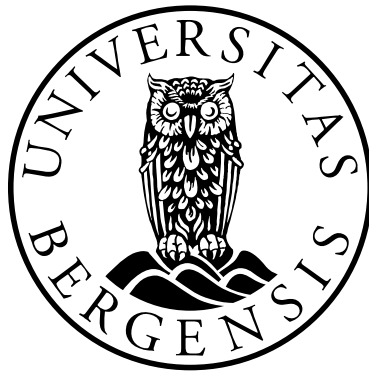


Amplifying Ambiguities

Art on the Fringes of Biotechnology

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Scientific environment

This four-year PhD project has been located at the Centre for the Study of the Sciences and the Humanities (SVT), University of Bergen, which has provided the candidate with working facilities. The PhD was supervised by Associate Professor Rasmus Slaattelid. The project has been funded by the Faculty of Humanities. Additional funding for travel was provided from the SVT.

I spent three months as a resident at the SymbioticA Centre for Excellence in Biological Arts, University of Western Australia, from February to May 2013, and benefited from the use of their facilities as well as the interactions with staff and residents.

The research group Images of Knowledge (formerly Cultural History of Nature) has provided a forum for discussion throughout the project.



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At the end of this four-year PhD project, I feel amazed and privileged at having been allowed to dedicate this time to work that has been meaningful, interesting, and fun, owing in large part to the wonderful people with whom I have been so lucky to work in the course of the project.

A thesis is never the product of just one person's work, time and interest. I am indebted to a great number of people, and can only mention the ones that have played the most distinctive roles here: Starting from the beginning, my sister Jenny, without whose ex.phil assignment I would probably never have veered towards the biological arts in my Master's thesis; and Siri Meyer, my Master's supervisor, who encouraged me to apply for the PhD position at SVT.

Being situated within the radically interdisciplinary environment at the Centre for the Study of the Sciences and the Humanities (SVT) has been a source of intense intellectual stimulation and the spiking of new research interests. During my years at SVT I have become enmeshed in a rare research culture that is concerned with research on knowledge, values and society, in disparate empirical settings. SVT practices a mixture of theory of science, science and technology studies (STS) and ELSI/RRRI (ethical, legal and social issues in science and technology/responsible research and innovation) research, and all of its employees possess a "double competency" (in theory of science, as we define it, and another subject ranging from physics to literature).

I am forever grateful to every single one of my SVT colleagues for their sustained encouragement, constructive criticisms, inspiring conversations, and mind-blowing lectures. At the SVT 25th Anniversary Conference, Fern Wickson initiated her talk with stating that SVT made her "the wonderful academic I am today". This is the effect SVT has on its emerging scholars: it inspires researchers to be reflexive, honest, curious, and rigorous (and with no hint of false modesty). Only some can be mentioned here by name: Rasmus Slaattelid, my supervisor, for reining me in when

my language got too poetic, and for otherwise allowing me independence. Silvio Funtowicz, Torjus Midtgarden, Ana Delgado, Helene Nilsen, Henrik Berg, and Jan Reinert Karlsen, for valuable feedback on drafts of individual papers. Anne Blanchard and Scott Bremer, for far-roaming lunch chats on long days of potentially lonely writing. And Tone Lund-Olsen, Idunn Bjørlo Tandstad, Line Nævdal, Judith Larsen, Sissel Småland Aasheim and Signe Solberg, for smoothing the process through their administrative genius at different points in time.

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Early drafts of the ideas presented in the articles of this thesis were presented at academic conferences, and I deeply appreciate the insightful comments, ideas and exchanges provided by conference participants at the S.Net meetings 2012-2014, the SLSA Postnatural 2013, The Posthuman: Differences, Embodiments, Performativity 2014, the ELSA Norway 2014, and the SLSAeu 2014 and 2015.

This thesis could not have come to be without the assent, collaboration and support from all the artists, scientists, engineers, hackers and makers who allowed me to study their work. To them I am most deeply grateful! Special thanks to the people who I worked, discussed with, and learned from at SymbioticA: to Benjamin Forster, Nigel Helyer, Shannon Williamson, Loren Kronemyer, Oron Catts, Ionat Zurr, Chris Cobilis, Cecilia Cmielewski, Guy Ben-Ary, Stuart Hodgetts, Stuart Bunt, Miranda Grounds, Greg Cozens, Devon Ward, Audrey Bester, Riley Zeller-Townson, and Andrew Lapworth.

To my friends, my family and my partner, who have been there for the tears as well as the joy: you make my life richer in so many ways.

On the Format of the Article-Based Thesis

Writing an article-based PhD thesis such as this one presents a set of challenges that are in important ways different from those of producing a monograph. For one, the formal requirements and limitations of the journals to which the articles are submitted inevitably pose restrictions on the length of the thesis, and as such, on what can be included. For another, the aims and scopes of those journals play into the angles of the individual articles, especially as comments from peer reviewers and editors play their part in the final shape of each article. This means that they might not be as coherent in approach as a monograph (see e.g. de Lange 2013). In addition, the stylistic requirements are quite different, not only in terms of styles of reference, but more fundamentally, in the linguistic style adopted by a certain disciplinary community. In a project such as this one, where the articles were angled towards quite different groups of readers, this was especially apparent.

However, the advantages of the article-based thesis are also substantial: The very brevity of the articles and the fact that publication is possible before the submission of the thesis means that more readers can access your findings, more quickly. And for a humanities scholar such as myself, who finds it natural to write expansively (my MA thesis was 120 pages), it constituted an important exercise in communicating lucidly in the most important format a researcher uses: the peer reviewed journal article. The compromise that I made in order to fit more information and reflection into this format was to include five articles – three is the minimum – and to write a longer introduction than the specified “same length as a normal scientific article in the research field in question” (Doctoral Education (PhD) at the University of Bergen 2009: 14). This is in the tradition of article-based theses delivered at SVT – all of which have had introductions of 40-70 pages – perhaps in acknowledgement of the grand Norwegian humanities tradition, in which a doctoral dissertation should be a tome of accumulated wisdom. As tomes go, the present work is a very lightweight one, but I hope this compromise has provided space for contributing in some small way to the knowledge pool.

Abstract

This doctoral dissertation presents a study of artists' engagements with wet biotechnologies, considering 'bioart' in relation to related approaches. Bioart is at present emerging as an important art form that enters directly into the sphere of biotechnology. Since its emergence in the 1980s, the phenomenon has evolved in parallel with the transition to the 21st century and what is often referred to, both optimistically and ominously, as the "biotech century". Today several hundred artists worldwide work with biotechnology. The thesis explores the tension between bioart's topical and methodological relationship to biotechnology, and its claims to some *other*, aesthetic quality defining it as art.

My thesis is empirically based on a case study performed at the SymbioticA Centre for Excellency in Biological Arts at the University of Western Australia. SymbioticA is an artistic research laboratory that invites artists in residence to do immersive lab research in order to develop their knowledge and ideas for bioartworks. The case study was supplemented by participant observation of other contexts, as well as visits to the exhibitions *Semipermeable(+)* and *Grow Your Own... Life After Nature*, and numerous conversations with practitioners during the period of 2012-2015. The thesis consists of five articles, bound together by an introduction.

Paper I discusses the hybrid field of 'artscience', as a wider context for the bioartworks studied in the other papers of the thesis. In the still emerging field of 'artscience', whose actors seek to combine the advantages and knowledges of the sciences with those of the arts and humanities, the idiom of the 'third culture' is common. How does terminology affect collaborations and ideas of interdisciplinary success stories in this field? I argue in this paper that the very term artscience, in simply joining together the words 'art' and 'science', is re-enforcing an old notion of a binary opposition between these two fields, building on a discourse from C. P. Snow's seminal Rede lecture *The Two Cultures* (1959). Furthermore, the term does not reflect the reality of interdisciplinary collaborations, which involves actors from multiple fields other than 'art' and 'science'. I suggest that this discourse may

occlude the multiple possible constellations of practitioners, roles and approaches, and thus be a potential limitation to real interdisciplinary collaborations.

In Paper II I introduce the concept of *fringe biotechnology*, in order to discuss bioart in relation to the younger movement of DIYbio, considering them as interlinked, and yet significantly different, practices. DIYbio consists of a diverse network of actors who use biotechnological methods for amateur and hacking purposes, and includes many bioartists. Since these approaches are thus closely related in practice, I argue that the lack of scholarly accounts and terminology connecting them seems to imply a continued fundamental divide between the *inside* of academic and corporate science, and the *outside* of public, social and cultural uses of the technologies. I suggest that the term ‘fringe biotechnology’ opens up for studying these practices across the inside-outside divide, and focus on four spaces of fringe biotechnology in order to illustrate this: The community lab Genspace in Brooklyn, NY, the artscience institution The Waag Society’s Open Wetlab in Amsterdam, the London Biohackspace and SymbioticA. Differences between practices, I argue, can be found as much within a single space as across these institutionally different laboratories. Both differences and relevant commonalities may be analysed comparatively when these practices are considered as examples of fringe biotechnology. Paper II thus presents an early contribution to scholarly thinking about these practices as interlinked.

