal discussion of methodological issues, such as how to construct the multi-sited space through which the ethnographer traverses. Such explicitly methodological discussions are rare." (1995:105) As it emerged, multisite work often found itself at the intersection of disciplines and specifically in works relating to the study of science and technologies (Marcus, 1995). Marcus situates multisite ethnography within the Malinowskian complex of anthropological fieldwork research (1995), yet multisite projects also embody a shift in the social sciences and humanities[11]. Philosophies and concepts of postmodernism and beyond, and specifically new materialisms encourage multisite work by following research objects, subjects, agents or things throughout networks (Latour), rhizomes (Deleuze & Guattari), biopolitics (Foucault), dark ecologies (Morton) or meshworks (Ingold). Despite the increasing popularity of these theories, their implications towards methodology have yet to be discussed at lengths. As such, many aspects of multisite ethnography must be put in tension. Some argue that ethnography as traditionally understood was multisited and did involve following movement: simply this movement occurred on foot within a mostly bounded geographical space rather than at the scale of cities or even countries which are now explored. The comparison paradigm also comes into play within multisite research: are we going to compare these different sites or are we following communities/objects/subjects? To what extent does each fieldwork contribute something unique to the research and if not, then why must we have multiple fields? Is multisite ethnography meticulously strategized or is it simply an assemblage of opportunities? Are time and

[11] This shift in methodology in the social sciences can be tied to our historical epoch. As such, theories have not deductively focused on multisite phenomena, rather the new possibilities opened to anthropologists led to the need to conceptually rethink our methodologies. New modes of transportation and the practices surrounding them led to a change in the sociocultural phenomena of travelling. Multisite ethnography emerged inductively, from the empirical reality of the anthropologist who can travel halfway across the world reasonably easily, quickly and affordably.

space interchangeable within the ethnographic research paradigm? How does multisite work change the ways in which we convey knowledge to the reader? In which way does collaborative work change the dynamics of multisite research? Can "understanding the shallow [...]itself be a form of depth"? (Falzon, 2009:9) Despite these tensions, multisite methodology has been prolific and helped us gain new visions within the anthropology of life and science and technology studies (Rabinow, 1989; Merleau-Ponty, 2017; Jaclin, 2013; Tsing, 2015). In my own research, the exploration of multiple sites unfolded naturally. As I had heard of SymbioticA at the Pelling Lab, it felt natural to attempt to follow the unfolding paths weaving the relationships of a leaky community of bioenthusiasts. In turn, SymbioticA led me from one UWA building to another to pursue some of these same paths. Upon returning to Canada, I found some unexpected connections actualized by these new relations in which I embedded myself. My work with the HAL has been a nest to come back between these excursions, housed within the department of anthropology I had a safe space where I could meet and exchange with my colleagues and mentors, present ideas or simply keep my research grounded in anthropological and beyond-anthropological reflections. Recently, we have stepped out into the wild to explore livings *in vivo* by hosting workshops in a park.

The last aspect of my methodology which must be problematized relates to multispecies ethnography. By placing humans at the centre of its inquiry, anthropology has long been concerned with the question of species. Most notably, it has been recently addressed through multispecies ethnography as a way to conduct research and writing (Kirksey and Helmreich, 2010). This type of research was designed to study "contact zones where lines separating nature from culture have broken down, where encounters between Homo sapiens and other beings generate mutual ecologies and coproduced niches" (Kirksey & Helmreich, 2010: 546). Yet, it still draws a line between species and brings the notion into play. What are species? How are they devised? What do they refer to, exactly? In contrast to the idea of multispecies ethnography, Ingold (2013b: 21) proposes "anthropology, not ethnography, […] beyond the human, not multispecies." Other authors such as Haraway and Jaclin have also criticized this use of multispecies in favour of heterogenous enmeshed communities (Haraway, 2008; Jaclin, 2016a). Specifically, "species, like the body, are internally oxymoronic, full of their own others, full of messmates, of companions." (Haraway, 2008:165). Haraway argues that every species is in itself a multispecies crowd, which renders our use of the concept mute. It is through the notion of companion species that she argues

we have never been human. In fact, "[t]o be one is always to become with many" (Haraway, 2008:4). These arguments led me towards a conceptualization of laboratory life – livings – that is heterogeneous: humans are far from being the only ones that can be found dwelling in biology labs! By speaking about livings, I move away conceptually form multispecies ethnography. As Ingold importantly states (& Palsson, 2013: 18): "in this world of becoming there are no species in the taxonomic sense". Despite this theoretical reality, the idea of species was still an effective entry point to fieldwork in the lab. For example, I took habit of calling my cells 'cells' while at the Pelling Lab where most worked with mammalian tissue. Once I got to Symbi, people often asked me to be more precise about which kind of cells I worked with and my daily referent to cells shifted slightly to "mice muscle cells" or simply "C2C12s".

2.3 Polite inquiry

> Why do we acknowledge only our textual sources but not the ground we walk, the ever-changing skies, mountains and rivers, rocks and trees, the houses we inhabit and the tools we use, not to mention the innumerable companions, both nonhuman animals and fellow humans, with which and with whom we share our lives? They are constantly inspiring us, challenging us, telling us things. If our aim is to read the world, as I believe it ought to be, then the purpose of written texts should be to enrich our reading so that we might be better advised by, and responsive to, what the world is telling us. (Ingold, 2011: xii)

As an anthropologist working in the field in the 21st century with cells and within biolaboratories, I need to address some ethical questions. Some of these run all the way back to the 'Writing Culture' crisis of representation which shook anthropology in the 1980s. Most notably, I feel I need to address my place, the place of the anthropologist, in relation to entities with whom I'm working. Specifically working with laboratory livings and researchers from many disciplines, I feel issues of collaboration, diplomacy and politeness must be addressed.

Stavrianakis has written an article about collaboration with scientists, framed by the three-year project STIR: Socio-Technical Integration Research (Stavrianakis, 2015). This project was configured with the hopes of designing forms of collaborations between the social and natural sciences, amongst others. By participating in this project, Stavrianakis was hoping to characterize the problem of collaboration within the project itself but also beyond, by questioning how, why and to what end do anthropologists engage laboratory scientists in collaboration (Stavrianakis, 2015: 169). Collaboration is characterized as not only the capacity of the anthropologist to be affected, but also the capacity of the anthropologist to affect situations, as per Favret-Saada's

conceptualizations. Unfortunately, the STIR project led to an impasse. This led Stavrianakis to declare that placing the boundaries of fieldwork within laboratory practices constituted an "excessive constraint for the possibility of *collaboration*" (2015:185). He acknowledges the problem is where and how the boundaries were placed but I question that it is a constraint to the possibility of collaboration. This stems from my own fieldwork. My first intuition to account for this difference is rooted in my colleagues' inherently open, pluridisciplinary and curiosity-driven approaches. I found that the collaboration with scientists, artists and other researchers changes over time. We must also take into account that prior experience in the lab itself enables one to push these collaborations further. Upon my arrival at the Pelling Lab, I was coming with no lab experience. Upon my arrival at SymbioticA, I had eleven months of mammalian tissue culture crafting under my belt. As such, what began as a meticulous and mostly unilateral experience of education in the lab turned into something akin to collaboration, a term I still hesitate to define with any level of certainty. They taught me things and, as I gained experience and grew, I became able to teach them things too. I navigated lab practices with more and more autonomy, in the same way that Latour & Woolgar had to gain confidence in their work as observers in scientific laboratories (1986 [1979]: 257). Instead of hindering collaboration, this just made it more interesting since I finally felt like I was getting closer to speaking their language. Many differences lie between my experience and the one of the STIR research team but one last thing got my attention in this article from Stavrianakis, and it is most vital to my research. There was little to no talk about collaboration with nonhuman life forms in the article. What about the symbiotic relationships experienced with cells or other biological systems in labs? I truly believe some of these experiences be a form of collaboration or rather a crafting with, one of organic vitality.

It is in the post-scrip of the second edition of *Laboratory Life* that I find a note written by Latour & Woolgar that resonated with me. They claim the anthropologist, unlike the sociologist, does not know the nature of the society under study (1986 [1979]: 279). This classic idea of the unknown fieldwork and the adventurous field expedition can take different forms: I was quite unfamiliar with the workings of biophysics and of cell culture labs when I was paired with a PhD student at the Pelling Lab, and this initial distance gave me a great deal of uncertainty. Despite the multisite nature of my fieldwork, it could be argued that I did some anthropology-at-home while working in the Ottawa lab spaces and within a familiar academic setting. It is by working in

collaboration with other researchers that I was able to discover some of the uncertainties and points of tension of these labs I had for years walked by, but that had so far remained undiscovered:

> It is not necessary to travel to foreign countries to obtain this effect, even though this is the only way anthropologists have been able to achieve 'distance'. Indeed, this approach may very well be compatible with a close collaboration with the scientists and engineers under study. We retain from 'ethnography' the working principle of uncertainty rather than the notion of exoticism. (Latour & Woolgar, 1986 [1979]: 279)

Being now informed of the impasse reached by the STIR project, I find an alternative to collaboration in Bruno Latour's proposition towards a diplomatic anthropology. Latour has long seen beyond the illusion that modern science consists of a separation of humans and nature: he said it loud and clear over two decades ago, we've never truly been modern (Latour, 1997 [1991]). He does not see science as a separation between object and subject but rather as an intricate mix of the two (Latour, 2004). From this non-modern realization, Latour attempts to derive a scientific yet diplomatic approach to anthropology. The idea of the diplomate is inspired from Stengers' work (2011). This allows not only to create an era of compassion amongst humans but also to include nonhumans in the discussion. While Stengers' cosmopolitical framework and Latour's agents know theoretical differences from the Ingoldian paths I am harnessing, it is our duty as researchers to table ethical considerations, which go beyond theoretical and conceptual differences. By questioning the notions of nature and culture, Latour discuses a kind of anthropology where we must listen intently to scientists, even more so as they come to realize their cosmologies are only one from many, and that they do not hold a privileged contact with reality. Science is efficient and has powerful capacities, but it does not account for every experience of reality. With this new diplomatic anthropology, Latour affirms the authority of western anthropology shifts, with risk but also more vitality, towards the question: "Comment survivre un peu?" (2004) In this sense, he proposes the diplomate, who must present himself politely to the world: with this politeness, he must bring patience but also persistence. With this stance, Latour is hoping anthropology may, rather than obsess over pride, try to contribute, with hope, to future negotiations of peace amongst all. I would also suggest, with honesty and modesty.

The question of politeness and honesty are intrinsically linked. In *Thinking with Whitehead* (2011: 518), Stengers refers to "polite questions that one creature may address to another creature". The etymology of politeness is the classical Latin *polītus* which means to smooth, to polish. This

etymological root speaks of the well roundedness of the polite researcher who, smoothly and by playing to the level with livings it encounters, keeps the other interested. This idea of politeness is linked to what Vinciane Despret refers to as the art of good manners: asking good questions emphasizes the idea of keeping the other interested (Despret, 2010). Focusing on animals, Despret reminds us they can only answer us given what they perceive, understand or imagine of our intentions (Despret, 2010:146). Haraway also emphasizes the idea of good manners and politeness in an homage to Despret's work. Even more, polite inquiry leads to new emergences: "Good questions were posed; surprising answers made the world richer." (Haraway, 2015b:6). This was especially relevant in my work with mammalian and fungal cells as well as slime mold. I felt that I had to, quite literally, "keep the slime mold interested" in order to experience our relationship in different capacities. As described by Stengers, as well as presented in Despret's art of good manners and Latour's diplomatic anthropology, I consider the ethical considerations of politeness as two-fold:

On the one hand, it can help ensure continued access and pleasant experiences as politeness – understood as the practical application of social etiquette – ensures that we are aware of the tensions on the field and can navigate them all the while respecting others and attempting to keep the other interested. In Stenger's words, politeness "seeks to be "adequate," refraining from insulting any living value" (2011: 518). In this first aspect of politeness, we can also place honesty. Honesty comes from the classical Latin *honestus* which means regarded with honour or respect, worthy of respect, decent. Honesty therefore encompasses the aim of politeness to keep the other interested as an end in itself, out of respect for the livings we encounter.

On the other hand, politeness helps to ensure that we obtain interesting answers to the interesting questions we posed. As such, the ethical reach of politeness concerns not only the other livings which we encounter but also the knowledge we can derive from those encounters. By holding back, by asking polite questions, the researcher can be modest. Modesty comes from the classical Latin *modestus* which means restrained, temperate, well-behaved unassuming. By presenting our curiosity with politeness and most notably modesty, we restrain our curiosity and enthusiasm to present questions free from assumptions in a way which aims to keep the other interested. This also highlights the inductive dimension of fieldwork research and participant

observation as a methodology: we are not asking premade questions until they are solved, rather we are opening our attention to livings and their concerns.

These ideas of collaboration, of diplomacy, of good manners and of politeness come back to Ingold's participant observation as an epistemological commitment and as an education of attention (Ingold, 2013a; 2013b). By being attentive to movements in my fieldwork, I attempted to show politeness, patience and persistence through being in correspondence with others (Ingold, 2013a). These reflections enabled me to mindful, and to approach 'collaboration' with artists, scientists, cells and fungi, establishing a rapport of politeness and trying to keep good manners which has rendered my fieldwork experience not only interesting, but also rooted in my own kinds of ethics. I vow to my engagement with the world, in the field but also beyond, my best efforts at a polite inquiry.

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This second chapter served to problematize my fieldwork methodology by presenting my research trajectory, methodological questions as well as the idea of polite inquiry. The next chapter serves to bridge relevant literatures on crafting and living to better explore the proposed thesis.

3 Bridging Crafting with Living

This third chapter is a bridging of the concepts of crafting and living as they are understood in anthropology and related literatures. This effort at bridging literatures is empirically grounded in my observation on the field. It became essential to probe into the literature on craft in order to better understand the implications of crafting with living materials. After covering the question of crafting, the question of life will briefly be addressed and bridged with craft.