Paper III starts with a description of the biological arts exhibition *Semipermeable(+)* (curated by Oron Catts, director of SymbioticA, in Sydney in June 2013), and then jumps back to describe the goings-on at the SymbioticA Centre in the previous months. I was a resident at SymbioticA from February to May 2013, and through participant observation followed the process of making the exhibition. During my residency, the *Semipermeable* exhibition was one of the main endeavours of the staff, and for some of the people more loosely affiliated with the Centre. The paper discusses a perceived “gap to the gallery”, considering that the *Semipermeable* visitors were not provided access to or information about the (bio)technological processes involved in making the artworks. What role, then, should dissemination

play in such exhibitions? While it is not necessarily problematic that different audience groups engage with the artworks at different levels of understanding, I propose that forms of dissemination that focus on both the technoscientific and artistic elements of the artworks may give gallery visitors new insight into how the artworks work *as art*, and thus contribute to the affective, visceral experience that such artworks can, in the best case, impart.

How may the open-endedness of bioart and speculative design act in communicating the topic of biotechnology, and specific issues within it? Paper IV discusses the *Grow Your Own... Life After Nature* exhibition (2013-14) at Science Gallery Dublin, which was presented as a “synthetic biology exhibition”. Considering this explicit framing, what conception of synthetic biology (synbio) was displayed through the contributions at the exhibition? In this paper, I discuss how the pieces in the exhibition relate to some institutional and corporate visions and practices of synbio, particularly in light of a conscious effort by synbio practitioners to shape public perceptions of the technologies. The framing of the exhibition may significantly influence the reception not just of the artworks but also of synbio, I posit, and conclude that the range of approaches and the open-ended nature of many of the pieces included in the exhibition imply that different visitors will interpret the exhibition, as well as the potentialities of synthetic biology, in very different ways.

Paper V considers artworks by the SymbioticA-based Tissue Culture and Art Project and their reception as the empirical starting point for connecting perspectives from art and morality discourses with those of bioethics, thus developing one possible ethics for bioart. I contend that consideration of what artworks can *do* is vital in validating ethically problematical applications of biotechnology for art, and argue that the affective, visceral qualities of *living* artworks may spur the audience on in developing their personal ethical framework.

In the introduction I give an overview of the terminology and literature about bioartworks, discuss the connections between these five articles, and consider how they may work to *amplify ambiguities*.

Sammendrag

Denne doktorgradsavhandlingen presenterer et studie av kunstneres bruk av bioteknologi, og leser 'biokunst' opp mot beslektede tilnærminger. Biokunst er en fremvoksende kunstform som går direkte inn på bioteknologiens område. Siden de første biokunstnerne startet på 1980-tallet har fenomenet utviklet seg parallelt med overgangen til det 21. århundre og det som ofte omtales, både optimistisk og illevarslende, som 'bioteknologiens århundre'. I dag jobber flere hundre kunstnere over hele verden med bioteknologi. Avhandlingen analyserer biokunst opp mot beslektede tilnærminger som biohacking og design, og utforsker spenningen mellom denne kunstens tematiske og metodologiske forhold til bioteknologi, og dens krav til en annen, estetisk kvalitet som definerer den som kunst.

Avhandlingen er empirisk basert på et case-studie utført ved SymbioticA Centre for Excellency in Biological Arts ved University of Western Australia. SymbioticA er et kunstnerisk forskningslaboratorium som inviterer kunstnere til forskningsopphold med sikte på å utvikle kunnskap og ideer til biokunstverk. Case-studiet ble supplert med deltagende observasjon av 'biohackere' og besøk til utstillingene *Semipermeable(+)* i Sydney og *Grow Your Own... Life After Nature* i Dublin, samt samtaler med kunstnere og biohackere i perioden 2012-2015. Avhandlingen består av fem artikler, bundet sammen av en innledende kappe.

Artikkel I diskuterer den tverrfaglige konteksten for 'artscience', som en bredere ramme for biokunstverkene jeg undersøker videre i avhandlingen. I det fortsatt fremvoksende feltet 'artscience', et engelsk begrep uten en norsk ekvivalent, søker aktørene å kombinere kunnskap og innsikt fra vitenskapene og kunsten, og idiomet 'den tredje kultur' er ofte å høre. Hvordan blir tverrfaglige samarbeid og ideer om hva som utgjør suksesshistorier på dette feltet påvirket av terminologien som brukes? Jeg argumenterer i denne artikkelen for at valget av ordet 'artscience', som simpelthen setter sammen ordene for 'kunst' og 'vitenskap', bidrar til å opprettholde en gammel binær opposisjon mellom disse feltene, og bygger på en diskurs som vokste ut fra C. P. Snows mye omtalte Rede-foredrag i 1959, *De to kulturer*. Videre

gjenspeiler ikke terminologien virkeligheten for slike tverrfaglige samarbeid, som involverer bidrag fra mange aktører fra andre felt enn 'kunst' og 'vitenskap'. Jeg argumenterer for at denne diskursen kan ha den effekten å skjule det store spekteret av utøvere, roller og tilnærminger feltet faktisk består av, og slik utgjøre en begrensning for ekte tverrfaglig samarbeid.

I artikkel II introduserer jeg begrepet 'fringe biotechnology' for å diskutere biokunst i forhold til den yngre bevegelsen 'DIYbio', og vurderer dem som både beslektede og forskjellige praksiser. DIYbio er et mangfoldig nettverk av aktører som bruker biologiens metoder i amatør- og hacker-øyemed, og inkluderer også mange biokunstnere. Siden de altså er tett forbundet i praksis, hevder jeg at mangelen på akademiske beskrivelser og terminologi som forbinder disse praksisene viser et fortsatt, grunnleggende skille mellom den *indre* sfære av akademisk og industriell forskning, og den *ytre* sfære av sosiale og kulturelle anvendelser av teknologiene. Jeg foreslår at begrepet 'fringe biotechnology' åpner opp for å studere disse praksisene på tvers av innside/utside-skiellet, og fokuserer på fire 'fringe biotech'-laboratorier for å illustrere dette: fellesskapslaboratoriet Genspace i Brooklyn, NY, kunst-og-teknologi-instituttet Waag Society's Open Wetlab in Amsterdam, London Biohackspace og kunstnerlaboratoriet SymbioticA. Forskjeller, hevder jeg, kan være like store mellom aktører og aktiviteter innenfor et av disse sentrene som på tvers av de institusjonelt ulike laboratoriene. Både forskjeller og relevante likheter kan analyseres komparativt om alle disse aktivitetene betraktes som eksempler på 'fringe biotechnology'. Artikkel II presenterer dermed et tidlig bidrag til akademisk tenkning om hvordan disse praksisene henger sammen.

Artikkel III starter med en beskrivelse av biokunst-utstillingen *Semipermeable(+)* (kuratert av Oron Catts, direktøren for SymbioticA, i Sydney i juni 2013). Deretter beskriver jeg hendelsene ved SymbioticA-senteret i de foregående månedene. Jeg utførte mitt case-studie ved SymbioticA fra februar til mai 2013, og fulgte gjennom deltakende observasjon prosessen med å lage utstillingen. Under oppholdet mitt var *Semipermeable*-utstillingen et fokus for arbeidet til de ansatte, og også for noen av kunstnerne som var mer løst tilknyttet senteret. Artikkelen drøfter *Semipermeable-*

tilskuernes manglende tilgang til hvordan disse kunstverkene ble laget gjennom (bio)teknologiske prosesser. Hvilken rolle bør formidling spille i slike utstillinger? Det er ikke nødvendigvis problematisk at ulike publikumsgrupper møter kunstverk med ulike nivåer av forforståelse. I tilfeller hvor verkene dreier avgjørende rundt en bestemt bioteknologisk metode foreslår jeg likevel at formidlingsformer som fokuserer på både teknovitenskapelige og kunstneriske elementer av kunstverkene kan gi galleribesøkende ny innsikt i hvordan disse kunstverkene fungerer *som kunst*, og dermed bidra til den affektive, kroppslige opplevelsen slike kunstverk, i beste fall, kan formidle.

Artikkel IV diskuterer utstillingen *Grow Your Own... Life After Nature* (2013-14) ved Science Gallery Dublin, som ble presentert som en utstilling som søkte å vekke diskusjon rundt syntetisk biologi (synbio). Med tanke på dette eksplisitte målet, hvilke ideer om synbio ble presentert gjennom utstillingen og dens ulike verk? I artikkelen diskuterer jeg hvordan bidragene til utstillingen forholder seg til institusjonelle visjoner og faktiske prosjekter innen synbio, særlig i lys av at syntetisk biologi-aktører bevisst søker å forme offentlig opinionen om synbio. Utformingen av utstillingen kan ha påvirket publikums oppfatning ikke bare av kunstverkene, men også av synbio, hevder jeg, og konkluderer med at det brede spekteret av tilnærminger og den åpne og tvetydige formen til mange av verkene i utstillingen innebærer at forskjellige besøkende vil ha tolket utstillingen, og ideene om hva syntetisk biologi er og kan bli, på svært forskjellige måter.

Artikkel V bruker kunstverk fra gruppen Tissue Culture and Art Project ved SymbioticA, og deres akademiske resepsjonshistorie, som det empiriske utgangspunktet for å koble kunst og moral-diskurser sammen med bioetikk, og utvikler slik en mulig etikk for bioart. Jeg hevder at etisk problematiske anvendelser av bioteknologi for kunst bør møtes med vurderinger av hva kunsten kan *gjøre*, og hevder at den affektive, fysiske opplevelsen av levende kunstverk kan anspore publikum til å utvikle sine personlige etiske rammeverk.

I innledningen diskuterer jeg sammenhengene mellom disse fem artiklene, og gir en oversikt over relevant litteratur og terminologi om levende kunstverk. Som tittelen

viser, søker jeg i avhandlingen å forsterke flertydigheter, og jeg vurderer i kappen hvordan de fem artiklene kan bidra til det.

List of publications

Paper I: Vaage, Nora S. (2015). On Cultures and Artscience. Interdisciplinarity and Discourses of “Twos” and “Threes” after Snow’s Two Cultures. *Nordic Journal of STS* 3(1), pp. 3-11.

Paper II: Vaage, Nora S. (forthcoming). Fringe Biotechnology. Under submission.

Paper III: Vaage, Nora S. (forthcoming). A Gap to the Gallery? A case study of the exhibition *Semipermeable(+)* and its makings. Under submission.

Paper IV: Vaage, Nora S. (2016). Grow Your Own Views on Knowledge. Visions and framings of synthetic biology, in N. S. Vaage, R. T. Slaattelid, T. Krigsvoll Haagensen & S. Smith (eds.) *Images of Knowledge: The Epistemic Lives of Pictures and Visualisations*. Hamburg: Peter Lang, pp. 127-159.

Paper V: Vaage, Nora S. (2016). What Ethics for Bioart? *Nanoethics* 10(1), pp. 87-104.

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1. Introduction: On the Fringes of the Biotechnosciences

Curiosity is endless ... in a way that answers are not

- Adam Phillips¹

If we see differently, we might think differently and act differently

- Siân Ede²

When a new process or product emerges from the laboratory, it undergoes a profound transition – from well-behaved, insular idea or object to a dynamic component of a complex interactive social system. Once embedded in that social system, the new idea or innovation may produce effects that are completely surprising

- Dan Sarewitz³

Biotechnoscience has been hailed by many as *the* science of the twenty-first century (Albrecht et al. 2010; Dyson 2007; Rifkin 1998). With its advent come hope and fear, and involvement from an increasing number of non-scientific actors. Among these actors are artists, who were among the first, in the 1980s and -90s, to realise how current advances in the biosciences could open up for new and inventive ways of using living matter in art. By now several hundred artists around the world use biotechnological methods directly, and even more artists reference them in “traditional” media. Other actors have followed suit in the last two decades. The

¹ Phillips, quoted in Baker 2000: 39.

² Ede 2000: 55.

³ Sarewitz 1996: 9.

DIYbio network, which includes numerous artists and is itself a related cultural approach to biotechnology, now lists about 4000 subscribers to their newsletter.⁴

This thesis studies the emerging phenomenon of ‘bioart’. It builds on an increasing amount of scholarship concerned with bioart, DIYbio, and other emerging practices that engage with biotechnology, as well as literature on ethics, interdisciplinarity and other relevant fields. Starting from a level terminologically “above” bioart, the article “On Cultures and Artscience” (hereafter “Paper I”) discusses the category of “artscience” and some of the challenges that such interdisciplinary endeavour encounters, providing historical and social context for the ensuing papers. “Fringe Biotechnology” (hereafter “Paper II”) relates bioart to DIYbio approaches, focusing on relevant similarities and shared spaces as well as important singularities of the different practices.

The primary object of study in the thesis is artistic laboratory engagements with wet biology, that is, using cells (bacterial, plant or animal), viruses, and higher living beings as media. An in-depth study of such practices is presented in “A Gap to the Gallery?”, hereafter “Paper III”. In “Grow Your Own Views on Knowledge”, hereafter “Paper IV”, I also discuss works which use other art media such as sculpture and photographs to speculate about the technologies and their societal impacts. In “What Ethics for Bioart?”, hereafter “Paper V”, I return to “wet” bioart and some of the ethical issues it raises, sketching a framework for the ethics of bioart that combines the approaches of bioethics and ethics of art.

A case study performed at the SymbioticA Centre for Excellence in Biological Arts at the University of Western Australia (UWA) forms the empirical basis of my work. SymbioticA is an artistic research laboratory which invites artists in residence to use UWA’s biology laboratories and learn from the scientific experts there, to acquire knowledge of biotechnological methods, develop research projects, and eventually produce biological artworks.

⁴ This number is assumed to be fairly equivalent to the current number of DIY biologists worldwide. For more on this, see the paper “Fringe Biotechnology”.

I came to SymbioticA with a deliberately open problem. During my residency at SymbioticA in the early months of 2013, a main focus of the work of the regular staff, and for some of the artists more loosely affiliated with the Centre, was the exhibition *Semipermeable(+)*. I therefore returned to Australia in June 2013 to see the exhibition, which was part of the ISEA in Sydney.⁵ The difference between the exhibited works and the research processes I had taken part in at SymbioticA informs Paper III. In January 2014 I visited the exhibition *Grow Your Own... Life After Nature* at the Science Gallery Dublin, which featured one of the works by Oron Catts and Ionat Zurr shown at *Semipermeable*, and was explicitly framed as seeking to raise discussion about the topic of synthetic biology. This exhibition is discussed in Paper IV.

Following the same, grounded mode of developing the research design, I decided during my case study to supplement the research at SymbioticA with participatory observation in a number of other contexts including community laboratories, workshops and conferences as well as conversations with practitioners.⁶ In the process of researching the connections between the different approaches I observed in these settings, supplemented by a literature review, I coined the neologism of ‘fringe biotechnology’ in order to capture *institutional, corporate and amateur engagements in biotechnology with non-scientific aims*. The concept of fringe biotech is developed in Paper II.

Bioart and DIYbio are, at present, global phenomena, with active practitioners on all continents. I have studied actors mainly in Anglophone (but also in Nordic) countries, because these approaches developed in the US, with significant early involvement in Australia, and I have chosen to engage primarily with major actors who were among the first to establish themselves as representing these emerging approaches.

This introduction aims to describe the connections between the research questions of the individual papers, and discuss the over-arching problem of the thesis. I also seek

⁵ The 19th International Symposium for Electronic Arts (ISEA) was a major art event, featuring more than 30 exhibitions across the city of Sydney as well as performances, workshops and a conference.

⁶ For an explication of the participant observation settings, see 3.2.

to place the research questions within a larger context, explicating the state of these practices and relevant research on which the thesis builds. In section **2.**, I discuss the problem and research questions of the thesis, what motivated them, and how they are reflected in the five papers. Thereafter, in section **3.**, I account for my fieldwork and methodology, also discussing issues of reflexivity, ethics and interdisciplinarity in the project. The following section expands on the context of bioart, presenting relevant literature on which this thesis builds as well as the terminology currently in use. I discuss the present situation of bioart, and reflect on its ontological, material and critical aspects as well as its existence within a logic of innovation. Expanding on the questions raised in Papers I, III and IV, I consider the relationship between art and science in section **5.**, before discussing ethical issues in art and other fringe biotechnology practices. Finally, I expand on the concept of ‘ambiguity’ as used in this thesis, explaining why I find it fitting to include in the title, before wrapping up and suggesting avenues for further work.

2. Problem

Bioart and DIYbio are emerging along with biotechnology as important cultural engagements with this field. In this thesis, I have been interested in the tension between bioart's topical relationship with biotechnology, and its claims to some other, aesthetic quality defining it as art.

2.1 Main Problem

The main problem I have sought to explore in this project is:

What is the specificity of bioart in relation to related phenomena on the topic of biotechnology?

The main contention of this thesis is that bioart is in important ways singular in its artistic approach to the biotechnosciences, and that it is simultaneously closely interlinked with the related phenomena of DIYbio and biodesign, as well as with biotechnology and the art world.

Various problems of these interrelations have been explored, in particular issues of collaboration (Paper I), communication and interpretation (Papers III, IV), and ethics (Paper V, and also Paper II). As a natural expansion of the main thesis, I have focused on issues of terminology. The terms used, I argue, have played an important role in the framing of these approaches in the minds of practitioners as well as the general public. Because I explore this issue from different angles in Paper I and II, I have chosen to include a review of the taxonomy of bioart in this introduction.

2.1.1 Rationale for the Problem, Part 1: Biotechnology

Biotechnology is one of the fields to which the highest hopes are attached when it comes to future research. It is often described with a “double definition”, as an ancient approach of affecting the environment through agriculture, breeding and fermentation, and a modern activity dating back to the development of recombinant

DNA technology in the early 1970s (Belt 2009).⁷ Today, biotechnology is a global endeavour, inextricably linked to issues of economy and politics (Thacker 2005). The “biotech revolution” has been announced by multiple actors, some with highly positive connotations (Bailey 2005), and some considering it as ominous (Nightingale & Martin 2004). While the proponents of biotechnology emphasise how it may help us cope with our grand challenges of our time, the opponents stress that there is a warning in how some of the “technological advances of the past reduced human freedom” (Fukuyama 2002: 15). Biotechnology also typically produces hybrids, which may be considered “disruptive” and even monstrous (Belt 1999: 1316).