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3.1 Crafting

Craft of tissue culture, tacit knowledge and 'new' media

I still remember the first time I proceeded to passage C2C12 cells by myself for the first time. It was July 20th, 2015. After having a couple of lab sessions where I crafted cells with Sophie's help and supervision, I finally had my own keys and supposedly enough practice to follow the protocol and its tacit nuances. It is with some anxiety that I arrived alone in the cell culture room for the first time. All was well. The definite but increasingly familiar smell of the cell culture room greeted me: this familiarity was caused by the regular spraying of lab things with ethanol. I proceeded to lay out my work space and warm my Trypsin and media. The first gesture I carried out in preparation for tissue culture was to turn on the water bath which warms the necessary liquids. Then, the biosafety hood needed to be turned on. A button serves to activate the fans which control the airflow and processes 'dirty air' in HEPA filters. Another press of a button allowed to turn on the lights from within the hood. Next, I prepared my tools and consumables: pipette gun with 10 ml pipette tips, a 20-200 µL micropipette with a box of microtips, a rack with a fresh 15 ml falcon tube, new Petri dishes, glass needles for aspiration and finally a bottle of PBS (a phosphate-buffered saline solution which is common in biolabs). Most of these items were in racks to each side of the biosafety hoods. As such, I could sit to grasp most of these items beside me before spraying them with the ethanol bottle hanging on the rack and sliding them inside the incubator. However, items in the fridge, incubators, water bath, sink, centrifuge and microscope stations all required me to get up and take some steps in the small tissue culture room. I could stand in front of the fridge, kneel to reach my shelf at the bottom of the lower incubator, sit at the microscope station, place items on the counter between the centrifuge and water bath or reach up into a cabinet. The PBS bottles were simply on a plastic shelf rack between the counter and the

microscope station. Again, each item was wiped with ethanol before entering the sterile hood of the biosafety cabinet. Depending on the quantity of cells I had to passage – especially when growing larger numbers of cells for experiments – I could bring in more consumables and larger pipettes. However, this is the bare minimum which I required to carry out this first cell passage all by my cellf. Finally, an additional obsessive splash of ethanol here, there and here again ensured death of all the cells that may get where they shouldn't be. It is crucial to maintain a sterile environment in the biosafety hood while carrying out mammalian tissue culture: some livings which enter the hood can pose a risk to us, such as HeLa cells which are cancerous and were handled by my colleagues in the shared work space. However, it is most crucial to maintain sterility to avoid contamination of our precious cells who are living and crafting through a fragile equilibrium emerging from human gestures. In the biosafety hood, I placed my hand tools in generally the same order every session; each individual seems to have their own preferred layout. I used the centre of the biosafety hood as a point of reference: near the centre of the incubator I posed the rack with the necessary falcon tubes and the metal box containing glass aspiration needles. I also laid my micropipette near the rack. At the back of the biosafety hood, I placed the micropipette tips, fresh Petri dishes and my bottle of PBS. Next to the wall of the incubator, I placed my pile of large pipette tips to use with the pipette gun which I generally laid in the middle of this work area, a bare space at the front of the hood where crafty gestures could unfold. After everything was in place in the hood, I removed my 50ml Falcon Tube of Trypsin and my large bottle of DMEM media – the liquid which provides a milieu of nutrients and growth hormones to cells growing in a Petri dish – from the water bath. After wiping them with ethanol, the tube goes in the rack within the biosafety cabinet and the bottle of media sits at the back of the hood close to the PBS bottle. It is with anxiety that I grabbed my cells from the incubator and began engaging the protocol.

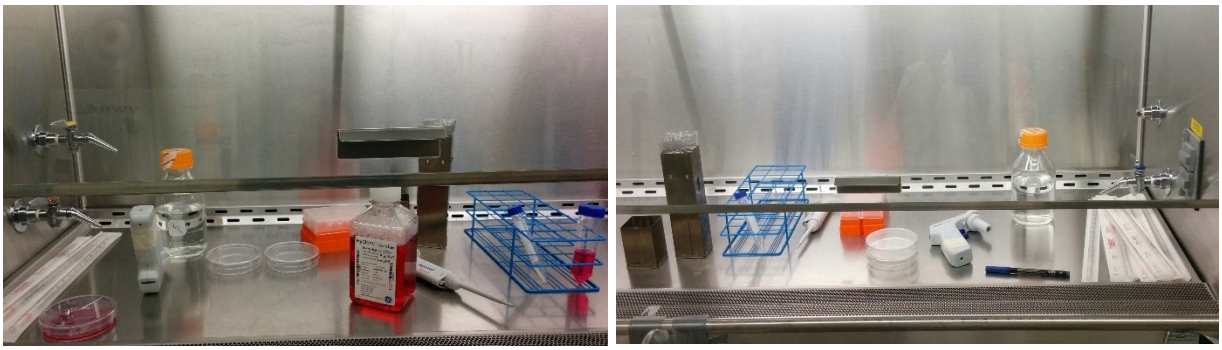

Figure 17: Set up for passaging of C2C12 cells on the left and right side of the biosafety hood

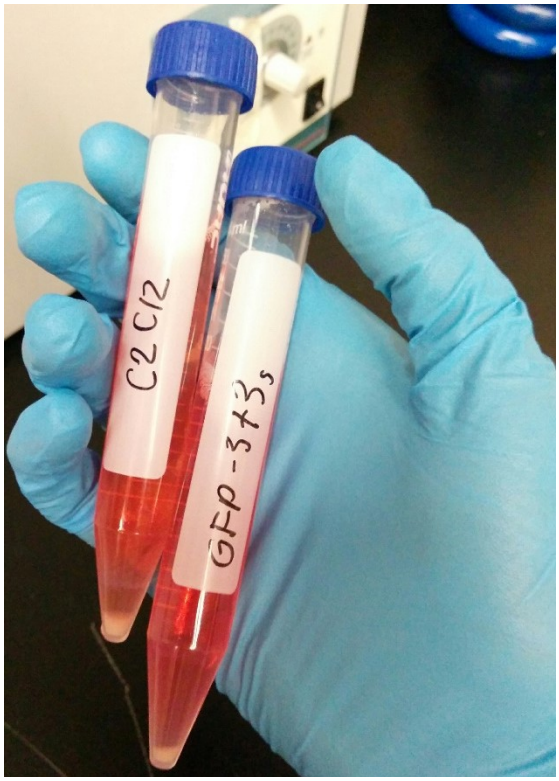

Figure 18: Cell pellets at the bottom of 15ml falcon tubes after spinning in the centrifuge

First, I proceeded to remove the media by aspirating the liquid with a glass needle connected to a vacuum tube. After, I had to wash my cells with PBS. This meant to add PBS with a pipette gun and swirl the PBS gently in circles in the Petri dish to remove any drop of media left – this step was crucial because media renders Trypsin inactive. This step had to be done gently to avoid damaging the cells during the washing. After the washing step, I added the Trypsin to the Petri dish and incubated the cells for 5 minutes. Trypsin is a scissor-like enzyme which serves to cut away the connective tissue grown by cells which helps them adhere to the plastic dish. During that time, I had a timer on my phone to calculate the 5 minutes, I prepared a 15 ml Falcon tube with 5 ml of media and put away the bottle PBS and Trypsin, respectively on a shelf and in the fridge. Hearing the beep of the timer reaching its end, I could remove my cells from the incubator and bring them back into the safe space of the biosafety hood. Petri dishes were never to be opened outside of the hood to avoid the aforementioned contamination. With the pipette gun and a 10 ml pipette tip, I aspirated the mixture of cells and trypsin and splashed it back on the Petri dish, which I held at a 45° angle. This helped to detach the last cells still partially bonded to the plastic. After this gesture, I proceeded to empty the pipette full of cell-trypsin mixture inside the pre-prepared falcon tube containing 5 ml of media. This mixture allowed to neutralize the cutting effect of the trypsin which could damage the cells over a longer period of time. By getting up and walking to the counter, I could place this 15 ml falcon tube in the centrifuge which ran for 3 minutes at 1000 RPM. Little was left to do once I reached this stage, though these last steps were crucial. Coming out of the centrifuge, the cells had formed a pellet at the bottom of the tube. Bringing the tube back into the biosafety hood, using ethanol to ensure sterility as with every removal and entry into the hood, I had to remove the Tripsin-media mixture without touching the pellet of cells at the bottom of the vial. I used the same glass needles first used to aspirate the cell media. The long thin head of the needle had to move

slowly closer and closer to the pellet to ensure a clean removal of the liquid without damaging the fragile cells. Once the pellet was left at the bottom of the tube, I could add fresh media. I then had to resuspend the cells in this media, which meant to dissolve the pellet and mix the cells to ensure a homogenous cell solution. With the pipette gun and a 5 ml pipette, I slowly pulled the liquid up and down in the pipette tip, gradually dissolving the cell pellet. I could see the pellet slowly break apart and the aggregated tissue visible to the naked eye slowly became invisible as it mixed in the pink media. After a few minutes of gentle mixing (being too aggressive can damage cell tissue), I had to count my cells to determine how much would be seeded to grow in new Petri dishes. Counting the cells allowed to determine cell concentration. This is when the micropipettes came into play. The tool used to count cells is named a hematocytometer (or, as it was casually known in the lab, the cell counter). With the shape of a microscope slide, the cell counter contained a chamber which could accept 20 µL of liquid. With a micropipette, I took a sample of my cell solution and filled the chamber of the hematocytometer. This was stored next to the microscope and I only brought it to the edge of the biosafety hood to fill the chamber. Next, I brought the hematocytometer under the microscope and adjusted the focus by turning a knob on the side of the microscope. Once I found the square grid of the hematocytometer, I could start counting the little circles which were my cells. I kept track of the number with a mechanical counter. Each cell counted meant my thumb went down on the handle. Using my lab book to record cell numbers and perform a simple equation, I could obtain the number of µL of my cell solution I had to transfer to fresh Petri dishes to ensure sufficient growth for a healthy culture all the while avoiding overgrowth which could result in suffocation of the cells. With this number in mind, I proceeded back to the biosafety hood, mixed my cell solution once again to ensure homogeneity and measured out the required quantities with the micropipette. Fresh Petri dishes received cell solution and a fresh 10ml of media through the pipette gun which handled larger volumes of liquid. The last step consisted of marking my Petri dishes: cell line, passage number, date and initials. After I had much practice, the whole procedure took me 45 minutes to complete. This, is the craft of mammalian tissue culture and growing cells in vitro.

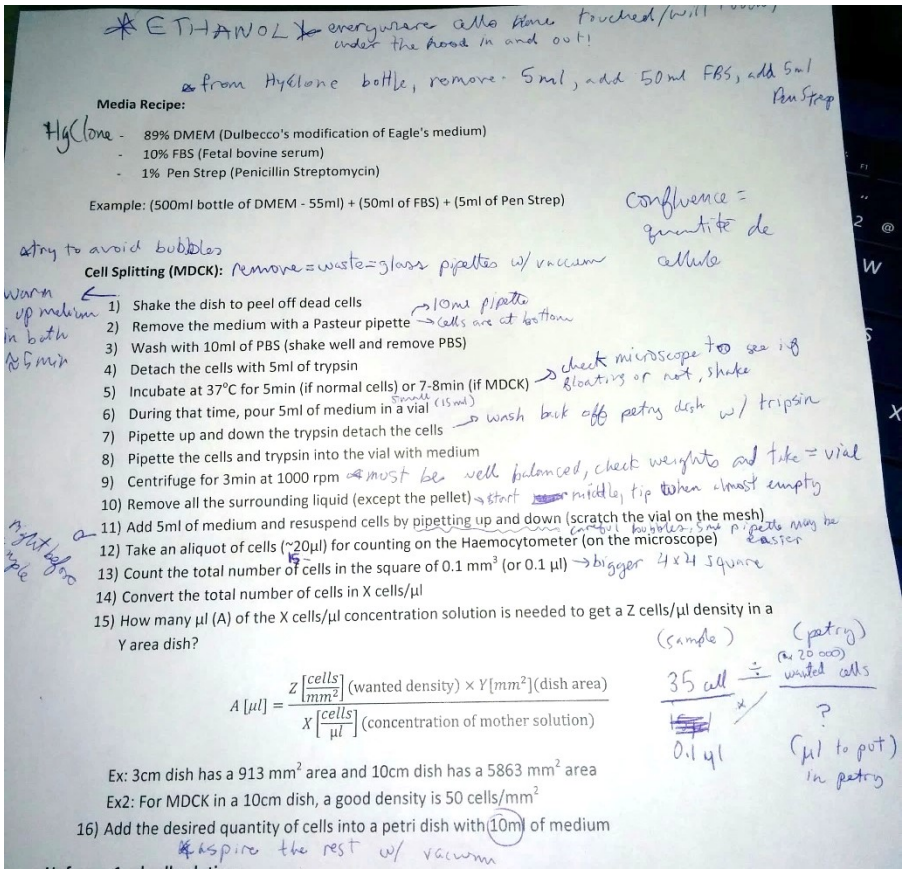

Figure 19: Photo of annotated protocol after a training session

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As this detailed account of a protocol I had to practice multiple times a week shows, my fieldwork has led me to questions of daily gestures and practices. Michel De Certeau proposed that we pay attention to the practices of everyday life as they are stuck in duration and broken time (1980). By paying attention to these practices, we can account for surprises and indetermination, for it is the unforeseen that allows *le quotidien* to unfold beyond the strict formalisms of institutions and technologies (De Certeau: 1980: 296). This close attention to practices when I entered biolaboratories has guided me towards studies of craft in line with the many scholars who turn their attention to craft for its close relation to the everyday (Adamson, 2009: 457). To reach the scope of craft as a human activity rather than a situated history, craft can be defined with clarity and simplicity: "the application of skill and material-based knowledge to relatively small-scale production" (Adamson, 2009: 2).

Craft theory has brought forth the intertwined theoretical knowledge and tacit knowledge involved in crafting (Dormer, 1997; Sennett, 2008). This tacit knowledge and intuition speak of

"doing it without having to think about it" (Farrar & Trorey, 2008: 42). Craftspeople need to be reflexive as they constantly engage in adjustments and decision-making behaviours by learning from their mistakes and engaging the improvisation of their craft (Farrar & Trorey, 2008; Metcalf, 2000). When someone finally masters their craft – a tool and its relation to the material – they enter a flow where they are immersed in the activity. Finally, this allows to account for the emotional experiences of crafting to be an integral part of the crafting expertise (Farrer & Trorey, 2008). Metcalf (2000) even proposes this emotional engagement is what is behind the resilience and patience of craftspeople. It could be said then, that craft is an intuitive and tacit knowledge of what can be done with a material (Tonkinwise, 2008). Crafting, in this sense, enables the maker to not only see what is in front of them but the potential that is there and to engage it – not only imaginatively – but through harnessing of bodily skills and the sensory extensions provided by tools. Tonkinwise (2008) suggests that the creativeness of crafting could rest in the dialectic relationship between maker and material; in this sense it is a co-creativity. According to Dormer, tacit or practical knowledge of doing is necessary in order to accomplish making in a first place; theory only serves in bettering our understanding of a practice we are already capable of grasping. Tacit knowledge is acquired through practice, repetition and watching other people's practices (Dormer, 1997; Farrar and Trorey, 2008; Hunter, 2015). In line with tacit knowledge, Metcalf (1997) situates craft within a bodily intelligence, specifically concerning the hand, that is developed through getting to know a certain craft material. The craftsperson will eventually stumble upon handwork that corresponds to their individual capacities and bodily intelligence (Metcalf, 2000).

This raises the question of craft and technology: can new technologies such as computing still be involved in craft processes? In this context, Greenhalgh (1997) and Paxson (2013) suggest that craft can help us bridge the gaps between art and science, which lead to redundancy. Dormer also sets out to show how craft, in the context of new technologies, shifts from the focus on handwork towards the knowledge that empowers the maker to master a given technology (Dormer, 1997: 140). Craft, then, would be distinguished from technology itself by its relation to tacit knowledge. Dormer (1997) believes craft is unlikely to disappear in the face of new technologies given the intellectual, imaginative and sensory pleasures derived from making. Some hesitate to speak of computer-making as crafting: it may be a mental craft but not a handcraft as the computer is more of a machine and less of a biological extension of the human (Myerson, 1997). However,

some computer makers master their tools so well that they reach an intuitive state of material manipulation with their tool which results in sensations like those experienced by potters and woodmakers. Harris (2005), who has background in textiles, has shaped her approach to computer graphics through a crafty consideration for shapes and movement. A sensory connection with a 'physical' object on view would be possible without the direct touch of traditional crafts (Harris, 2005). In this sense, the values and knowledge of craft can be understood, expanded and tested not through language but practice: "It makes craft difficult to write or even talk about with clarify and coherence." (Dormer, 1997: 219) The idea of craft as a practical philosophy (Dormer, 1997), an activity of self-exploration and disciplined knowledge, refers to the inability of laboratory protocols to contain the tacit knowledge of the craft of tissue culture. In this sense, "the knowledge of making cannot be extricated from the specificity of its material context[, it is] a type of localized knowing, but as non-abstractable" (Tonkinwise, 2008). Many others allude to the idea that "so much of "crafting" is an indescribable experience." (Harris, 2005: 26; McCullough, 1996). The difficulty of transforming this knowledge into words is an incentive, for me, to work towards bridging the gaps between the anthropology of life and crafts as two complementary movements which unfold in the world. All the while, this bridging is difficult to write or speak about since it unfolds in the lived, practical world, through an experienced duration and as sensory and haptic experiences.

To speak specifically of mammalian tissue culture as a new media for craft, cellular anthropology highlights the processes and replications and growth of livings, but repetition also refers to the act of maintaining cells has to be repeated over and over. Simply letting the cells grow in the dish will quickly lead to them overfilling the dish and suffocating each other. As such, multiple times a week, I and others working with mammalian tissue, had to go in the lab to passage cells. This process has been described at the beginning of this section. A protocol which can be carried out at various speeds, this repetitive aspect of tissue culture results in a reflective and reflexive state which can emerge once the craft has been mastered. Oron Catts speaks of this state during one of our conversations:

> It's a very different existence. There's something, as I'm sure you've noticed, very meditative in kind of sitting in the hood with the white noise around you and the bright lights, totally separated from the world and kind of focusing on the world-being of those entities that require this routine quite laborious maintenance regime. It can be a

> really great place for contemplation. Once you reach a stage where it's almost automatic, you have the body memory of doing it. (August 16th, 2016)

In laboratory unfoldings and improvisation, machines and tools seem to behave as an extension of the hand and mind[12] and deep immersion into the crafting processes depends not on the material being crafted but rather on the ability of the crafter to manipulate their tools (Harris, 2005). As McCullough observes, the human hand – as one of the most sensitive and probing body parts – is deeply involved in this kind of immersive experience and in the development of tacit knowledge (1996). "We *enjoy* being skilled", reminds us McCullough. In fact, "We experiment to grow more so." (1996: 7) In this sense, it is not the simple use of the computer which is a craft but rather the use of the computer as a tool which requires skill (Harris, 2005: 32). In this sense, various tools such as screwdrivers, electric wires, microscopes, telescopes and scalpels enable us to engage crafts imaginatively (Sennett, 2008). The microscope allowed the invisible to be revealed, for example. Any tool requires some practice to be handled properly. The more we master our skill of a certain tool, the more we can use it for reasons other than its primary dedicated purpose (Sennett, 2008). It is also by using new potentials beyond the tools' initial purpose that we grow our skills. Just as in digitalized crafts, livings in a biology lab require us to use technologies in order to find their substance which is invisible to the naked eye. The question of abstraction in craft can help us bridge 'traditional' and 'new' media through practices. Though there is some ambiguity regarding the role of the computer as media or tool, theorists generally agree that some computer manipulations involve materials and technologies, improvisation, play and learning as well as crafting itself as a skilled, generative practice (McCullough, 1996; Harris, 2005; Harris, 2012).

Interestingly, Harris proposes that "through experimental engagement with digital media, computing is to some extent indirectly repositioning, perhaps even reinvigorating, craft practices, highlighting strengths." (2012: 109). As such, we can also recognize practices of biohacking and bioarting in the laboratory with living materials as gestures of crafting. For example, Wylie has inquired into the craftiness of fossil preparators, the technicians of paleontology laboratories (2015). She has found that work of these technicians involves creativity, problem-solving and skillful practices articulated around personal tacit knowledge (Wylie, 2015). This can bring us to the question of living laboratories which are harnessed through crafting. *Biomateria: Biotextile*

[12] This reminds us of Marshall McLuhan's idea that new media are extensions of our human bodies and senses.

Craft (2015) is a short book/exhibition catalogue/assemblage of protocols meant to present the craft of tissue culture through the perspectives and artworks of bioartist WhiteFeather Hunter. WhiteFeather Hunter, like Jane Harris (2005), also has background as an artist and crafter working with textiles and biomaterials, specifically human and animal hairs, flesh and bones. Her practice is also centred on hacking of electronics and livings materials. I had the chance to meet WhiteFeather through my fieldwork: she has ties both to the Pelling Lab through an ongoing residency since 2014 and to SymbioticA where she spent 15 weeks in 2014. In *Biomateria*, WhiteFeather presents tissue culture as a craft – which is how members of the Pelling Lab spoke about the practice. She proposes haptic epistemology as both a methodology and a philosophy which helps to reinsert cellular livings into research. Positioning herself as a vitalist materialist, WhiteFeather conceptualizes laboratory livings as vibrant matter, in line with neomaterialist Jane Bennett (2010), therefore ascribing agency to cells and other organisms or fragments. In the context of *Biomateria,* WhiteFeather has woven small scaffolds made of non-cytotoxic materials. She placed this woven, connected scaffold in Petri dishes with cells. She describes the craft of tissue culture as the centre of her haptic epistemology:

> The negative spaces of the structures are small enough to be utilized by individual cells, while also large enough to present a creative challenge. Through their capacity for detection and response, they [cells] build structural embellishment, an outer skin, by embodying the scaffold, vitalizing the architecture, inhabiting and carrying out life processes within and on it.
>
> Discovering a successful interaction between cell type and scaffold material is a process of haptic epistemology conducted through the cell membranes, as well as through the hand of the artist. The attractiveness of the structures I've created may or may not be aesthetic, but for certain is chemical. […]
>
> My work means to explore the notion of multiple intelligences and showcase the potential for haptic 'intelligence' or understanding through tactile contact, within a culture of cells in the formation of tissue mass. (Hunter, 2015: 55-56)

With this proposition, WhiteFeather allows us to focus on the handicraft that human practitioners deploy but also on the haptics and gestures of laboratory livings. This exploration of the craft of tissue culture allows us to account for knowledge which is generated through touch as we engage materialities and vitalities. As such, WhiteFeather Hunter's work brings us practical and theoretical intuitions for an approach which attempts to decenter the human in the context of

craft and crafting. Allowing us to bridge elements of the anthropology of life and craft theory, the approach of WhiteFeather Hunter shows that there are implications to working with livings and that we can take into account the gestures of these various livings beyond-the-human. In turn, I can give a place to my cells in this thesis without formalizing anthropomorphic caricatures.

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Broken pieces, sloppiness, hacking and problem solving

My biggest incident at the Pelling Lab occurred on July 14th, 2015, exactly twelve days after my first lab adventure. It was my second time meeting in vitro mammalian cells: I had proceeded to my first passage five days prior. The seemingly simple step of cell passaging, which I described at the beginning of section this chapter, I discovered was an intricate sequence of handy procedures which harnessed both analytical and intuitive skills to lead to successful completion. One of the last steps of passaging cells involves cell counting with a hematocytometer. Once a uniform suspension of loose cells and media is contained in a falcon tube, a sample of no more than 15-20 µL is to be loaded – by pressing down on the end of the micropipette to pick up cells and releasing the button to release them – in the hematocytometer, between the particularly costly glass slide and a thin glass slip. If the sample has been properly loaded, it can be placed under a microscope and, at an enlargement of 10x, a small, carefully calculated grid appears. With precise enlargement factors and a simple equation, counting the number of perfectly round circles in one area of the grid results a ration of cells per microliter. Soon, I realized the cells were the little circles I had to count; the imperfect circles metaphorically yet actually standing as dead or injured cells. Some chemicals can be used to stain dead cells which then ensures, beyond a simple qualitative evaluation, a count of viable cells, but for simple passaging such precision is not required. In fact, as Sophie was teaching me how to count my cells in July 2015, she recounted that she counted her cells for a whole year before developing the intuition required to passage her cells without first ensuring the count. Enthused, I found myself at the microscope, working both my eye and ability to focus as well as my hand, fingers flicking away on a simple, analog mechanical counter which helped me materially keep track of the count. To match all levels of precision that could be desired, the hematocytometry offers you the chance to proceed to 4 counts which you can then average out to obtain a solid cell count: undoubtedly, this level of certainty takes 4 times as much time to achieve. I found, on January 14th, that I had plenty of healthy cells

to passage. When I finished counting my cells, my body shifted from one of the rooms to the other and I returned to the biosafety hood where I had left the falcon tube full of cells in suspension. With my calculations, I determined the appropriate quantity of solution to transfer from the tube to fresh petri dishes (at a confluence of 87 cells per 0.1 microliter, and with a goal of passing 20,000 cells in each of my new petri dishes, I added 23 μL per dish). Once my cells were safely in the incubator came time to clean up. Cleaning up a cell culture facility, as I quickly learned, is not a final step but an ongoing movement. Throughout the procedure, a spray bottle provides easy access to a solution of water and 90% ethanol. To keep the biosafety bench sterile requires cleaning each tool coming in the hood, and keeping the lab room and the surrounding environment safe requires cleaning each tool coming out of the hood. With a clean biosafety bench and most of my biotechnological assistants away in their drawers, the hematocytometer was left sitting on the microscope stand. As I grabbed it to sterilize the cell chamber for the next user, CRACKKK. It slipped out of my hand. Though luckily, this incident was without further complications – we simply had to order a new cell counter and were without for a few days – the 'contaminated' broken glass could have resulted in an injury which could have been exposed to harsh chemicals and reagents as well as cells. It also did have an impact on the day to day activities in the lab, as members of the Pelling Lab had to borrow the hematocytometer of another group using the tissue culture room. However, this led to the creation of new relation unfolding in the lab in the meshwork of forces. Ultimately, the biggest effect of this small incident was that I learned to be much more cautious when handling glass in biolaboratory settings. I wished to avoid causing the lab another unnecessary expense (the hematocytometer cost around $100 to replace) and aimed to minimize the movements of the cell counter around the lab. As such, my specific gestures in the execution of this crafty protocol were changed and perfected because of this accident and other small mistakes that I would make along the way of the unfolding lines of livings.

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This latest vignette serves to expose the generative potential of this practice in learning and growing as well as to bring forward the sloppiness and hackiness which are present in crafting. Questions of postdisciplinarity in craft oppose themselves to that of trans-, inter- and multidisplinarity in that it does not suggest bridging discrete disciplines but rather to operate without such boundaries in a move closer to antidisciplinarity (Adamson, 2009: 586; Ito, 2014;

Pelling, 2015). Sloppy crafts emerged as a "constellation of meanings of craft" (Paterson & Surette, 2015: 10) associated with DIY communities who engage in crafts as a hobby. Sloppy crafters engage in crafts without having a fully developed skilled, and they do not achieve glossy results but, nonetheless, they at least accidentally engage materials. This can help account for my first few sessions of tissue culture at the Pelling Lab where, without having fully mastered the craft and breaking some equipment along the way, I engaged the cellular. I'd argue that the relation between livings (in this case, of human hands engaging the processes of knowing and being known by other livings), is not concerned by dualisms of matter or materials versus ideas or representations but rather in the haptic relationship that unites them, through which we can understand some of the unfoldings of laboratory labs.

Steinmetz, through an ethnographic study of hackers, reveals a parallel between this community and craft practices and proposes that hacking is a crafty, or a transgressive craft (2015). This kind of approach to craft is especially interesting when considering the DIYbio and biohacking communities which emerge worldwide. As Steinmetz outlines, these 'deviant' activities lead to the development of skills and knowledge but "[t]hey are not mere acts or behaviours—they are connected to greater constellations of social and personal developments." (Steinmetz, 2015: 142). In this sense, the physical biohacking which Pelling harnessed has been not only a crafting practice through its unfolding gestures linking human hand and other living materialities; it has also been a clear opposition to the hegemonic paradigm of genetics within biological sciences. Gabriella Coleman, well-known as the expert anthropologist of the Anonymous hacker community, also speaks of hacking as a meeting ground for craft and craftiness (2016). In this context, craftiness refers not only to the political convergence between crafting and hacking but also to the inherent value of crafting something, making something by unfolding one's own skill. As such, we can understand craftiness as pushing our tools, technologies and materials in a way that "exceed[s] mere instrumentality" (Coleman, 2016: 163). If we take the example of physical biohacking harnessed by Andrew Pelling, we find this crafty character in the unfolding of science discoveries which stem from jokes in the lab and in bioart pieces which allude to knowledge that is localized and situational to the life sciences. For example, Repurposed 46 was titled because of the repurposing of apples to grow human tissues, who have 23 pairs of chromosomes. All in all, the works which came out of the apple project were not developed

hypothetico-deductively but emerged through trial and error, in sloppiness and craftiness, and due to the value found in the crafting process itself.