In the last fifteen years, synthetic biology has emerged as a new field, continuing to some extent the approach of genetic engineering and becoming increasingly endowed with promise (Rinaldi 2012; Vinson & Pennisi 2011). The field is defined by its engineering approach to biology, and as such can be seen as the epitome of biotechnology. Researchers are currently engaged in projects such as modifying bacteria that can produce non-petroleum-sourced plastics, biofuels, and pharmaceutical drugs (Church & Regis 2012; Ro et al. 2006). At this point, real environmental changes are also being implemented (see e.g. Carvalho et al. 2015). The synthetic biology competition iGEM has been important in the emergence of the DIYbio movement (Landrain et al. 2013), and an increasing number of artists as well as hackers and other amateurs are engaging with this technology and its future visions.

Sheila Jasanoff has observed how “[w]hat happens in science and technology today is interwoven with issues of meaning, values, and power in ways that demand sustained critical inquiry” (2004: 15). Many have pointed to the urgency of increasing public and expert understandings of biotechnology and the ways in which it might shape our contemporary and future societies (Fukuyama 2002; Pandilovski 2012). Bioart, several scholars posit, can function as critical inquiry of biotechnology, or stimulate such inquiry (Andrews 2007; Mitchell 2005).

⁷ The term was coined in German (‘Biotechnologie’) in 1919 by Karl Ereky, a Hungarian economist, to describe the interaction of biology and engineering in animal husbandry (Bud 1993).

2.1.2 Rationale for the Problem, Part 2: Bioart

Since its emergence in the 1980s (Gessert 2010; Reichle 2009), bioart has in the 2000s developed and spread to a global scale. The art form is by now quite institutionalised: the SymbioticA Centre is joined by an increasing number of other artist's residencies and laboratories (see Paper I), most of which are based within fine arts departments. Concurrently, a number of artists work in community laboratories, defining their practice also as DIYbio, as I discuss in Paper II. Bioart and other forms of artscience are being discussed, practiced, shown and disseminated in conferences, workshops and seminars across a number of fields. The scholarship on these practices is quickly accumulating into a rich knowledge pool on which this thesis builds, and to which it seeks to contribute.

Many scholars and journalists have discussed bioart as a way of inducing reflection about the procedures and the future of biotechnology (see e.g. Andrews 2007; Anker & Nelkin 2004; see Paper V). Curator and art theorist Jens Hauser, who according to George Gessert (2010: 2) more than most has “addressed philosophical, aesthetic, and art historical issues” of bioart, has acknowledged how bioart “is currently addressed less as art and more as a discursive and often instrumentalised form of contributing to ongoing public debates beyond the aesthetic realm” (Hauser 2008: 83). In this, he follows others who have pointed out that the tendency to consider bioart primarily as a means for discussing issues of biotechnology disregards its artistic properties, and have sought to focus more on the nature of bioart *as art* (Bureaud 2002; Gessert 2010).⁸ In this thesis, I seek to address this tension through balancing bioart's topical relationship to biotechnology with discussion of its art-specific properties.

2.1.3 The Problem in Light of Biotechnology and Bioart

This thesis seeks, then, to consider the singular nature of bioartworks directly up against the complexity of the art form's relationalities, through studies of its interrelations with DIYbio (Paper II), bioethics (Paper V) and biotechnology (Papers

⁸ See 4.1-4.3 for a discussion of different approaches to bioart in the literature.

II, III, IV and V). In the course of the thesis I discuss these relationships from multiple theoretical perspectives.

The question of the singularity of bioart in the social sphere of biotechnology, as such, serves as a starting point to analyse the relationship between bioart, DIYbio, and design, as well as representations and disseminations of experimental life sciences (biotechnosciences). The coaction and tension between these activities provide a basis for commenting on topics of biotechnology, and developing materialised living objects that may shape our visions of a potentially biotechnologically transformed future. How does the status of these materialised objects *as artworks* function to make them different from other approaches? This is discussed from the perspectives of the artists and their collaborators in Paper III, from the perspectives of scholars in Paper V, and in a comparison with DIYbio in Paper II. I follow Robert Mitchell (2010) and Joanna Zylińska (2014) in arguing that the affective, embodied nature of bioartworks and their ethical dimensions are important in considering these pieces *as art*.

2.2 Papers I-V: Research Questions and Findings

The main problem has been investigated through five research questions, each discussed primarily in the paper corresponding numerically. The research questions grew out of a grounded approach (Geertz 1973), emerging as my research at SymbioticA and subsequent participant observation at Genspace, Biohackspace London, and Science Gallery Dublin unfolded. The grounded approach was chosen because it gives opportunity for identifying novel problems through observation of the situation in the field.

2.2.1 Paper I “On Cultures and Artscience”

Bioart is generally considered part of ‘artscience’, whose actors seek to combine the advantages and knowledges of the sciences with those of the arts and humanities, in what is often referred to as a ‘third culture’. Based on the observations and stories of collaborative efforts at SymbioticA, I developed *RQ1*: How does terminology affect

collaborations and ideas of interdisciplinary success stories? Specifically, as I ask in Paper I: how do discourses about artsience relate to current practice in hybrid projects? And why are ‘the two cultures’ so often invoked to explain difficulties in collaboration? I argue in this paper that the very term artsience, in simply joining together the words ‘art’ and ‘science’, is re-enforcing old notions of a binary opposition between these two fields given weight through the discussion following C. P. Snow’s 1959 Rede Lecture, *The Two Cultures* (1998). This binary distinction is still implied within the image of a ‘third culture’, and serves to disguise the plurality of perceptions and approaches within and across fields. While useful in pointing out shortages and difficulties of communication between fields, the binary discourse tends to overemphasise divisions, ignore complexities, and, in some cases, remain inarticulate on important parts of the picture. I suggest that the discourse of the ‘third culture’ and the term ‘artsience’ may jointly occlude the multiple possible constellations of practitioners, roles and approaches, and may be a potential limitation to interdisciplinary collaborations that involve multiple fields and result in hybrid products.

2.2.2 Paper II “Fringe Biotechnology”

In the course of my research it became apparent that the practices of DIYbio and bioart are closely related. However, this has rarely been reflected in scholarly work. Although recent accounts of DIYbio often mention that artists and designers are deeply involved (Delgado 2013; Seyfried, Pei & Schmidt 2014), there has as of yet been little academic discussion with regard to *how* they in different ways contribute to the cultural and societal sphere surrounding biotechnology. Similarly, scholars of bioart may observe that its practitioners have engaged in DIYbio activities, without expanding further upon how these artists work differently from other DIYbio actors. *RQ2* was designed to come to terms with these issues: How can one conceptualise the ways in which DIYbio and bioart are interlinked and yet significantly different practices? As already mentioned, this question inspired the neologism ‘fringe biotechnology’, introduced in Paper II. This term includes institutional, corporate and amateur engagements with biotechnology from non-scientific perspectives. While

‘DIYbio’ has in recent years become a term that covers a wide range of hobbyist approaches to biotechnology, it still excludes many other alternative approaches, including artistic activities in institutional labs such as SymbioticA. I argue in Paper II that this implies a continued divide between the *inside* of academic and corporate science, and the *outside* of public, social and cultural uses of the technologies. I suggest that the term ‘fringe biotechnology’ opens up for studying activities that engage differently with biotech across the inside-outside divide, and present a range of examples of fringe biotechnology departing from four of its spaces: The community lab Genspace, the arts/science institution The Waag Society’s Open Wetlab, the London Biohackspace, and SymbioticA. As a study of these spaces show, art and design practices are found both in institutions and in DIYbio laboratories. Considering their coexistence in the same spaces, the demarcation between art and design and other DIYbio activities (biohacking and science communication) on the theoretical level is notable. I argue that it is a reflection, in part, of relevant differences. However, these very differences as well as relevant commonalities may be more distinctly explored in a comparative treatment. Paper II thus presents an early contribution to scholarly thinking about these interlinked practices.

2.2.3 Paper III “A Gap to the Gallery?”

The experience of participating in artistic research processes at SymbioticA, and then seeing the exhibition *Semipermeable*, led to *RQ3*: What is the connection between process and presentation in artworks created in the wet biology laboratory? More specifically, in the case of an exhibition of artworks created using scientific methods, what would be the benefits of allowing the research process to be apparent in the resulting artwork, and what, conversely, might inform the decision to leave out of the exhibition most traces of the process? These questions form the basis for Paper III, which discusses a “gap to the gallery” which is, arguably, particularly prominent in art production based on knowledge of scientific technique, collaborations, and laboratory work. The *Semipermeable* exhibition presented its twelve artworks, all by artists with current or former connection to SymbioticA, in the context of the theme of the membrane, interpreted widely as dealing with semi-permeable boundaries from

cell membranes to state borders. While this topic was relatively clear throughout the exhibition, I argue in Paper III that the research done by the artists and their collaborators may fluctuate between *semipermeable* and *impermeable* to gallery goers, in that they might get some sense of the (bio)technological processes involved, but not really be given opportunity to understand much, either of the artworks themselves or the methods with which they were made. I illustrate this through an account of the research processes I observed at SymbioticA, and discuss the choice of leaving process-oriented elements out of the exhibition. One reason for excluding the process from the exhibition was the wish to emphasise the artistic elements over the technoscientific. Sometimes, however, this very desire may represent a limitation in the potentiality of the artworks to communicate their inherent issues. For instance, I argue that the fusion of immortalised human cells with primary white blood cells from a mongrel dog in the artwork *Kynic* by Benjamin Forster is particularly appropriate for *Semipermeable*'s theme of the membrane, as it involved actually dissolving the membranes of the cells, and consequently that the choice of not communicating this aspect of the process to the audience detracts from the potency of the finished artwork. I also point to the repeated statement from the artists and scientists at SymbioticA that these artworks are often misunderstood and misrepresented, and observe that this may be a direct result of the open-endedness of the piece.