A "woodworker, teacher and sometime theorist" (Adamson, 2009: 35), developed the workmanship of risk: this concept refers to "workmanship […]in which the quality of the result is not predetermined, but depends on the judgment, dexterity and care which the maker exercises as he works." (Pye, 1968: 4). In contrast, there is no risk in the workmanship of certainty where results are predetermined and oriented around production and automation. Though this view is dualistic, dualisms can be rethought through practice (Markovitz, 1994). To speak of crafting with livings, the workmanship of risk accounts for the gestural dexterity at play in handy practices but also for the risks which the human-cell relationship faces in order to keep crafting in the lab. Acknowledging the large variety of hand tools, materials, practices… Pye insists risk is the one common element to which we can refer to speak of "craft". This helps clarify my conceptualization of laboratory gestures as crafting because working with livings in the laboratory, there is always risk: risk that a specific procedure has not worked, that the equipment breaks, that the cells themselves die. Though laboratories are often thought of as spaces of control, sterility, predetermined protocols and repeated gestures, paying close attention to laboratory practices reveals a kind of uncertainty. I still remember the morning of August 8th, 2016. It was a Monday morning and I had just arrived at SymbioticA when Chris asked me if I used the incubator on Friday. I say yes very matter-of-factly, wondering why he asked that question, and he said the door hadn't been closed properly over the whole weekend. Oron said that the temperature was at 19°C when they got in this morning while mammalian tissue culture incubators need to maintain a temperature of 37°C. I was horrified. A sinking feeling dawned in the pit of my stomach. I felt so awful. I couldn't believe I had killed my cells, again! I did encounter previous difficulties keeping my cells afloat when I first arrived at Symbi. I grabbed my notepad and headed downstairs to the Symbi lab with a heavy heart. When I arrived, Ionat was there with another resident: she hadn't checked my cells yet, so she didn't know if they were dead or alive. In reassurance, she said the exact same incident had happened at least twice to James before. I took my flasks and checked the cells. The first one was full of little aligned dots. The second one had an odd star shape. I assumed they were all dead. But the third flask was still going! The other resident looked at them, she had just arrived it was her first time seeing mammalian cells grown in a dish! Then Ionat had a look at it as well, she said they looked alright. I got her to look at the second flask since they were so

funky looking. She told me I must have been on the wrong focus because they looked good! I brought my face to the eyepiece of the microscope and realized she was right! The first flask I had initially dismissed looked great as well! I think I was so sure that they would be dead that I ended up not looking properly and finding the focus. I popped them back in the incubator and dropped my bottle of media in the water bath. I decided I would change the media to give them an extra nutrient boost since the drop in temperature couldn't have been good for them. Risk is prevalent in biolaboratory work and that our crafting gestures must adapt to the rhythms and sensibilities of other livings; we always have room to grow and perfect our crafting skills.

Akin to Pye's workmanship of risk, Sennett identifies resistance as important for the development of craftsmanship: whether that resistance is found to block us or whether we make our own difficulties, we learn to tolerate frustration and to engage imaginatively to deal with resistance (2008: 226). This was especially relevant to working in biolaboratories. Often, protocols failed or worked once, and the results could not be replicated. I had previously thought that the difficulty of working in a biology lab would come from collecting data. However, I realized I was wrong after spending many months at the Pelling Lab. Most graduate students were spending months simply trying to determine a working protocol. Once the procedure was established, collection of 'scientific data' was simply the repetitive execution of a set of gestures which had finally been mastered. Something similar was present at SymbioticA, where artists researched in the lab different ways of being and interacting with their biolaboratory livings. Ultimately, the artworks which were later formed and ended up in galleries unfolded from the practices – specially crafting gestures – which had been mastered.

Trevor Marchand, in line with Sennett's resistance, developed an anthropological understanding of *Craftwork as Problem Solving* (2016). Marchand's methods were similar to mine: sign up as a labourer or into programs to really be involved in the subject matter, just as I engaged biolaboratories through residency programs. The exploratory anthropologist residency I pursued at the Pelling Lab allowed me to become fluent in the biophysical language, in biosafety concerns, in biolaboratory environments and finally to start practising the craft of tissue culture. This allowed me to arrive at SymbioticA to pursue another residency this time allowing to reach new contexts and to unveil new tensions from within a certain crafting practice which was developed over twelve months. Marchand argues that problem solving is essential to learning and

knowing and that craftwork and craftspeople offer the perfect opportunity to study different levels of problem solving: through various calculations, through physical and motor skills, through budgeting of materials, resources and time, through production of craft things which are received in a certain context, through community at a social and political level (2016). These elements all pertain to the unfoldings of biophysical sciences, biohacking and DIYbio, bioart and laboratories. By defining craft as polythetic and in a constant state of evolution, Marchand turns to problem solving to focus on making but also on learning and education. Mistakes serve to highlight the situational, physical and perceptual character of learning a craft as well as highlighting the emotional engagement of the practitioner towards the materials and the gestures.

3.2 Living

Bees, ceramics and the liveliness of materials

Mike Bianco is a beekeeper, artist, activist, curator and researcher currently undertaking a PhD in Biological Arts at SymbioticA. I had the chance to meet him during my stay and was also lucky enough to visit a local exhibition where two of his artworks were presented. To summarize his research, Mike studies the symbiotic relationship between bees and humans. Often using posters of horror films featuring bees as a menace to humans, Mike attempts to show through his work how the long-standing, reciprocal relationship between bees and humans can help us better understand tensions surrounding food safety and care. It was in the group exhibition Radical Ecologies, which was shown in Perth, Australia from July 31st to September 4th, that I got to see many of Mike's artwork concerning the human-bee symbiosis in person. Mike exhibited two major works at Radical Ecologies: a painting for bees as well as bee bed. The painting for bees stood at the top of a long stick. Held up in the air was a simple diamond of wood coloured with stripes of blue and yellow as well as scented with pheromones recognized by bees. This acted as a painting for bees when placed outdoors. Just like humans passing by different artworks in a gallery, bees can linger on or around the painting, then continue on their path and fly away. The bee bed was made with skills of carpentry and beekeeping: a sheet of wood upon which the human lies, bees can be heard buzzing around from within plastic tubing. The wooden bed takes the role of a beehive and the plastic tubing connects the bed to the wall and makes a path leading outdoors. Through

these artworks, Mike attempts to work through questions of empathy and care and highlight the symbiotic nature of the human-bee relationship.

Figure 20: Mike Bianco presents his PhD work at SymbioticA to students and professors of the School of Anatomy, Physiology and Human Biology at UWA

As an artist and a maker, Mike also has experience working with ceramics. This is reminiscent of WhiteFeather Hunter (2015) and Jane Harris (2005) who both share experiences working with traditional crafts – specifically textiles –, before moving on to crafting with 'new' media – respectively living tissues and computer graphics. I will present an excerpt of our recorded conversation which relates to the question of living materials involved in crafting:

> What if I was that cell? And they're dead! Again, it's anthropomorphizing it but… They're not just materials. They're both materials to be manipulated but they act on us in deeply emotional ways. Maybe at some point that passes, and you become numb to it but I do think that coming to this work from a different perspective, you care if the door was open! Not just because it affects your research, but because of your emotional involvement. […]
>
> Why are we drawn to certain things and why do we care about certain things? My deep background in terms of making is in ceramics and I'm very passionate about clay, about what happens to clay when you put it through fire, crush it with rocks and mix it with water… this is a deep passion and a lot of the ceramics I'm interested in are moments in which…. A great potter said: "the pot speaks, the clay speaks", it participates in the production of the form. For me, there's a kind of animated quality to that idea, to that understanding of the material. So I would argue that clay very much has a life for me. As much as I care for my partner, our nonhuman kin that sheds in the living room and bees, as much as I care for these other things, I would argue that I also care for clay quite a bit. I think in terms of why… I don't know why we choose certain materials to care for whether they're organic or inorganic, animated in a timescale we can see or not… but I think, there is for me at least, this question of value. What is the

> difference between clay and C2C12? I think there is a difference, it feels like there is a difference… but I wonder if I'm a life-ist or a vitalist… that thing has a metabolism, but that thing doesn't at least not in a scale I can see so therefore I feel I have to take care of that thing in a different way. But I think it's an interesting question in terms of what we choose to care about. When we think about the cells that you throw bleach on and kill… here I'll scratch my arm. Gone, dead. Does it matter? No. Do I really care? No. But at some point, it does matter. How do we differentiate life in the lab and life outside the lab? Because in weird ways, I think life in the lab is valued in ways that is much higher than similar life outside of the lab. (August 22nd, 2016)

Through this conversation, we can see the ambiguity and indetermination which unfolds through crafting with livings. Mike's comment contributes to the expansion of the concept of livings. As such, some laboratory and studio experiences which engage materials of various levels of vitality can be accounted for through cellular anthropology. The growing of clay into ceramics, to follow Mike's example, manifests leaky boundaries, various experiences of duration and are linked to technologies. Finally, we can think seriously about polite inquiry: what would it mean to keep clay interested? Politeness ties in with duration and risk, for example, through the necessity of keeping clay wet for it to remain responsive. The process of drying out clay and cooking it into ceramics, rather than representing a simply change in function or the crystallization of a form, accounts for the porous membranes of clay who leak out of the studio and experience the meshwork through new knots and new durations.

As Markowitz highlights, craft objects usually have utilitarian use while art objects belong to the realm of representations and aesthetics (1994; Risatti, 2007). This work is very different from my approach in that it focuses on craft objects and their functions whereas I focus on processes and relations. However, the idea of function could be interesting when speaking about laboratory practices which were intentionally designed to harness life: we could conceptualize laboratory craft through anthropocenic visions of a world dominated by humans and biotechnologies themselves emerged as humans crafted life. To speak of cellular anthropology means to acknowledge the 'functions' which cells can pursue, but more importantly to highlight the symbiotic fulfilling of human and cellular needs through a mutual relationship. This is where polite inquiry becomes a living concept, in the realization that others can respond to my own laboratory gestures. As such, craft does not only refer to the end result (the craft object), but also to a whole set of practices, processes and materials. As Markovitz importantly states, "Craftspeople differ, though, about why medium and workmanship are so important." (1994: 63)

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> Life: In an age when biologists push their research to its limits—by using computer simulation to model living things, by scouting for extreme organisms in sea and space, by seeking to synthesize new life forms in laboratories—the definition of "life" is becoming unfastened from its familiar grounding in existing earthly organisms. The relation of life to possible materials, circumstances, and processes is multiplied, moved towards uncertain limits. (Helmreich, 2016: x)

As a study of the human (read: anthropos), anthropology has concerned itself with animals and other livings not only as different from us, but also as organisms which are inevitably our cohabitants in the world. Beyond the idea of social or political life, nonhuman lives have been at the heart of some more recent anthropological enterprises which take up cross-species interactions with vigour to understand our shared spaces (Kohn, 2007, 2013; Kirksey & Helmreich, 2010; Keck, 2010; Ingold, 1994 [1988], 2013b). Relationships between livings trace a gestural intimacy which science, as a one-way process, has not traditionally included in its renderings[13].

Within anthropology, the work of Kohn in the realm of semiotics has gotten my attention for its conceptual capacity to bridge gaps between livings. Inspired by the philosopher Charles Pierce, he proposes that "life, then, is a sign process" (2007: 6). Kohn speaks of an ecology of selves: there are selves, beyond us humans, and these selves have some attributes that we share and some which differentiate us (2013: 226). I have come to the realization that modes of communications vary between what he calls 'selves'. The nondualistic representational system of semiosis (Kohn, 2007; 2013) allows us to pay attention to the continuity of the modes of representation between humans and nonhumans. This leads to the insight that modes of communication are heterogeneous: as such, (biotechnological) mediations used to actualize the relations in becoming vary. I come to see language as mediation which can actualize meaning in a human collective, sound as mediation between livings who sense vibrations, colour as mediation of beings that interpret light waves, […], chemical composition as mediation between beings who absorb and expel, surrounding viscosity and hardness as mediation of beings who physically roam.

[13] Myers exposes the affective and kinesthetic aspects of the experimenter who tries to excite the life in scientific operations. Research concerning life then, would be series of intimate encounters. It is through gestures and movement that biological researchers embody the ongoing changes of the living systems they are studying (2008; Myers & Dumit, 2011). Here, laboratory gestures are seen as performative manifestations which have the potential of exciting matter into action. In my fieldwork to study the human-cell relationship, cells were often performed as a naturalist taxon for life but also as an experimental biotechnology with leaky boundaries.

Paying attention to concurrent lines and the mediations through which they unfold gives me a conceptual yet concrete tool which is in line with Roosth's example of yeast, which she claims lends itself to multisensory experiences (2009). This brings us back to the importance of considering sensorium of different laboratory livings, whether human or not. By situating my attention in the realms of gestures and the cellular, I can acknowledge the transfer of information between livings which relies on the porous membranes of the cellular and to the durations of different livings who entangle themselves in each other. An example of these (biotechno)mediations can be found in some of my work with fungal tissue. I grew various strains of fungi from samples of wood which I had collected in the park. These pieces of wood's duration resulted in prolonged living in the Chooi Lab. Their boundaries leaked into the nutrient agar and fungal bodies emerged, forming both regular and irregular forms of filamentous, fuzzy and slimy textures generating blacks and whites, blues and greens, reds and yellows. They grew and grew each according to their own speeds and durations, hidden away in a dark drawer. A new function was brought to form when I combined fungi to slime mold in an agar dish, hoping to awaken their interest and to see new gestures unfold. Some fungi survived the slime mold while others were engulfed; ultimately, these cohabitants had found their way through (anthropobiotechno)mediations by carrying out their own gestures alongside those of skilled, crafting human hands. My proposition of cellular anthropology wishes to show how "materials are life-giving, and their movements, mixtures and bindings are creative in themselves." (Ingold & Hallam, 2007: 11)

Through examples both from the human and nonhuman worlds, examples of both growing and making, examples both of western and non-western socialities, both of material engagement in the world through practice and through the transformative experiences of sensations, Ingold proposes that "Ecology, in short, is the study of the life of lines." (Ingold, 2007b: 103) Becomings of the meshwork engage in mutual constitutions which can be understood as the knotting and entanglement of lines within emergent fields of relations (Ingold & Palsson, 2013). The study of life then is the study of how we grow in correspondence with others we meet along unfolding paths. We can know and learn from the world only because we are part of it. As such, Ingold presents anthropology as a movement of openness towards the world, where we learn to attune our attention to concrete unfoldings. In this approach, anthropology turns to experimenting, to inquiry which moves forward, along other lives and with the world (Ingold, 2013a: 7). Similarly, Tsing

argues for a return to curiosity in research: we will only find life if we keep looking in the ruins (2015: 6). The focus on the gestures and practices of researchers – be they scientists or artists – involved with living media, in turn, allows to account for the transformative capacities of the media at play and to develop what Myers & Dumit term haptic creativities (2011: 240). At play in biolaboratories, is the mingling of data, instruments and stories; there is crafting. Haptic creativity refers to the affective and kinesthetic practice of improvising metaphors and explanations which result from experimentation (Myers & Dumit, 2011). Through this practice, researchers become story tellers of the laboratory lives they work with. The idea of haptic creativity also allows to account for the dexterity at play when working in a lab with cellular livings. Specific kinds of attentions are developed when working in the lab, depending on the methods harnessed to sustain, explain or grow with life: "the blur of movement within a cell is hard to parse. Learning how to see in time is no small feat." (Myers & Dumit, 2011: 253)

Ultimately, I consider life – in line with Ingold and Bergson – as a movement of opening and creativity. Instead of opposing them, processes of making and growing can be folded in each other, allowing for a focus on the immanence of becoming. Such a way to conceptualize life allows me, regarding the liveliness of the human-cell relationship, to regard the unfolding relationship as the growing of a line. As such, I do not ask what cells and humans are and I am not looking to compound or assemble a conceptual response. Specifically, the relational approach of this thesis has enabled me to ask "not so much of what a pangolin [or cell] is, but rather of what a pangolin [or cellular] body is actually capable of." (Jaclin, 2016a.: 405). This leads us to ontogenesis. The forms that emerge in the field of specifically human relations are understood within "anthropogenesis [which] is neither making nor growing, but a kind of making-in-growing" (Ingold, 2015: 122). This proposition is relevant to my study of the human-cell relationship in laboratories especially in the context of biohacking and bioarting practices where making and growing unfold concurrently, where artefacts and organisms are found to be indiscernible and skills and movements are of pivotal importance in experiences of the phenomena. As such, the crafting I presented in this thesis can be understood as the carrying on of anthropogenic and cellulogenic unfoldings. Crafting could be understood in fold with making and growing, concerning the sensory and haptic relations between livings. Folding into each other as movements of openness and forwardness, crafting is an improvisation, a making-in-growing.