What role, then, should dissemination play in such exhibitions? I note that the most renowned bioartists are typically ones who write copiously about their work, which seems to suggest that insight into the ideas and processes behind the artworks adds to the audience's fascination with the artworks. While it is not necessarily problematic that different audience groups engage with the artworks at different levels of understanding, I propose that forms of dissemination that focus on both the technoscientific and artistic elements of the artworks may give gallery visitors new insight into how the artworks work *as art*, and thus contribute to the affective, visceral experience that such artworks can, at their best, convey. Choices regarding how artworks should be communicated, how art should relate to (scientific) facts, and

which liberties artists can and should take, are important topics for discussion both among artists and scholars, and I continue the discussion of this in Paper V.

2.2.4 Paper IV “Grow Your Own Views on Knowledge”

In light of the discussion about communication of biotechnology in Paper III, and within the general focus on ambiguities and open-endedness, another research question emerged: *RQ4*: How may the open-endedness of bioart and speculative design act in communicating the topic of biotechnology, and specific issues within it? How does the topical relation to biotech affect other qualities of the artworks? In Paper IV (published as a book chapter), these questions are explored through discussion of the *Grow Your Own... Life After Nature* exhibition (2013-14) at Science Gallery Dublin. Specifically, I ask in the paper: How did the framing of *Grow Your Own* (*GYO*) as dealing with synthetic biology influence visitors’ perception of the exhibition, and their impression of what synthetic biology is? What conception of synthetic biology was displayed through the contributions at the exhibition? And how does this conform to, or diverge from, descriptions and depictions of synthetic biology by experts? I approach this in a comparative manner, starting off by discussing some of the discourses and practices of two established synthetic biology practitioners, Craig Venter and George Church. Then, I analyse how the objects and images in *GYO*, created by designers, artists, hobbyists, and students of synthetic biology, used a wide range of cultural and scientific expressions to disseminate projects, problems, and possibilities in synthetic biology (synbio) – without necessarily showing what synbio is, today. I discuss the aesthetic and material means used, and how they relate to institutional and corporate visions and practices of synbio.

The framing of the exhibition works on several levels, I argue: the exhibition is framed by the topic of synbio, and the individual works are framed as being concerned with that topic. In addition, the exhibition proposes a frame *for* synbio. These framings, I posit, may significantly influence the reception not just of the artworks but also of synthetic biology. I propose that this seems to converge with a conscious effort by synbio practitioners to shape public perceptions of the

technologies (for more on this, see section 5. of this introduction). The range of approaches and the open-ended nature of many of the pieces included in the exhibition suggest that different visitors will interpret the exhibition, as well as the potentialities of synthetic biology, in very different ways. The very subtlety and open-endedness of these pieces, I argue, may lead to confusion for audience members who have little or no previous knowledge of the still emerging field of synthetic biology. From my contextualist position (see Paper V) this conclusion is based on the explicit framing of *GYO* as seeking to achieve discussion of synbio. Despite this caution, I conclude that the exhibition manages to create a balance where open-ended works still give room for a multitude of reflections. This function of inspiring the audience to reflect on what future they want technology to bring about, I further argue, is important. Awareness of how the frames involved may shape audience reactions might serve to induce more nuanced reflections.

2.2.5 Paper V “What Ethics for Bioart?”

Living artworks created through biotechnological methods give rise to a range of novel ethical questions, such as: How does the artist relate to the ethical issues of biotechnology? What levels of verification should be expected, and what are the limits of acceptable manipulation of the living for art? (see e.g. Levy 2006). These questions are often treated within the framework of ‘bioethics’, the ethics of the life sciences. Existing discussions on art and morality are rarely taken into account. Departing from this observation, I developed *RQ5*: How are ethical issues in bioart discussed? How could discussions of the ethics of bioart be improved, making it more relevant for practice? In Paper V, I argue that the framework of bioethics is not sufficient when dealing with art, because it is not equipped to deal with art-specific questions. Therefore, I suggest that art and morality discourses *combined with* bioethical questions can give increased depth to both the understandings and ethical discussions of bioart. Such discussions, I suggest, can inspire new ways of thinking about art and morality, as well as about bioethical issues. Taking discussions of artworks by the Tissue Culture and Art Project as my point of departure, I connect perspectives from discussions of art and morality with those of bioethics, thus

developing one possible framework for ethics of bioart. This framework forms the basis for an analysis of different ethical stances on bioart, and I suggest that the art-specific effect of these artworks must be taken into consideration in ethical discussions of bioartworks. The affective, visceral qualities of living artworks may, I argue, spur the audience on in developing their personal ethical framework.

2.3 The Five Papers in Light of the Main Problem

Through the five papers, I seek to tease out different aspects of the specificity and relationality of bioart as set within the larger category of ‘artscience’, artistic approaches directly engaging with scientific methods and topics. Multiple themes emerge that recur in several of the papers.

The first of these themes concerns the relationship between artistic and scientific topics, messages and worldviews. As I discuss in Paper I, equal collaborations and outcomes that serve both artistic and scientific aims are considered as ideal by most actors in this field, but this ideal is often seen as difficult or close to impossible to achieve (contributions from other fields than ‘art’ and ‘science’, as I point out in Paper I, appear largely to be considered of secondary importance). Papers III and IV depart from exhibitions that respectively privilege the artistic and the scientific topic. In section 5. of this introduction, I further discuss perceptions of how art does and should interact with science.

A second theme regards problems of dissemination and communication in art that deals with biotechnology. Whilst also a topic in Papers I and V, Papers III and IV specifically explore different aspects of these problems. Paper III focuses on the potential impermeability of the technoscientific components of the artworks, specifically when this is amplified by choices that emphasise the artworks’ status as art, whereas Paper IV is concerned with the problem of an exhibition claiming to be specifically about a certain biotechnological approach, that of synbio. As such, their discussions have some commonalities, but also approach the problems of dissemination from quite different angles. *GYO*, as opposed to *Semipermeable*, was highly interactive, and focused on fun and tinkering. *Semipermeable*’s “do not touch”

signs were a signal that the living artworks were either fragile, or potentially dangerous, or both, and thus served to emphasise the very *presence* of the artworks in the same space as the visitor. *Semipermeable*, through its very lack of explicit focus on the technologies behind the artworks, may have left audience members more cautious about biotechnology's potential applications. The problems of terminology and discourse covered in *RQ1* are discussed particularly in Papers I-II, but also in Papers IV and V, and relate directly to the theme of the relationship between scientific and artistic goals.

Artist duo Oron Catts and Ionat Zurr, the only permanent artists at SymbioticA, have been important figures in my study. Their approach is discussed particularly in Paper V, but they figure to varying extents in all five of the papers. Catts and Zurr's artistic work aims to be open-ended, but their academic articles make explicit criticisms that are also inherent in their work. Their critique is predominantly directed towards the conceptualisation and particularly the hype surrounding new technologies and applications of technologies, as exemplified in their *Victimless Utopia* series, which engaged materially with the idea of creating meat and leather in vitro, and their more recent work on "the substrate", *Crude Matter* (2012) and *The Mechanism of Life – After Stéphane Leduc* (2013), which deal with synthetic biology. *The Mechanism of Life* was included in both *Semipermeable* and *GYO*. Paper IV discusses *GYO*'s conceptualisation of synbio, and visions of its potential applications. Within this, I consider the engineering mindset as embodied in synbio – developing the notion of "life as code" (Thacker 2005) into the idea that living matter can indeed be standardised and made into "living machines" – which is a recurring topic in Catts and Zurr's critique (see e.g. Catts & Zurr 2010). However, their ironic approach and wish to keep their artworks open-ended may, in many cases, mean the critique is so subtle as to be easily lost in the context of the exhibition, and I argue in Paper IV that this is to some extent the case for theirs and other artworks in *GYO*. The issue of what message is conveyed through bioartworks is further considered in Paper V, in relation to the question of ethical considerations of such artworks. As such, *RQ4* is also considered in Paper V.

The approach to a bioart ethics presented in Paper V highlights the specificity of bioartworks' status as art. However, some of the questions posed about these artworks may relevantly be transferred to DIYbio or fringe biotechnology as a whole, in order to develop a more mature ethics of these activities, as I suggest in Paper II (which, thus, also deals with *RQ5*). This approach is not elaborated in Paper II, but is discussed further in section 6. in this introduction, and forms one of my suggestions for further work within this field.

The need to consider the particular, art-specific issues concerning bioart is thus continually held up, in this thesis, towards the importance of realising its functions as engaging with and commenting on biotechnology, and its interactions and overlaps with DIYbio and design activities. Bioart is singular, compared to these related approaches, in that it is presented and received as art, but should also be considered, I argue, as an activity that comments directly on science in society.