A cellular anthropology focuses its attention on leaky boundaries, growth, polite inquiry, duration, and biotechnological mediations. Working with cells, this specific calibration of the researcher's attention reveals some of the intricacies of laboratory gestures. Setting out to understand skill (as coordination between action and perception within an unfolding field of relationships) and dwelling (as a perspective of immersion which situates the practitioner in an active engagement with its surroundings), Ingold (2000) proposes to overcome dualisms by putting forward the centrality of skilled practice. By trying to understand how humans and nonhumans relate to their surroundings, he also proposes that we are in processes of growth[14] (Ingold, 2000; Ingold & Hallam, 2014).

3.3 Bridging

In sum, this chapter served to present key tensions of crafting and living. Tissue culture led to a discussion on hands, tacit knowledge and new media. Broken pieces in the biolaboratory led to a discussion of hacking, sloppiness and problem solving. Finally, the work of Mike Bianco and the liveliness of bees and clay led us to questions of human and nonhuman livings in laboratories. Two authors specifically lead to a bridging of crafting with livings.

As previously mentioned, Paxson identifies cheesemaking as a practice of craft, which would involve sensory knowledge and intuition. When it comes to cheesemaking, there is a constant movement between what is practically apprehended and the protocol of practice. The same movement between gestures and rigid protocol was found through my experiences in the lab with various livings. The idea of synesthesia is also important in Paxson's account: "I extend this notion to get at how artisans "understand" milk and curd by allowing their sight, touch, smell, and taste to register through one another." (Paxson, 2013: 131). As such, this allows a return to the sensory experiences of engaging other livings and to the biotechnologies which mediate these relationships. For example, the temperature of a liquid, the colour of the cell media, the smell of

[14] In explaining this growth, Ingold positions himself against the dominant genetic paradigm, much as I do by focusing on the biophysical world of cells instead of their genetics. By addressing the limits of design, Ingold claims that our DNA is not a blueprint to our corporeal forms just as imagined ideas do not manifest themselves with exact precision when unfolding craftskills are at play (Ingold, 2000). In a similar fashion, working with cells does not entail designing or controlling their growth. Rather, the human hand gestures conditions of possibility where cells *themcellves* grow. In sum, livings may not be determined strictly by some genetic hegemony or even by organic *bios*, but they can be defined through their capacity to grow in their given surroundings. This also brings us back to the ongoing physical biohacking at the Pelling Lab which challenges definitions of biohacking referring only to genetic manipulations. In biolaboratories, there is the potential to hack and craft more than DNA sequences.

ethanol, the noise of the biosafety hood fans running: these sensory experiences help guide the gestures which unfold in the field. Unlike the making of cheese, which Paxson used to base her anthropological theory of craft, the culturing of cells *in vitro* takes place at microscopic scales. Biotechnologies give us the illusion of a direct manipulation of life through crafty practices. The contact between hand, glove, pipette and media is at once empirical and imagined: as Paxson states, "Experience counts." (2013:135). Within the practice of tissue culture, crafting imposes itself between protocol and biotechnological touch. You follow instructions only to experience something not accounted for. Beyond instructions, an aspect of craft present in the works of many (re)emerges in Paxson's account: craft involves a touch-based intuition of the unknowable, and such skill can be passed on between bodies and known through repetition. This alludes to tacit knowledge and the ideas that problem-solving unfolds as an improvisation on the field. As such, just like Andrew's knowledge of the craft was passed to his students, Sophie taught me how to move in the cell culture hood and laboratory. More importantly, she taught me how to feel cells. Guiding me through a pre-written protocol, Sophie carefully described how to handle each tool, how to position them in the biosafety hood as to most efficiently use the space. She told me that taping the side of that particular pipette gun gave it back its function if it got stuck. Something about the angle to take to aspire a cell solution through the pipette, and about how hard to press on the button to control speed as you mix the cell solution, cannot be read or simply known through a protocol: it has to be shared, sensed and practiced. And when new tools come around, one must (re)discover new crafts. These are the kinds of gestures I have attended my attention to in my research.

Tim Ingold's work also distinctly leads to a bridging of anthropology of life and anthropology of craft. Ingold's framework of making and growing has been introduced at various capacities. He identifies the process as "a carrying on – a passage along a path in which every step grows from the one before and into the one following, on an itinerary that always overshoots its destination." (Ingold, 2013a: 45) This allows a return to relational movement. By surpassing the distinction between growing and making, or natural and artificial, Ingold once again refutes hylomorphism and dualistic accounts. This also leads to shifting the focus away from finished craft objects, as every thing in the meshwork keeps unfolding, shifting and growing along others (2010). This helps me to develop my approach of crafting with livings: anthropologists, biologists, biohackers, and bioartists are not separate from their objects of study (other humans and other

livings, respectively), rather we are all part of the same processes of formation, participating in a dynamic meshwork of forces and energies. As such, Ingold doesn't refer to organisms as discrete objects but rather as things that unfold and take shape through movement. Knowing and growing are practices of correspondence: it is by being in the world and paying attention to other unfoldings that we can unfold with other materials, things, livings: "He is thinking with his eyes and with his fingers." (Ingold, 2013a: 111) This knowledge may not necessarily be identifiable through words, but the synesthetic unfoldings of crafting as understood through Ingold's framework allows to replace the gestures taking place in biolaboratories as a crafting with livings: the correspondence of Mike, *Candida albicans*, Tarsh, C2C12s, Andrew, unidentified fungal bodies, Sophie, bees, James, *Physarum polycephalum* as livings which unfold along the same lines while sharing spatiotemporal settings lead to the survival of fragile livings in a setting where the human hand and biotechnologies allow the living of materials themselves to unfold and form to emerge. In this sense, the gestures which compose the craft of mammalian tissue culture, for example, are necessary in order to permit further unfolding of corresponding forces such as experimentations with successfully grown cells. Through hands-on engagement with others, livings can then develop a specific type of sensitivity. In this sense, livings engage through an education of attention as they unfold along the same lines, and this allows skills and the mastery of crafting practices to emerge. By obtaining some sense of stability in my crafting practice of mammalian tissue culture at the Pelling Lab, I was able to further my research into crafty gestures at SymbioticA by continuing to pursue tissue culture and by being exposed to other crafting practices which involved livings such as fungi and amoebas. The haptic aspect of Ingold's meshwork (2013a: 136) allows to focus on the tactile and other sensory aspects crafting in biolaboratories; it refers to life not as an abstract or theoretical object but rather to living as unfolding physically in a field of emergent forces in relation.

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This third chapter addressed the literatures of crafting and living in relation to my fieldwork. This chapter also served to bridge the anthropology of craft and life to further support crafting with livings and to highlight different facets of the human-cell relationship.

4 Calibration

This fourth chapter is a generative dialogue with the concept of calibration in research. In anthropology, our main research tool is our attention. Having spent much time in biolaboratories calibrating biotechnological equipment, I explored the idea that anthropologists could calibrate their attention on the field and I specifically inquire about gestures and cellular anthropology.

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4.1 Calibration

Anthropological and social research can be concerned with things, objects or beings of different scales depending on the question one is researching and the approach that has been chosen to answer it. Modern proponents of ethnographic research and participant observation speak of a theoretical, analytical and empirical framework which allows the researcher to attune their attention to the relations in the world (Harvey, 2011). In this chapter, I will unpack two different scales of relationality in my research. Framed as different scales to which I have attuned my attention, this element of my research must be clarified because my work diverges from the usual scales of anthropological research. First, I will introduce practitioners' hands as necessary to engage in crafting, addressing the scale of gestures. Finally, I will describe some modes of attention one can harness to interact empathetically and politely with laboratory livings – I have framed this as cellular anthropology. This proposition opens up to the different ways in which we can navigate the multiple entanglements of biolaboratories.

I stumbled upon the idea of calibration during fieldwork, but especially in my first 10 months learning mammalian cell culture in the Pelling Lab. At the back of my lab book, for example, are notes which I recorded about the manipulation of microscopes: an upright phase-contrast/epifluorescence microscope and an inverted confocal microscope which could also be used for fluorescence. Calibration of the microscopes ensures a better capture, but it is also important for the processing of the images such as data analysis and volume visualization. For the confocal, I wrote detailed instructions about the on and off procedure to get the microscope going: power supply, body of the microscope, fluorescence box, computer, imaging software, etc. Most of my instructions refer to the shape or colour of the respective boxes and could only be understood by reading them next to the microscope contraption. Another interesting aspect of the confocal microscope was that it was calibrated with water. Before using the microscope to capture images

of samples, I had to place a drop of distilled water on the objective with a transfer pipette. Once the drop was placed and all the machines and software were on, I had the conditions of possibility to start acquiring. Most of the calibration I did when I used the confocal happened in (Nikon Instruments Software) NIS-Elements AR (Advanced Research).

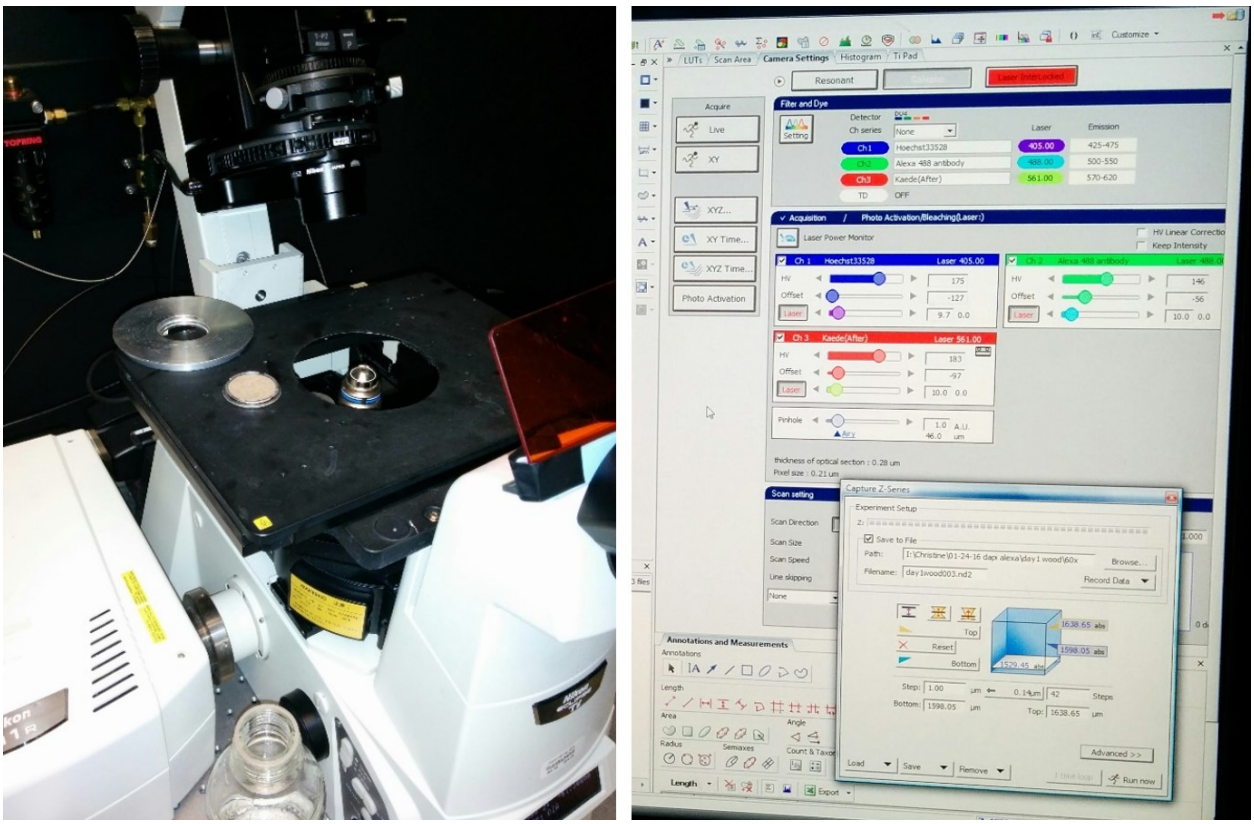

Figure 21: Confocal microscope and settings in NIS-Elements AR

In fluorescence microscopy, lasers of different colours are used to excite different photons. As such, the input channels sending the signals from the microscope to the computer need to be calibrated according to which stains and dyes were used to prepare the sample for imaging. As such, I set Channel 1 for Hoescht (this also works for DAPI stains), Channel 2 for AlexaFluor and Channel 3 for Kaede, which I was told was default. I also had to place the filters always on the last square. These were the main settings I used for every imaging session: after turning on the procedure, I would calibrate the tools to use for my purposes. Once everything was calibrated and ready to go, I could use various controls within the software to adjust saturation and other image settings while changing the fluorescence channel, magnification and focus required me to manipulate knobs on the microscope. For the other microscope which I used much less often, I learned the steps to calibrate the device for phase-contrast microscopy. First, I had to close a shutter

on the microscope, then I rolled a knob until a circle of light came into focus. To calibrate the microscope, one must use 4 little grey screws which are located above the eyepiece: by rotating the screws, the circle can be moved into the centre of the field of view. Once the circle is centred, you open the shutter again and are ready to go! Just like for confocal microscopy, NIS-Elements provided many additional settings and controls. In contrast with scientists' use of imaging, which aims to generate empirical data to be quantitively tested, my analysis of imaging techniques in the field goes beyond representation of reality. I consider these images as forms which emerged from unfolding entanglements. Anthropologically, these forms which appear to be frozen in time on the screen, can be reinserted in the movements of the world as new creative possibilities that give access to different scales of relationalities.