3. Empirical Material and Methodology

3.1 Case: SymbioticA

For three months early in 2013, I was a resident at the SymbioticA Centre at the University of Western Australia (UWA). I was an active participant in the day-to-day work at the centre, observing, learning techniques and assisting other residents where I could. Since Latour and Woolgar's *Laboratory Life* (1986 [1979]), observation and participant observation in laboratories have become increasingly common. And, in fact, the much smaller phenomenon of artists in labs has also been studied by scholars from a range of fields, from human geography via media studies to art history.⁹ Similar to studies of scientific projects, such research can shine light both on the significance of the artistic projects and the problems encountered in transferring the artistic research into an object outcome – the artwork (see e.g. Scott 2006).

When SymbioticA was founded by artist Oron Catts, neuroscientist Stuart Bunt and cell biologist Miranda Grounds in 2000, it was the first of its kind: an artistic research laboratory that used actual biotechnology and scientific methods to explore the possibilities they opened up for in the creation of works of art. The Centre began its first undergraduate unit in 2002 and in the next few years started several others, expanding to a Master of Biological Arts in 2006.¹⁰ Today SymbioticA is a Centre of Excellence in Biological Arts within the School of Physiology, Anatomy and Human Biology at the UWA. As a division belonging to a university institution, but with the explicit purpose of producing artworks through untraditional methods, SymbioticA is neither fish nor fowl, but rather a hybrid, much like some of the artwork it has engendered.

⁹ SymbioticA has attracted several such scholars. Cultural geographers Deborah Dixon and Elizabeth Straughan, theatre scholar Adele Senior, STS scholar Hannah Star Rogers and art historian Pernille Leth-Espensen were formal residents, and numerous others have conducted shorter research stays.

¹⁰ SymbioticA archives, February 2013.

As emphasised by several members of the regular staff (interviewee 49, 53, 56), the School of Physiology, Anatomy and Human Biology had to have a special set of preconditions in place in order for SymbioticA to become established. Before Oron Catts in 1996 approached biologist Miranda Grounds requesting to work in her laboratory, artist Hans Arkeveld had been an artist in residence at the School since 1968, creating anatomically inspired sculptures that now occupy many of the building's corridors. Through the convergence of open-minded people and a fortunate instance of funding from the Lotteries commission, SymbioticA was founded, and has continued to exist relying on the skill and connections of its scientific and artistic affiliates (interviewee 44, 53, 56, 60). However, it is apparent that efforts at collaboration have not always worked out, and that the hopes of some of the Centre's early supporters were frustrated (interviewee 56, 60). Oron Catts stressed already during our communications negotiating my prospective residency at SymbioticA that they "tend not to discuss SymbioticA projects as collaborations but rather as research projects that involve different levels of mentorship" (email communication with the author, 12 June 2012). The many statements evidencing the continued tensions and diverging interests of some of SymbioticA's early supporters (interviewee 56 expressed, in a personal conversation, that "I now think the two cultures are in fact incommensurable"), combined with the explicit wish of other supporters to counteract "the divorce that happens between science and art" (interviewee 56), led to the development of *RQI*, the question of how terminology may affect collaborations and ideas of what constitutes success in interdisciplinary projects, and why 'the two cultures' are so often invoked in such contexts.

SymbioticA today offers artist residencies, workshops, symposiums, seminars and university courses in addition to the continual activity of the centre's affiliated artists, Oron Catts and Ionat Zurr. Guy Ben-Ary, formerly member of the Tissue Culture and Art Project along with Catts and Zurr, is a technician at the School, and is more indirectly affiliated as an informal long-term resident. Their artistic research includes the exploration of strategies for and implications of presenting biological art in different contexts, and also the further development of protocols and technologies into an "artistic tool kit" (SymbioticA 2015).

Because of its particular circumstances, SymbioticA seemed well suited for a multiple methods case study. One of the advantages to this method is the multiperspectival approach. As an artistic research centre existing on the interface between artistic and natural scientific traditions, combining different ways of knowing in the creation of novel artworks and research, SymbioticA is inherently mixed, and it would not be productive to conduct a study on such an environment from a single perspective.

As a participant observer, I actively took part in the day-to-day activities at SymbioticA, from Friday seminars to lunch-hour conversations and lab projects. Every day, I wrote at least one entry into my field notes. The focal point of the case study was the artists in residence at SymbioticA. Following their work, and as participant observer on a Master's course in biological arts, I ended up spending quite a bit of time in the wet biology laboratory. The detailed activities of the artistic processes of creation at SymbioticA, using scientific techniques, were a main area of focus. As such, I found it relevant to study and analyse both the scientific and the artistic aspects of the processes. People's attitudes, relationships, hierarchies, and other social aspects of the environment also formed part of the scope of my study.

The SymbioticA website states that it supports "non-utilitarian, curiosity-based and philosophically motivated research" (SymbioticA 2015). The artworks created as a result of research at the Centre are predominantly conceptual in nature. They often require some explanation from the artist in order for the audience to relate to them, at least in the way the artist intended. The artworks tend to explore issues relating to our current or future society, but in an open-ended way that rarely carries a univocal message. This point is discussed further in Papers III and IV.

SymbioticA is a place of convergence and radical interdisciplinarity, but also a site of contested terrain. It features examples both of successes and difficulties of collaboration, of disciplinary openness and prejudice, of knowledge and critique. I had arrived in Perth with an open research design, determined to let the findings at the Centre steer my research's direction from there on. I soon found that several interesting lines of comparison would be relevant to include.

3.2 Supplementary Participant Observation

After three months at SymbioticA, I had plenty of material, but also numerous unanswered questions. Many of them concerned how the practices and ideas of these artists were reflected in related approaches and in exhibitions. Therefore, I decided to visit *Semipermeable(+)*, the exhibition curated by Oron Catts and SymbioticA as part of the ISEA (International Symposium for Electronic Arts) in Sydney. I attended the vernissage of the exhibition as well as the ISEA conference, in which the pieces were discussed, and also returned to the Powerhouse Museum twice to study *Semipermeable* in detail. As previously noted, this informed the formulation of *RQ3*, regarding the relationship between process and presentation in bioartworks.

The SymbioticA group had in the early 2000s started running workshops teaching artists and other non-biologists to do biology themselves, using equipment one might find at home. This early contribution to DIY biology was a clear link to the DIYbio movement, made stronger by Catts and Zurr's recent interest in synthetic biology, a field that as mentioned, through the iGEM competition, inspired the emergence of the DIYbio network in 2008. An example of a makeshift laminar flow hood, created from a plastic box and a fan, is featured prominently in the SymbioticA office. Concurrently, Catts expressed a sense that what they were doing at SymbioticA had different aims than the practices of DIYbio laboratories (see Paper II). The tension between similarities of method and shared ideals of democratisation of knowledge, juxtaposed to differences in aims and identities, seemed to require further research into these related contexts.

In October 2013 I visited Genspace, New York's Open Community Laboratory in Brooklyn. I participated in an Open Community Night, explored the community laboratory space, and followed up with subsequent discussions with participants, including an artist, a museum employee, and a Swiss academic then about to open up a community lab in conjunction to the University of Geneva, as well as practitioners

from the BioCurious DIYbio lab,¹¹ several students, a biotech researcher and a software engineer. In January 2014, I visited the London Biohackspace, taking part in an Open Community Night.

Finding the interrelations between synthetic biology, biohacking, art and design particularly relevant to explore, I visited the *Grow Your Own* exhibition at Science Gallery Dublin in January 2014. I spent two days at the exhibition, participating in a four-hour DIYbio workshop organised by the La Paillasse community lab, and attending a lecture by Drew Endy. In September 2014, I collaborated with SVT colleague Ana Delgado and biohackers Malthe Borch and Rüdiger Trojok to organise a four-hour biohacking workshop within the BioStrike series,¹² and a two-hour discussion about DIYbio, at the S.Net conference in Karlsruhe (see Vaage et al. 2015).

In addition, I engaged in relevant participant observation at the Article biennials 2012 and 2015, Stavanger, the Metamorf festival 2012, Trondheim, and the Píksel festivals 2014 and 2015 in Bergen, visited the Center for Postnatural History, Pittsburgh and the Beyond Human: Artist-Animal Collaborations exhibition at the Peabody Essex Museum, Salem in October 2013, and attended the conferences *Mutamorphosis II* (Prague, 2012), *Life, In Theory*, SLSAeu (Society for Literature, Science and the Arts Europe, Turin, 2014) and *Postnatural*, SLSA (Notre Dame, October 2013). Besides the practitioners partaking in these contexts, I met and discussed with other artists and biohackers including Joe Davis, Jalila Essäidi, Adam Zaretsky, Amy Youngs, Heather Dewey-Hagborg, Marc Dusseiller, and Emil Polny.

¹¹ BioCurious is among the most well-known groups within the DIYbio network, and on its website is described as "the World's First Hackerspace for Bio, Built in the Heart of Silicon Valley" (BioCurious 2016).

¹² Biostrike is an on-going citizen science project that seeks to screen soil bacteria for antibiotic properties, in support of open science against big pharmaceutical companies, as well as discover the presence of antibiotics resistant microbes in local environments.

3.3 Methodology

My research design was a single multiple methods case study supplemented by subsequent participant observation and visits to exhibitions. The case study has not traditionally had one clearly defined application, and the term case study can still be understood in a number of ways. It is sometimes used interchangeably with participant observation (often referred to as ethnography, see Bryman 2012), but opens up for including other methods. Yin (2009: 18) defines the case study as

an empirical inquiry that

- investigates a contemporary phenomenon in depth and within its real-life context, especially when
- the boundaries between phenomenon and context are not clearly evident.

The second part of this definition is significant for this thesis. Unlike an experiment, there is recognition that you can never isolate a case completely from its context. Each case is embedded within a complex network of social, geographical, political and cultural factors, which all serve to shape the circumstances found within the case and which will to some extent fluctuate over time. This is why it is important to gather evidence from multiple sources. My sources of evidence ranged from field notes, archival records, semi-structured research interviews, direct observation and participant observation, to physical artefacts such as scientific instruments and artworks in exhibitions (Kvale & Brinkmann 2009; Yin 2009).

Initially I intended to produce a “thick description” of the case at SymbioticA,¹³ and certainly collected enough materials and produced enough field notes to make such a description. However, the format of an article-based thesis as well as the relevant questions emerging during my stay at SymbioticA, which led to the comparative research laid out above, necessitated that I be more selective in my representations, leaving more of the description implicit. This means that the account is not, perhaps, as rich as it might have been had I worked within the monograph format.

¹³ Geertz states that he took the notion of “thick description” from Gilbert Ryle, more precisely the two essays “Thinking and Reflecting” and “The Thinking of Thoughts” (1968).

Where theory guides the research, the approach is deductive; the approach is inductive when the theory is shaped as a result of the research (Bryman 2012). Martyn Hammersley (1992: 48) suggests that all research carries in it elements of both deductive and inductive approaches, as “in all research we move from ideas to data as well as from data to ideas”. Overall, my approach has been predominantly inductive and exploratory, with theoretical considerations to a large extent built on analyses of data. This goes both for my proposal of the neologism ‘fringe biotechnology’, drawing up an analytical space for relevant comparisons, and for my suggested framework for an ethics for bioart. An example of a deductive element to my research is the alternative hypotheses that I formulated prior to my case study at SymbioticA, about the possible relationships between artists and scientists/technicians at the Centre. The formulation of these alternatives was based on the hypothesis that collaboration would be an important and challenging aspect to such radically interdisciplinary work:

- 1) The scientific and technological experts act as helpers that aid the artist in realising his or her vision.
- 2) The scientist and the artist are co-producers of the artwork, contributing with their separate areas of expertise.
- 3) A mutual learning process takes place, which results in a shared artistic vision and product.
- 4) The scientists are the main producers of the artwork, to which the artist adds his “signature”.

I hypothesised that one of these four alternatives would prove to be prevalent, and consequently others would be less common. In the course of my case study, I found that 1) was confirmed in most instances, and 4) was disconfirmed altogether.¹⁴ Equal collaboration was still held up as an ideal (interviewee 45, 53, 56), but most of my interviewees did not consider it easily achievable in practice, as I discuss in Paper I.

¹⁴ Other artists, such as Eduardo Kac, have employed this fourth approach, considering the concept to be the main part of the artwork, and as such feeling comfortable to leave the production of the transgenic creatures to scientists. Interview with Eduardo Kac, Chicago, 19 Oct 2010.

An important means of data collection for my case study was the semi-structured interviews with eleven residents, mentors and staff at SymbioticA. My interview technique was partly inspired by what Brinkmann (2007) refers to as “opinion polling” interviews – a doxastic registration of the interviewee’s subjective experiences and opinions. Brinkmann suggests that qualitative interviews can also produce epistemic knowledge, “that has been found valid through conversational and dialectical questioning” (2007: 1117). This form of interview seeks to address the respondents as “accountable, responsible citizens” (ibid.), a model that, I argue, may have great value when conducting expert interviews, such as conversations with the artists and scientists at SymbioticA. The point, of course, is not to be argumentative. Rather, when the occasion suggested it, my reasoning was that the offering of other perspectives than the ones presented by the respondents may give some further, fruitful responses and lift the conversation to a more abstract, epistemic level. On some occasions, it seemed indeed to have that effect. Especially since I had spent two months in the environment of SymbioticA and the School of Anatomy, Physiology and Human Biology before proceeding with the interviews, I had relevant observations that could be tested through such discussions, and the interviewees responded well to this approach.

Following transcription, I did a discourse analysis of the interviews. When using the case study as a research method, “theory must always be grounded in context” (Mjøset 2006: 760). In the analysis of my collected information, I have considered it important not to treat the media and techniques used to capture different modes as separate and isolated from each other, rather considering the interviews, field notes and photographs from SymbioticA in relation to each other, and comparing those to the field notes, photographs and more informal interviews that I accumulated through supplementary participant observation.¹⁵

¹⁵ I did not opt to do semi-structured interviews in these settings, as I experienced several of these actors to be reluctant to enter into formal interviews, and the questions from the semi-structured SymbioticA interviews were in any case not suited for the community laboratory settings.

I have analysed the data in light of several theoretical frameworks. Discourse analysis (Jørgensen & Phillips 2002) was used to analyse the semi-structured research interviews, and theories of framing (Derrida 1987; Preziosi 1996; Torgersen & Schmidt 2013) were used in the analysis of the *Grow Your Own* exhibition. In Paper II, I relate both ‘boundary work’ (Gieryn 1983; 1999) and Foucault’s (1986) concept of ‘heterotopias’ to my neologism ‘fringe biotechnology’. Various ethical theories play into my discussions both in Paper II and particularly in Paper V. The discourse of ‘two cultures’, referring back to C. P. Snow, kept coming up in discussions at SymbioticA as an explanation for difficulties in collaboration across fields (see 3.1), and this, along with theories of interdisciplinarity, became the basis for Paper I.¹⁶ In choosing this topic as a contextualising and problematising first paper, I opted against other kinds of historical and social contextualisations (some context is provided in Paper II, however). Part of the rationale for this is that such context has been expertly provided in other PhD theses including those by Ingeborg Reichle (2004), Hannah Star Rogers (2012) and Pernille Leth-Espensen (2013) (for a list of other relevant literature, see section 4.2 of this introduction). The explicit discussion of these issues at SymbioticA made it, in the end, a natural choice.

In this thesis, I have not engaged explicitly with the theoreticians most referred to in the context of bioart (in addition to Foucault), namely Deleuze and Guattari, Simondon, Whitehead, and Benjamin (theories of new materialism and object oriented ontology are also commonly applied). Their perspectives have, however, yielded valuable insights to a number of scholars to which I do relate (see e.g. Mitchell 2010; Zylinska 2014), and as such they are indirectly present in my treatment of the artworks. In my Master’s thesis on transgenic art (Vaage 2011), I did engage explicitly with Deleuze and Guattari’s philosophy, and their thinking may therefore resound also in the present study. However, since the practices of bioart and DIYbio play a role in shaping our future visions, and have potentially increasing

¹⁶ In this process, I studied Michel Serres’ theory of a passage (or several passages) between the “exact sciences” and the “life sciences” (Serres 1982, 1984), but decided to leave this out, as it also builds on a binary logic through its stressing of the “third”.

significance to the way we continuously reshape social imaginaries (Castoriadis 1987 [1975], Taylor 2004) about both present and future technological societies, I have prioritised developing new conceptualisations within the ethics of bioart (Paper V) and ‘fringe biotechnology’ (Paper II), as well as critiquing existing ones of artscience (Paper I), with the aim that these contributions be easily approachable and useful for the actors (artists, hackers, science communicators, as well as scholars and the public).

3.4 Researching Artworks in the Making: Sensory and Material Aspects

The sensory is always an inherent part of a case study, as a good case researcher must be able not only to register verbal information whilst interviewing or observing, but also take in other signals such as body language, moods and underlying tensions (Yin 2009). How does one register this? In my case, photographs were an important aid, but I also relied on writing down such observations in my field notes.

As this case has a particular weight of visual and other sensory elements, I have employed the visual method of photography extensively. In the course of the three months in Perth, I accumulated a number of photographs, both of the SymbioticA space, of laboratory procedures and of seminars and social occasions. In addition, I photographed the exhibitions *Semipermeable(+)*, *Grow Your Own*, and Center for Postnatural History, as well as interactions at Genspace and the Article Biennial 2012 and 2015. Some of these photographs are included in Papers III-V, whereas others have served as data for analysis and as such form part of the backdrop for my conclusions in the papers.

Sarah Pink (2007: 6) stresses that although images should “not necessarily replace words as the dominant mode of research or representation, they should be regarded as an equally meaningful element of ethnographic work”. In the case of an artistic research laboratory, the consideration of visual and sensory elements is more than usually important. Even though the artworks created at or in connection to SymbioticA are predominantly conceptual in nature, and are intended in part to

stimulate intellectual reflection in the spectator, the fact remains that the impact of the artwork is largely made up by its sensory attributes: how it looks, smells, feels, its size and place in the room. In a real sense, the content is conveyed *through* those elements.

Aesthetics in a wide sense of the term is, to varying degrees, a focus for these artists, and as such it has also formed a part of my research. Similarly to what Dicks, Soyinka and Coffey (2006) observe about the science centre, the gallery exhibition and research laboratory, too, are multimodal, consisting of material semiotics, action/reaction sequences and interactivity. Text alone is rarely sufficient to describe and explain such environments. The photographs included in this thesis may be considered not merely as illustrations, but as supplements to the information given in the text.