The notion of calibration came into play in more than just the microscope room! In fact, many machines in laboratories must be calibrated regularly for speed, timer, power or light accuracy. For example, a centrifuge must be calibrated when it is installed to ensure that it is safe and effective. There are ways to test the speed of a centrifuge and short protocols to execute which help determine if the settings need to be adjusted – this kind of calibration is not very frequent though it is very important. On a regular basis, I consider that each use of the centrifuge implies a certain act of calibration: the weight of each load needs to be balanced. During lab safety trainings, before I even set foot in the lab as a practitioner myself, I learned that centrifuge loads need to be symmetrically balanced in weight. These machines turn as very high speeds and an uneven load can lead to explosions and potentially deadly accidents. As such, every time I had to use the centrifuge (almost daily as it's essential to the basic procedure of growing cells *in vitro*), I had to pay close attention. For example, if I wanted to centrifuge a 10 ml solution of cells suspended in media inside a 15 ml Falcon tube, I had to add an equivalent tube filled with 10 ml of water and position it symmetrically opposite to my cell solution in the centrifuge. If I wanted to spin 2 tubes of cell solution of equal quantity, I didn't require the water tube and simply opposed my tubes. Another machine which required calibration at the Pelling Lab was the 3D printer. In order to print accurately on the printer stage, the 3D printer software enabled one to calibrate the axis. These laboratory gestures all concern the machines and equipment which allow us – as humans – to establish and sustain a relationship with cells of various scales, species, kingdoms. But, (bio)technologies in the lab can also calibrate themselves. For instance, the cell incubators are the most essential pieces of equipment in a tissue culture lab. Essentially a warm box kept at 37°C and

maintaining levels of CO_2 at 5%, incubators do not require daily manual calibration to create the desired milieu. Valves control the flow of CO_2 and electronics help set a precise temperature. These boxes – plastics and metals which serve to reproduce the basic conditions of mammalian bodies – calibrate the air in which fragile cells can survive.

To calibrate is "to determine the calibre of; […] To determine the correct position, value, capacity, etc., of; to set an instrument so that readings taken from it are absolute rather than relative (OED Online, 2017). I want to see calibration in anthropology not as a way to standardize or objectify, but rather as a way to be attentive to things, a way to invite ourselves to precisely attend to various ways livings unfold in the world. This chapter serves the same purpose as the laboratory gestures described above: safely and effectively determine the calibre of this project, the position of this research. In calibrating my research, I am correlating my fieldwork to the scales of attention which are standard in anthropology. I am introducing hands and gestures as well as cells as two scales of relationality which are seldom the focus of anthropological research. By calibrating my research to account for these scales where relations unfold, I am hoping to provide the necessary context and information for the reader to fully understand my proposition of crafting with livings. In this sense, my use of scale is not "reduced to a technical problem" (Tsing, 2015: 41). Beyond the biotechnologies which allow relationships to unfold between scales, my use of calibration takes on a new anthropological meaning: it allows to unpack the modes of attention which caught the researcher and further orients the evolution of fieldwork. Conceptually, anthropological acts of calibration can help adjust the dialogue between fieldwork experiences and literature and is central to the composition of the analysis. I will first unpack the importance of the human hand and gestures.

Figure 22: Flasks and Petri dishes inside a mammalian cell culture incubator

4.2 Gestures and hands

Gestes comes from the latin *Gestus* which means movement of the body, attitude. Working in biolaboratories undoubtedly brings into play questions of bodies and gestures as tools and (bio)technologies are manipulated. Once I was working in the lab and stumbled on Sophie, a physics PhD student working in the Pelling Lab. Sophie was also the grad student who first trained me to do mammalian tissue culture and some staining protocols. As we were discussing, I found out that Sophie had completed her masters in the field of theoretical physics. At that time, she was working daily sitting at a computer, working within complex software and mathematically manipulating numbers and variables. Though she had no prior training in biology, she had decided to pursue biophysics for her PhD based on day-to-day activities. She no longer wanted to spend hours on the computer, her body immobile with simply hands moving on the keyboard, alone. She told me how, since she arrived at the Pelling Lab, she was thrilled with the unfolding of her research and was happy with her transition from dry to wet physics. She learned to grow mammalian tissues and started building contraptions for cells using microfabrication technique. As such, while she was working on her experiments, she spent much of her time in the tissue culture and the microfab room manipulating, pipetting, tweaking materials which aren't visible to the human eye without a microscope. Though she missed some theoretical questions, Sophie also spoke about the skills and expertise she acquired and wished to continue lab work after her PhD. Ultimately, she would like to work in the biotechnology and specifically the biomedical industry, developing concrete tools that could help people in the real world. Through this vignette, we can

see how body, gestures and practices are part of emerging choreographies of livings in laboratory work.

Figure 23: Hand mortar and pestle used to crush DNA of fungi with liquid nitrogen

Sociologist Richard Sennett attempts to understand the skills of humans "making a life in common" (Sennett, 2008: 6). Sennett outlines that our bodies have the ability to be trained and that the hand holds potential: it is up to each and everyone of us to use our hands for the purposes we see fit. In this sense, each craftsman trains their hands through the repetitive enactments of their chosen approach to craft. The hand can also be a locus of touch, which brings materiality and haptics into question. For example, calluses that form from engaging repetitively into a specific practice are a trace of localized touch between hand and another surface (Sennett, 2008: 153). The idea of repetitive practice comes into play: movements are repeated, and a certain rhythm and posture is developed, it is through this long-term engagement that craftsmen can master a certain materiality and involve themselves emotionally or intellectually with materials (Sennett, 2008: 173). Ultimately, the unity of mind and hand is what leads to the emergence of a repertoire of learned gestures which can be practiced, revised, refined and changed (Sennett, 2008: 178). Through prehension and comprehension, Sennett argues that each step of the process should not only be understood as technical unfoldings but also as full of ethical implications which link back to polite inquiry. In this sense, we can understand every grip of biolaboratory consumables, tools and equipment as part of a broader repertoire of practices and gestures which can be practiced.

Growing with mammalian cells in the lab requires the unfolding of a distinct set of gestures. Protocols can give an indication of the steps one needs to take, but oftentimes tacit knowledge of growing cells as well as specific information related to the equipment and layout of the particular lab you're working in are not explicitly outlined in protocols. In this sense, biolaboratory work

relies on the improvised execution of a set of gestures. It must also be noted that each human adopts a different style of gestures. As previously stated, Sophie is the one who first trained me on how to engage in mammalian tissue culture in the lab, that is to say she introduced me to the protocol to grow cells. However, I engaged in other laboratory gestures which sometimes, or rather often, required me to ask for help. It was at that moment that I noticed that everyone had their own set of laboratory gestures: whether it was the angle at which they used the glass aspirator, the grip they have on the pipette, the exact sequence of actions, the organization of things in the biosafety hood… Working in biolaboratories revealed the multiple potentials of lab gestures. This was initially surprising, as science and laboratory work seem clinical, precise and homogenous if they are to generate objective data to be analyzed. The hand itself takes a role in biolaboratories as most of the manipulations require precise dexterity. Equipment, tools and biotechnologies are designed with humans' hands in mind and most of this apparatus which undergoes frequent and long-term manipulations often have grips and other features to facilitate prehension by the human hand and diminish fatigue. Ultimately, it is also through the gestures that our hands carry out the human-cell relationships that have emerged, been maintained and sustained and lead to a growing together of livings. By adopting gestures as a scale of relationality in my research, I can focus my research on the crafting aspects of the human-cell relationship. Gestures allow us to harness a mode of attention that focuses on the entire body in a move towards distributed cognition, sensory ethnography and the synesthetic experience of engaging (mammalian, plant, fungal, amoebic) cells seriously.

> Au lieu de rétrécir notre champ d'observation sur la lettre « morte » des textes, nous avons apporté une méthodologie qui est d'abord, et surtout, la prise de conscience d'un outil « vivant » : le Geste humain.
>
> L'Anthropos n'étant essentiellement qu'un complexus de gestes, nous avons ainsi, pour l'analyse de l'homme, l'outil le plus pénétrant, le plus opérant qui se puisse manier. C'est, pour ainsi dire, l'« Outil à démonter les outils ». Or, cet outil s'élabore instinctivement en chacun de nous et il s'affine sans cesse au fur et à mesure que nous en prenons une plus claire conscience.
>
> L'Anthropos, cette terre inconnue ! pourrait-on dire. Depuis quelques années, on commence à parler d'explorateurs des gouffres et des abîmes souterrains de la terre. On ne parle pas assez des gouffres et des abîmes souterrains de l'homme. (Jousse, 1969: 32)

Marcel Jousse's approach to an anthropology of gestures can be viewed as an attempt to describe, with a universal law, the reality of anthropos. Concerned with gestures, orality and

language, Jousse addressed the mechanisms of rythmo-mimicry, bilateralism and formulism as well as the idea that these gestures and actions inter-act and mingle (Jousse, 1969). While diverging from my framework in universality, this approach to gestures is coherent with the relational frameworks I adopt. Jousse has been consistently concerned with finding ways to widen our observational reach all the while focusing on the living moments we can reach as anthropologists (Jousse, 1969: 31). For Jousse, "Ce geste humain n'est pas métaphorique. Le Geste, c'est l'énergie vivante qui propulse cet ensemble global qu'est l'anthropos : *Vita in gestu*. C'est bien une chose qui joue, qui rejoue et que nous pouvons enregistrer." (Jousse, 1969: 50). Jousse pushes his theory of gestures further by claiming not that humans are only gestures, but that the underlying mechanisms of anthropos is a complex of gestures (Jousse, 1969). In this sense, gestures can be a useful point of entry to understand how different forms of livings emerge from the meshwork. As such, an anthropology of gestures relies on a mind-body monism which accounts for bodily manifestation of the cognitive and the social (Candau et al., 2012). I inspire myself from Jousse to consider the importance and centrality of gestures in understanding Anthropos who is not seen as a static entity but rather as an interminable complex of livings gestures (Jousse, 1969: 49). We are reminded : "On ne pense pas seulement avec les yeux et les mains […] mais « avec tout son corps », un corps dont les techniques sont largement façonnées par le social […] à l'intérieur d'un champ des possibles naturellement déterminé. (Candau et al., 2012: 10).

Artists, artisans, scientists, engineers, students, professors, designers, social scientists, parents, children, citizens, biologists and physicists, biohackers and DIYbiologists, makers, researchers… There is no clear label with which to characterize the human 'participants' of my research. The humans I encountered in the context of my research mostly came from different fields, have different backgrounds and gave themselves different labels. Some are Australian, Canadian, American, Japanese, from Indigenous roots, Israeli, English, French... Some are young, some are old. Some are female, male or trans. Some make a lot of money, some make less and some live in between. Some are of high socio-economical and professional status while others not. To be clear: I am positioning my questions in a flat ontological meshwork, which doesn't preclude the ontological plurality adopted by humans and other laboratory livings. My research question does not concern the numerous power relationships which could be identified, nor the cultural rituals and differences surrounding the practice of mammalian tissue culture. Rather, I have focused on what brings together these various livings I've encountered and the ways in which they

correspond. The common phenomenon to which I have chosen to attend is their engagement in material practices. To be even more precise, it is the way they all engage with living materials through laboratory practices and gestures. For different humans, these practices take different shapes (ex. mammalian tissue culture, cultivation of yeast, beekeeping, genetically engineering strains of fungi), but material engagement of practices involving biological systems within laboratory-like settings is the undeniable common criteria.

As such, a scale of attention that has become central in my research is gestures and specifically practitioners' hands. On the field, I have attuned my attention to the material practices and gestures which people engage in the lab and other related spaces. It is into the relations between human hand, plastic tools, glass tips, liquid medium, invisible microlitres of stains or proteins that I have inquired a new sense of what it is like to be in the world. In line with this thinking, Brinkmann and Tanggaard (2010) propose an epistemology of the hand. This epistemology is an attempt to dissolve the duality between creative thinker and craftsman; the implicit values of craftsmanship and hard work are portrayed as the conditions for creativity (Brinkmann and Tanggaard, 2010: 252). This approach ties with Ingold's approach of making and growing. Both Brinkmann and Tanggaard (2010) and Ingold (2014) speak of the transformative experiences of being in the world not only as research but as education. In the context of an epistemology of the hand, "if we use the hands to get better acquainted with the world, to get a better grip, learning involves moving *closer* to things, moving *into* the world." (Brinkmann & Tanggaard, 2010: 254). Finally, this epistemology of hands lends itself well to the study of laboratory settings where learning a craft comes from accidents and problem solving: "[I]n a research lab or workshop, little formal teaching takes place. On the contrary, research is learned by doing research, learning from mistakes, experimentation, and feedback. Feedback can be provided to the novice as a pat on the shoulder, and it can be felt by the novice as the right kind of feeling in the stomach." (Brinkmann and

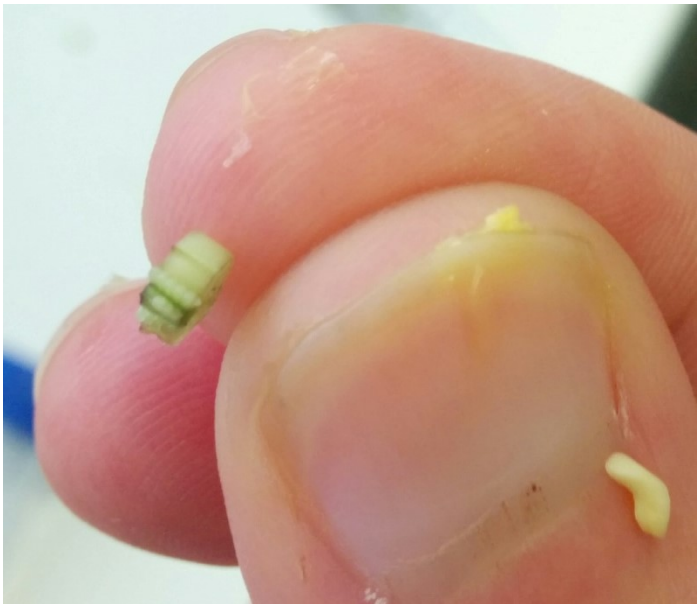

Figure 24: Hands-on engagement with livings during a plant tissue culture workshop

Tanggaard, 2010: 255) While attending to *gestures* unfolding in laboratory settings, I harnessed craft theory to clarify my inquiry into the vast realm of material practices and found hand fabrication is a core element of craftsmanship (Risatti, 2007; Metcalf, 2000; McCullough, 1996).

Additionally, the scale of gestures and the hand is relevant to the field of biophysics within which I was immersed during my research. Biotechnologies and the tools to work in laboratories with biological systems have mostly been built at the scale of human hands. Gloves generally come in four sizes (XS-S-M-L) and pipettes nestle themselves comfortably in the palm, the focus nudge on a microscope matches the size of your finger, the handle on the incubator doors match ones' grip. These tools allow us to transcend scales and to engage different modalities of relation with other livings. As such, I have learned to attune my attention to the scale of human hands in order to better understand the gestural relations at play in certain laboratory settings. In the last part of this chapter, I will unpack cellular anthropology as a specific mode of attention which can be helpful when working with cells.

4.3 Cellular anthropology

Rat, mice, horse, human, insects, yeast, fungal, amoebic… There is no clear label with which to characterize the nonhuman 'participants' of my research. Despite this heterogeneity in form, I have chosen to analyze my fieldwork in part by developing cellular anthropology. Just like the humans in my research which cannot be homogenized, the nonhuman livings which I've encountered also escape this homogeneity: they require different conditions to thrive, their care implies different protocols, some can thrive outside of biolaboratories and some cannot, some are found in the wild while others are bred specifically for lab work. Ultimately, biolaboratory gestures are what allows me to bring together these cells. Humans are not the only ones who are at play in this research project: rather, I attempt to give cells a place in this text. By considering that cells – though they don't have hands – engage in gestures in their own way, I can use the term livings to speak of both humans and nonhumans which I've encountered in the field. While gestures allow me to focus on the human hand, cellular anthropology allows me to adjust my attention – as an anthropologist carrying research in biolaboratories – to a scale that is useful to better understand human-cell relationships. It has been said that it is more useful to conceptualize beings as knots rather cells (Citton & Walentowitz, 2012). However, my cellular anthropology does not aim at conceptualizing things as cells. Rather, it is a calibration of one's scale of relationalities to better

attend to livings, some which are scientifically determined to be cellular but also livings who go beyond traditional definitions of the cellular. This proposition emerged inductively from my work in the field. In proposing a cellular anthropology, I wish to provide tools for researchers to problematize tensions of the cellular.

The life sciences have investigated the idea that cells are the basic unit of life. Ecosystems would be made through the bodies of complex and non-complex organisms, sometimes composed of organs which are in turn differentiated tissues formed through the agglomeration of enclosed cells. Shaped by a phospholipidic bilayer membrane, the biologically (as in scientifically) determined threshold to bios provides a sense of structure, function and reproducibility. The fifth edition of *Molecular Biology of the Cell* – "one of the classics for us" I was told by Andrew Pelling in our first set of e-mail exchanges at the end of June 2015 – tells us from the get-go that "all living things are made of cells, and that these units of living matter share the same machinery" (Alberts et al., 2008). Ideas about cells emerged after Robert Hooke's observation of cork under a compound microscope he built himself; he published the first drawing of cells and other microscopic creatures in *Micrographia* in 1665 (Wolpert, 2011: 12). The word cell takes its origin from the Latin *cellula* or *cela*, which means little room and referred to prisoner cells or monks' rooms (Wolpert, 2011). From the onset, the idea of the cell has been of closed yet porous membranes and discrete units. Classical cell theory emerged – penned amongst others by Theodor Schwann and Matthias Schleiden – as a theory not of cellular enclosures but of life itself (Wolpert, 2011). Defining living things as comprised of one or more cells, attributing this structure with the power of division, energy flow and differentiation, the limits of cell theory lie in the mystery of origins, the non-living viruses who nonetheless show signs of life and the animated independence of mitochondria and chloroplasts within eukaryotic cells (Wolpert, 2011) foreshowing symbiogenesis (Margulis & Sagan, 2002).

Throughout the years, Western biologists attempted to characterize cellular logics both in exploratory and applied settings. This cellular thinking and its living paradoxes have been guiding the study of biological systems from within the sciences for the past two hundred years. It joined the path of larger questions of universal bodies, of genetic diversification and of (ecologically linear) evolution. Steering the study of the organic in many directions, molecular and cellular biology found allies early on to reach new modalities of investigation of life and its basis. Science

met with engineering and something emerged though it had been prefaced at least since 1890: cells became a technology (Landecker, 2007: 1). 1907, the same year Henri Bergson published his *Évolution Créatrice*, marks the year Ross Harrison first sustained survival of *in vitro* tissue in experiments for weeks at a time (Landecker, 2007; Wolpert, 2011). This discovery centred itself on the Petri dish. The success of cell culture, then, is articulated around the biological plasticity of certain cell samples, which have proved more resilient than first anticipated, and around the establishment of a viable milieu: concoction of growth media and design of cell incubators. Fast-forward to the twentieth century: not only have enthusiasts of cellular biology managed to grow mammalian fragments of living *in vitro*, they unearthed an illusion of timelessness to this living materiality that can be frozen, suspended in time, and recalled to grow infinitely in some glass or plastic dish. Immortal lines, a practice co-engineered between cells' artificially autonomous reproducibility and Alexis Carrel's desire for control, had been first established through culturing embryonic chicken heart cells (Landecker, 2007: 16). The idea of a human body living in a dish started concretely forming itself. In 1951, Henrietta Lacks' cervical cancer was aggressive enough to subsist *in vitro* (Skloot, 2010): the disciplinary field of biology was forever transformed and "cell theory was thus definitely established." (Wolpert, 2011: 24) HeLa cells can now be found in laboratories across boarders, waters and lands in a transcendence reminiscent of the Anthropo(s)cene. As our use and conceptions of biology and biotechnology change, "the unit of the cell becomes more scientifically, technically, philosophically and economically important to how living things are thought about and manipulated." (Landecker, 2007: 7).

Living cells inscribe themselves in temporality: of cellular logics, of developmental biological processes, of human manipulation in time, of human conceptualization of biotechnologies and life. As Landecker importantly notes, "this assumption of living matter as technological matter is constitutive of life today, in terms of both how it is lived and how it is concretely approached, handled and manipulated" (2007: 2). Cellular biology and the advent of *in vitro* tissue culture marked a historic shift in human conceptualizations of the living. Widely spread in academic and industrial research settings (Landecker, 2007), tissue culture with its engineered nature has come to shape our idea of life as vital yet overwhelmingly material, with flickering degrees of movement. Entering a cell culture laboratory, I was taken aback by the apparent absence of the life presented to me. Wearing a white lab coat for the first time since a high school dissection, faced with black letters forming numbered lines on a white piece of paper,

entering a room with white lights shinning, only the blue of my gloves reminded me I was supposed to go meet something living. This falls in the tissue culture point-of-view introduced by Dr. Honor Fell and recounted by Susan Squier (2000): it raises questions about the boundaries between life and death, brings to light the scientific analogies drawn between animals and humans, fragments and whole, and allows a reinsertion of living movement in cellular biology (in opposition to sole histology). Squier notes that "[w]hile [Dr. Fell] purported to represent 'the tissue-culture point of view,' that was what neither she nor her researchers could do." (2000:45) The tissue culture point of view, while limited to our human perspective, allows us to grasp the changing mindsets of the researchers and scientists around the growth of mammalian cells *in vitro*.

I spent weeks making time between classes and meetings to come by the Pelling Lab to care for C2C12s. Putting on a lab coat, I walked into the cell culture room to find them. C2C12 is an immortal cell line of mouse myoblasts. Myoblasts are precursors of muscle cells, and the unique attribute of the C2C12 line is that they can differentiate into myotubes if grown in certain conditions. The origin of this cell line was a mouse of subspecies C3H, a female, which underwent serial passaging by Yaffe and Saxel in 1977. The Cellosaurus, an online resource that "attempts to describe all cells lines used in biomedical research", lists 5 ontologies of C2C12: BTO:0000165, CLO_0002071, CLO_0050871, EFO_0001098 and MCC:0000079 ("Cellosaurus C2C12 (CVCL_0188)", N.d.). Just as the names of most cell lines have been reduced to letters and numbers by biologists and biotechnologists, so have their ontologies. These numbers refer to various entries in databases, retracing, studying, a static rendering and the history of these cells: detailed with labels and subclasses, cell lines are mapped through a hierarchical system literally organized in the shape of a tree. Though this was the most easily accessible kind of information I found when I started tissue culture, I quickly realized much of my experience in the lab missing from scientific accounts. The language of the life sciences rendered itself inefficient and insufficient to my understanding of the human-cell relationship in its reduction of the living to taxonomical sterility. Already in the seventies, Latour and Woolgar spoke of the crafty character of scientific practice through daily *in situ* observation (1986 [1979]). By focusing on specific practices, practices of movement which support human relationships with laboratory livings, I am attempting to speak of a *cellular anthropology*. In doing so, I move away from static and objective biological consideration of cells to consider them as livings who grow and unfold in correspondence with other livings in biolaboratories.

To be precise, the size I had to concern myself with ranged from a few micrometres per cell (C2C12s and other mammalian tissues such as 3t3-GFPs and HeLa cells) up to several square metres per cell (*Physarum polycephalum).* Taking the form of both microscopic and macroscopic structures (ex. mycelium or fruiting bodies), fungus comprises quite a large range of complex eukaryotes. They can be unicellular or take filamentous shape. Fungal bodies were invisible on the woods and barks I sampled but quickly grew into visible colonies filling up entire Petri dishes 10 cm wide. In sum, different cells bind together differently and work within different regimes of cellular gestures and crafting.

This cellular anthropology addresses specifically the modes of attention one can harness to interact with laboratory livings. By paying attention to some of the acts-in-motions and tensions of the cellular paradigm, I hope to present a way to engage with cells through proximity, intimacy and empathy. Some characteristics of cells can be problematized – specifically by confronting biological and neomaterialist perspectives – and used to navigate fieldwork with biological systems of small scales. Cells are notably characterized by porous membranes which act as a boundary between said cell and other livings; as such they have leaky boundaries. Cells go through cycles of replications and engage in growth. Cells generally accomplish a function with brings us back to polite inquiry. Cells inscribe themselves in temporality but also experience duration. Finally, cells have become a (bio)technology. A cellular anthropology concerns itself with these cellular characteristics in an attempt to put them in tension, question them and explore the human-cell relationships to complement and go beyond the traditionally scientific approach of biology and biophysics. Cellular anthropology harnesses efforts towards better understanding the anthropological other that can be found in laboratory livings through an empathetic effort of accounting for different scales of relationality (Watts, 2013). I will now explain cellular tensions in more detail.

- **Porous membranes and leaky boundaries.** I have used the cellular idea of boundaries to artificially limit my fieldwork, all the while acknowledging the porosity of the membrane surrounding the artificially bounded space. I have also pushed the idea of a membrane by working with fungal bodies which are dispersed from the original fruiting bodies; fungi are also capable of engaging in horizontal gene transfer, a process which can put into question the hegemony of genes. Working with *Physarum polycephalum*, a large acellular amoeba

also allowed me to play with the idea of boundaries and membranes. When they meet, mycelium of slime mold merge. Therefore, only one membrane subsists between the amoebic living and the rest of the world and nuclei find themselves free flowing, exchanging genetic material within the large cell which is easily visible to the naked eye. Though cells are conceptualized as discrete objects in cell theory, cellular anthropology acknowledges the constant leakage which results from the concurrent crafting of livings. The lab itself can be seen as a kind of cell, with a porous membrane, allowing various things to enter its bounds and repulsing others. As such, a cellular anthropology is in sorts an anthropology which attends to movements of leaking.

- **Replication and growth.** The idea of replication – or growth – has also guided my inquiry into laboratory livings. An essential assessment of all my various livings in the lab that was performed either by naked eye or with the aid of a microscope and concerned the identification of movement, growth or replication amongst my samples. This ensured that I could know right away if my laboratory livings were living as expected, if they were having a difficulty adapting to an unknown element of their environment or if some stronger shock took the life from them. The idea of replication can also be put in tension when thinking about fungal bodies which frequently engage in horizontal gene transfers, therefore bypassing sexual modes of reproduction to transfer genetic information (it is interesting to note fungi can generally reproduce sexually and asexually). Ultimately, this idea of replication brings us back to processes of growth within biolaboratories. The idea of replication is also relevant to the study of gestures, specifically gestures in the context of crafting which involves repeated practice and imitation. As such, as the hand is practiced through performing biolaboratory gestures, it gains in efficiency and accuracy.
- **Function and polite inquiry.** The question of function can be applied to the literal function of the biological systems below my eyes (mammalian cells differentiate to fulfill different functions of more complex tissues and organs, slime mold is motile in search of food, fungi can disperse spores to reproduce or unleash molecules in the environment with potential for the better and the worst, yeast can latch onto human tissues, bees collect pollen which transforms into nectar in their stomachs and becomes honey as the water content reduces). Often, these last questions were framed and addressed by scientists as much as they were by artists. The idea of function of a craft objects is also quite central in craft theory. As an

anthropologist, the question of function enabled me to attune my attention to a specific aspect of the human-cell relationship: cells living in laboratories need human care to survive, just as human researchers need their laboratory cells to fulfill their experiments and thrive in the academic world. This specific attunement allowed me to uncover relations of symbiosis between practitioners' hands and laboratory livings, a relation which is mediated by tools, things, objects or chemicals which allowed me to transcend scales and engage laboratory livings. The idea of function helped me to better understand the various potential of different cells in relation to the surroundings in which we met and is a way for me to bring in the ethics of polite inquiry. By problematizing cells' functions, I can find ways to keep them interested.

- **Temporality and duration.** Temporality allowed me to always adapt my fieldwork to the rhythm of different laboratory livings. By following the temporality of laboratory livings, I negotiated different scales of relationality in my research around the moments where I had to feed cells, split cells, carry out cellular experiments, fix cells, mount cells, image cells, discard cells, sample cells and those moments where I worked with other humans. The linear appearance of protocols is stiffer than the temporality of experiments and care which is actualized in the presence of laboratory livings. The level of flexibility one could impose on those linear biological clocks was not always the same for all livings nor cells, some requiring more precise care than others, and it has been important to learn the ways and moments in which each laboratory living unfold. For example, I sometimes had to go to the lab on weekends because cells do not grow from 9-5 but rather in a continuous unfolding. Bergson's concept of duration is useful here (Bergson, 1907). Ingold and Hallam (2007) also address the question of temporality in improvisation through Bergson's duration. Bergson allows us to account for the importance of time as experienced, and not only as objectively measured. In doing so, he argues that life itself is a creative force, always moving forward and that this tendency cannot be scientifically harnessed. I acknowledge that other livings I have encountered in the lab have different durations, and that my fieldwork experience represents no more than the concurrent unfolding of our durations for a short time. The question of temporality and duration also reaches into questions of politely attending to livings encountered in the framework of my research and to wait for them when necessary. As such, this element is central to cellular anthropology.

- **(Bio)Technology**. Finally, it has been argued that cells have become a technology. The question of biotechnology imposes itself working in a laboratory with biological systems. The word *biotechnology* was used for the first time in 1919, in German by a Hungarian entrepreneur Karl Ereky who published a book titled *Biotechnology of Meat, Fat and Milk Production in an Agricultural Large-Scale Farm* (Stevens, 2016: 118). It is difficult to pinpoint a specific definition of a concept such as biotechnology because there are many perspectives. I will refer to Stevens' introductory definition to clarify the concept, but it is important to remember the tensions that surround it. As such, "biotechnology is a sociotechnical system in which some of the elements are active biological processes. […] Biotechnology is directed towards control over biological processes at the molecular level." (Stevens, 2016: 17-19) In other words, biotechnology refers to the emerging relations of interdependency established between biological processes and humans, with an emphasis on molecular or genetic control. One problem surrounding the definition of biotechnologies surrounds the opposition of 'old' and 'new' biotechnologies: some will argue that only modern biology can be considered biotechnologies while others support the idea that biotechnology has been around since the first attempts at agriculture and domestication more than 10,000 years ago (Stevens, 2016; Twine, 2010). For my present purposes, I will keep with Stevens' basic definition of biotechnology as a sociotechnical system. Herein I will refer to biotechnologies as "a whole complex of social and technical elements, only some of which need be strictly "biological." This accords well with usages of the term biotechnology not just to genetically modified mice or cell lines but also to laboratories, institutions, companies, methodologies and laws. Biotechnology is a whole system of animate and inanimate elements that must function together." (Stevens, 2016: 17) As such, biotechnologies will refer to the assemblage of tools, methods, protocols, materials and perceptions of some processes found in certain biological labs such as the biotechnology of tissue culture technology (Landecker, 2007) or the technique of polymerase chain reaction used in genetic research (Rabinow, 1996). This research project was enabled by the (bio)technologies to which I had access at the various labs where I worked. By keeping in mind the question of biotechnology and biotechnological mediations, researchers who work with cells can try to better understanding unfolding relationships in the laboratory and tie them to extra-biological institutions.

In sum, I have framed cellular anthropology as the harnessing of different cellular tensions to orient observational and empathetic efforts and to identify specific areas of relationality to which one should be attuned. Cells leak, grow, deserve to be taken seriously, experience duration and, in some cases, they are (bio)technologies.

***

This calibration chapter allowed me to introduce some empirical propositions derived from my fieldwork. This calibration was necessary to clarify the scales of relationality concerned by this thesis and to propose new ways of thinking the scaling of biolaboratory gestures as based not on proving but on probing. My research is situated in a specific sociocultural context of relationality which transcends national boarders and disciplines yet is anchored in four specific lab spaces (HAL, Pelling Lab, SymbioticA, Chooi Lab). This chapter specifically served to immerse the reader in the scales of relationality relevant in this project. First, the scale of gestures and the practitioners' hands allows one to bring their attention to the precise bodily movements at play when humans engage laboratory livings. Finally, I introduced the idea of a cellular anthropology. These different characteristics of cells have been put in tension throughout the thesis to account for my following of laboratory livings, both for cells of a few nanometres or a few centimetres. Just as the concepts of gestures and the practitioner's hand allow me to bring all the humans in my research to the same level, the idea of cellular anthropology can serve as a guiding principle for the study of many laboratory livings.

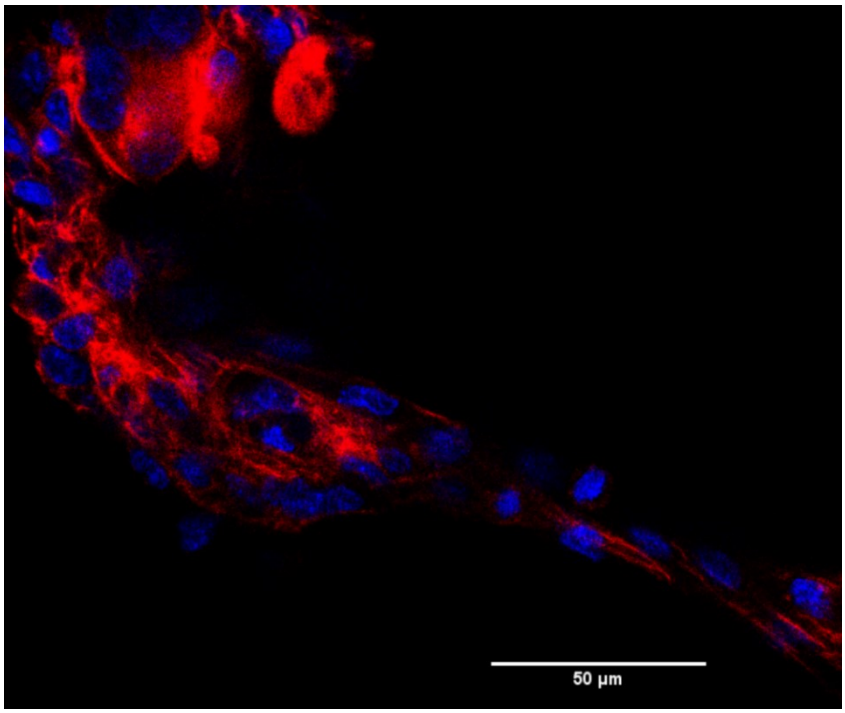

Figure 25: C2C12 cells stained with DAPI (nuclei) and AlexaFluor 546 (actin filaments)

Conclusion

I had some objectives when I set out to carry out my research in biolaboratories. In our increasingly connected world where open use of biotechnology is spreading rapidly, it becomes increasingly critical to acquire an anthropological understanding of how livings are conceptualized and engaged with. These emerging spaces of transdisciplinary dialogue have implications for policy makers and bioethics: with the tools available, people may engage in plant tissue and bacteria culture is already a common practice for DIYbio and artist communities. This has political, economic, ethical implications[15]. Beyond these sociocultural dimensions, the consideration of gestures, emerging movements and practices opens new possibilities about our understanding of what it means to be human when meeting and forming relationships with livings. In this sense, I consider my thesis to be akin to basic research pursued in the natural sciences. There has been no concrete, predetermined goals or questions which have guided my research other than trying to find a place for cells in my research. Rather, this research project is an attempt to contribute to our understanding of a simple anthropological question: how do we, humans, come to establish relationships with other livings? By considering crafting with livings, we have the possibility to change the way we think about laboratory livings and their capacities in relation to humans. I have thus proposed that through the lenses of gestures and cellular anthropology, we can better understand certain aspects of the human-cell relationship.

By seeking ways to account "for difference and novelty despite continuity" (Kohn, 2013: 226) – or as Bateson (1987 [1972]) says it regarding information, a difference which makes a difference –, I come to see how "every being, in its movement, stitches itself into the fabric of this world […]`, feel[ing] its way forward, following whatever clues it can pick up." (Ingold, 2013c)

[15] I acknowledge that the human-cell relationship could be problematized politically and ethically. Foucault's biopolitics could have been the main analytical lens to understand unfoldings in my fieldwork. Another lineage of research concerned with laboratories I could have followed is that of Paul Rabinow, Gaymon Bennett and Anthony Stavrianakis who have all authored works on collaboration between the human and natural sciences. In *Designing Human Practices: An experiment with Synthetic Biology* (2012), Rabinow and Bennett focus on the practices of synthetic biology to inquire, through collaboration, the ethics of flourishing. While this work is important, it uses concepts and sheds light on questions that were not at the centre of my inquiry, which had to be narrowed down given the brevity of a master's research. I preferred to focus on the leakages of cells growing *in vitro* and the gestures surrounding those encounters. As such, it is the practices surrounding biotechnologies which give me various access to cells and led crafting to unfold concurrently. As Rabinow and Bennett recognize, synthetic biology has the goal of creating new objects (2012: 3). For this thesis, I restricted my concerns while investigating our relationships with these *new* biological entities, which emerge when *new* people harness *new* biotechnologies and establish *new* ways of being in the world, through the idea of *crafting with livings.* Meanwhile harnessing *cellular anthropology* to calibrate my relational attention.

Both Kohn and Ingold strive for anthropology beyond humanity (Ingold, 2013b; Kohn, 2013) which moves away from the reductionist dualistic approaches. By cohabiting with nonhumans on earth, by "join[ing] with and learn[ing] from" (Ingold, 2013b: 21) cells, fungi, *Physarum polycephalum*, scientists, artists, I came to conceptualize them as something other than an object and I started to retrace the tensions of these visible and invisible relationships. Different modes of perception and attention, biotechnological, scientific, artistic, performative, hand-scaled, are all oscillations which reveal new things to see, yet also lead to the (re)emergence of new invisibilities.

By working on the idea of crafting with livings, I have been led to consider how anthropology itself is also a practice of crafting. In his historical account of the intellectual craftsman, Mills advises us in *The Sociological Imagination*:

> "Be a good craftsman: Avoid any rigid set of procedures. Above all, seek to develop and to use the sociological imagination. Avoid the fetishism of method and technique. Urge the rehabilitation of the unpretentious intellectual craftsman, and try to become such a craftsman yourself. Let every man be his own methodologist; let every man be his own theorist; let theory and method again become part of the practice of a craft. Stand for the primacy of the individual scholar; stand opposed to the ascendancy of research teams of technicians. Be one mind that is on its own confronting the problems of man and society." (Mills, 1959 [2000]: 224)

Some of this advice stands for my study of crafting with livings. I have attempted to develop my own approach as a learning student in the field of qualitative social sciences. Blending methodology, empirical work, philosophical questions and conceptual tensions, I've attempted to craft a study of the human-cell relationship which can contribute to our understanding of specific biolaboratory unfoldings. Gowlland addresses the question of anthropology as craft through images. As such, he discusses anthropologists who capture static and moving images to render visual accounts of crafting practices that can sometimes be difficult to write about. A different kind of sensory knowledge comes into play in the construction of the ethnographer if he chooses to report his fieldwork in images. Situating himself in Ingold's approach of skill and making, Gowlland attempts to show how craft "[s]kills are not 'correctly executed movements' but an ensemble of gestures and attitudes that are learned and fine-tuned in the context of the performance of making, and in dialogue with materials [Ingold 2000]" (Gowlland, 2015a: 294). In this context, the ethnographer himself leaks into the image of the craftsman when she participates along with the skilled artisan, who is then forced to slow down in order to initiate the novice to the gestures

of his practice. With his work, Gowlland wishes the emphasize the need for anthropologists to be reflective of their own use of images in the crafting of their ethnographic account on questions of craft (Gowlland, 2015b). Paul Atkinson is another author who has focused on the knowledge of creative works and craft as well as the creative workings and craftings of ethnography (2013a; 2013b). Atkinson pursued an interesting experiment: he subscribed for a one-day course in glass blowing and set out to engage a full day of immersive participant observation (2013a). Following this exercise, he set out to write out ethnographic accounts and compare them to another anthropologist who had studied glassblowing, O'Connors: the parallels between these works "are testimony to the robustness of the ethnographic gaze." (2013a: 403). As Atkinson states (2013b: 62), craftwork "is creative work, dependent on improvisation that is in turn dependent on repetitive, disciplined work. […] But, such work is never mechanical. It does not depend just on the precise replication of formulaic procedures. It depends on a creative, improvisatory engagement with several things." This applies to arts, crafts and performance just as it does to anthropological inquiry and specifically participant observation which is about learning by repetitively engaging in the daily life of others. Atkinson thus highlights that inquiry into craft practices is bound to lead to the (re)emergence of the same concepts and ideas throughout fieldworks (Atkinson, 2013b).

Anthropology itself, as an empirical discipline, is practiced in the field and through writing. The master's thesis is seen as the practice of a set of research gestures, going out in the field and coming back to write about it. As my first anthropological text, I am proud to present an inductive, empirical account which, I hope, shows crafty and polite efforts at accounting for the human-cell relationship.

Limits

All the while trying to be a good intellectual craftsman, my approach has its limits. New materialist studies within the ontological turn accounts are critiqued for giving ontological primacy to vital, animate matter embedded in relational flux as an *a priori*, all the while neglecting the role of social and mental representations (Sullivan, 2012). Another critique of works in the ontological turn and flat ontologies concerns their difficulties in dealing with minorities and questions of power such a race or species for example (Tompkins, 2016). In addition, works in this lineage can be critiqued as lacking abstraction to broader sociocultural issues by focusing too much on

personal and affective understanding of phenomena (Tompkins, 2016). These critiques can be applied to this thesis which does give primacy to matter in movement as such putting aside representations and power asymmetries. I have done so to focus on the continuity which we can find in gestures. My approach has focused itself on gestures and the cellular scale – as such, I have explicitly neglected to investigate political and complex social tensions which were present in the field. In some ways, my research also proposes to move beyond dualisms. However, ontological divides are sometimes harnessed despite my desire to bridge the gap; this critique also applies to Ingold (Gardner, 1988). As an example, I can highlight the inherent contradiction in my refusal of the species concept which is still used colloquially in my text to refer to different livings (ex. Protist, apples, mice, yeast, fungi, etc.). Additionally, I recognize the conceptual blurriness of terms such as entanglements, meshworks and relations. In another realm, movements, practices, actions (acts-in-motion), gestures and crafting also embody a certain blur. These are thoughts which I've mostly avoided to define in a static way to focus on the processual. The question which was ultimately addressed in this text was well suited within an inquiry of gestures and the cellular but other questions could have been addressed: imagination, ethics, collaboration, production of artworks and scientific works, politics of wet labs, questions of community, biosafety, etc. Finally, it must be noted that my propositions emerge from a particular anthropological fieldwork and participant observation; my methodology does not allow for generalization of these results to other fieldsites. In conclusion, I wish to outline limits to my proposition of crafting with livings to avoid it being harnessed pervasively, which would render its contribution meaningless. Crafting with livings then allows a focus specifically on gestures of livings, humans or not, which are articulated around some technology. My specific fieldsites led me to propose gestures and cellular anthropology to understand the unfolding of crafting with livings specifically in biolaboratories. These limits open up to further possibilities of study for future research projects – in the field and in writing – to speculate on the crafting of different livings and to better understand how livings (cor)respond.

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