One of the considerations I had to bear in mind was that technological equipment, in addition to being determined by economic factors, should “also account for how the equipment one uses will become part of one’s identity both during fieldwork and in academic circles” (Pink 2007: 47), as the presence of such equipment will inevitably “impinge on the social relationships in which he or she becomes involved and on how informants present themselves” (Pink 2007: 48). If I were to walk about with an enormous film camera on my shoulder, I might have caused changes in behaviour that would not have occurred if I carried a microphone in my pocket. The latter, on the other hand, could be considered a covert method. I used my digital recorder only to conduct research interviews, and carried my Pentax X5 digital camera only in those cases where I knew an experiment or event would take place. This also meant that I missed out on some occasions for photography, or resorted to the use of my cell phone camera as a means of documentation.

The products of the research at SymbioticA are mostly artworks with visual manifestations. Although explicitly framed as a research and development centre, where there need be no concrete outcomes by the end of the stay, most artists who have been in residency at SymbioticA go on to produce artworks inspired by their research there. In Paper III I discuss the relationship between the research and its art

product, and whether there should be attempts made to make smaller “the gap to the gallery”. This question arose from the sensory and immersive experience of being a participant observer in the lab, taking part in these research processes, and then observing the products in *Semipermeable*.

My choice to focus on artwork analysis, participant observation and textual analysis in my comparative studies presented a limitation to the material for Papers III and IV. Had the scope of the PhD project allowed it, surveys of the audience responses to the *Semipermeable* and *GYO* exhibitions, for instance through short semi-structured interviews such as those conducted during the *synth-ethic* exhibition in Vienna (Kerbe & Schmidt 2015), qualitative questionnaires or similar, as well as observations of their physical reactions in the space over a longer period of time, could have given grounds for further analysis of how the exhibitions were actually perceived by visitors.

3.5 Reflexivity and Ethical Aspects of the Project

In the course of my research, I have encountered several ethical issues. First, there was that familiar issue of participant observation, of the need to inform the research participants thoroughly and get their consent. Since my case study took place in a professional setting and I was interviewing the artists and biologists about aspects of their professional practice, these should be regarded as expert interviews, meaning that there is no need for anonymisation. However, since the questions also concerned relationships with collaborators and other potentially sensitive information, I found it most appropriate to anonymise the interviews, as well as any mention of individuals in my field notes, according to a key. Thus, sensitive information could remain anonymous, whereas the names of the artists and biologists could be used in the papers where this was relevant for the context. Permission for this approach was granted from the Norwegian Data Protection Official for Research (NSD).

All interviewees signed a written consent form, which informed them of the ways in which the recordings would be treated. Pink (2007: 43) emphasises that even when informants have signed consent forms, they are not necessarily fully “informed”, in

the sense that their understanding of the project is different from that of the researcher, thus leaving the ethical issue unsolved. Therefore, to minimise this problematic factor, I started each interview by informing the interviewee about the preconditions for the interview, how their responses would be anonymised, and that I would contact them to gain permission for any quotes used under their own names.

Secondly, the fact that both I and other residents and staff at SymbioticA were performing laboratory work with living matter called for a proper consideration of the bioethical issues. Since SymbioticA is based within a biology department, I underwent standard laboratory inductions, including an online course on Gene Technology Awareness in case I should end up working with genetically modified organisms. As my aim was also to understand the basics of different laboratory techniques employed by the artists, I sought to get a hands-on, experience-based knowledge of different techniques. During my residency at SymbioticA, I had the chance to learn from several scientific and artistic mentors, covering the basics of tissue culturing and working with *E. coli* bacteria.¹⁷ For the duration of this process, I kept a detailed log of the progress, protocols used, difficulties and knowledge gained, as well as of the styles of interaction involved.

Throughout the case study, consideration of the level of reflexivity required with regard to my own ethical beliefs and the extent to which they might influence my research was vital. With collaborative methods came other problems situated somewhere between ethical issues and quality criteria: to what extent does the participant's knowledge of being observed and/or recorded alter his or her behaviour? Is the participant (consciously or subconsciously) affected by what he or she knows/supposes to be the researcher's aims? I kept these questions in mind during the analysis of the collected materials, so as not to necessarily accept the subjects' statements at "face value". To ensure the validity of my research and the informed consent of the involved parties, I asked Benjamin Forster, the artist I followed most

¹⁷ I also participated in bee keeping, multiple electrode array (MEA) assembly, and acted as health and safety officer for an artist who was working on a sleep science project, but did not end up writing about these processes.

closely in the lab, to read through my field notes from our laboratory sessions, and requested that all the relevant actors confirm my accounts of events as well as the quotes I ended up using.

Because reflexivity carries different meanings in different disciplines (Pink 2007), I will endeavour to define how I have approached it, in my interdisciplinary study of the multifaceted space of the artistic research laboratory. By taking into consideration my own and other actors' preconceptions and different perceptions of my chosen case, I maintain awareness that my account is by no means value free. Rather, I strive to make it clear, both to myself and to my readers, how and to what extent my background and personal values have worked into my processes of data collection, analysis, and writing. The values, personalities and day-to-day moods of the particular people who were resident at SymbioticA while I was performing the case study have, no doubt, influenced my representation of the process of creating bioartworks in the lab (Geertz 1973; Jørgensen & Phillips 2002).

In my analysis of the collected data, I have not aimed to give a comprehensive account of the emerging field of bioart and its interrelations, but to represent some perspectives out of many possible. Paraphrasing Clifford Geertz, the descriptions in the following papers will inevitably be my representations of what the study subjects have done, and the opinions they have expressed, at certain times and places (Geertz 1973: 9). The neologisms I propose, similarly, are analytical tools developed through my research questions, with the aim of providing relevant descriptions in response to those particular questions.

From the beginning, I tried to maintain an awareness of the challenges of my research. Being a participant in the processes I was studying as well as an outsider of both art and biology called for particular caution with regards to methodology. Being integrated into the actual work in the lab was highly advantageous, not only with regard to direct access to actors and processes in real time, but also through the embodied knowledge that I gained through following the various artists and residents at SymbioticA, working with tissue culture and bacterial lab work, sleep science, and bee keeping. At the same time, this very integration made it challenging to maintain a

“neutral” position as an observer to the process. My strategy for negotiating these two potentially conflicting roles was, once again, reflexivity, registering in my field notes and in discussions with colleagues when those challenges surfaced, and recording how I dealt with them.

3.6 Interdisciplinarity and Transdisciplinarity

This thesis studies artists entering into the university environment, particularly in the disciplines of the arts, but also as residents in scientific laboratories, and contrasts such approaches with artists, amateurs and entrepreneurs who have chosen to remain apart from such systems. This topic is by nature transdisciplinary. Examining the very interactions of professionals from different fields, theories of interdisciplinarity, hybridity, boundary objects, boundary work and transdisciplinarity (Gieryn 1983; Klein 1990, 2000; Russell, Wickson & Carew 2008; Scott 2006; Star & Griesemer 1989) are an important backdrop, and some of these concepts are explicitly discussed in Papers I and II.

Bioartworks relate directly to the methods and the future of tissue culturing, synthetic biology, and other new and emerging technologies. In doing so, they are actively part of, and often furthering, public discussion on the role of technology in society. There does seem to be a lot at stake here. Commentaries from the audience can contribute to widening or narrowing the borders that artists are trying to create awareness of, thus influencing, for instance, a (near) future decision on the direct genetic manipulation of human embryos through CRISPR-Cas9¹⁸ or other means.

Both the concepts and practices of interdisciplinarity and transdisciplinarity run throughout my thesis. In Paper I, I discuss some of the potential pitfalls of interdisciplinary work. The ‘two cultures’ controversy forms a starting point for a discussion of the relationships between the disciplines today. ‘Artscience’ has in

¹⁸ The CRISPR-Cas9 technology, taking advantage of a viral defence system from bacteria and archaea provides a tool for quicker and easier gene editing than ever before, facilitating germline modifications (Riordan et al. 2015).

recent years become widely used as an umbrella term covering interdisciplinary work involving “cross-fertilisations” between art and science. However, I argue in the paper that the simplistic joining together of these two terms, designating very different fields, may be more of an obstacle than an aid to true transdisciplinary, hybrid endeavours.

Having myself travelled from a background in art history and aesthetics to the inherently interdisciplinary theory of the sciences and the humanities (“research on research”, as the activities at our Centre are often described), it was natural to discuss ethical and societal dimensions of these fringe approaches and how they relate to the field of biotechnology. In my master’s thesis, *Hybrids in Art* (Vaage 2011), I used a multiperspectival approach to Eduardo Kac’s transgenic art project. The nature of the artworks was such that it required a contextualisation into the relevant areas of biotechnology, as well as into different ethical approaches to research in biotechnoscience. The broad, basic knowledge I gained from this work was an essential foundation on which to build on in this PhD project.

My training in art history and literature has for the last four years been supplemented with intensive self-studies of biotechnology, ethics, science and technology studies and philosophy of technology. To situate oneself in the borderland between many different disciplines is challenging, exciting, and carries a real danger of being “a jack of all trades, but a master of none”. I have been conscious of the possibility that my background might make me less sensitive than trained social scientists as to the scope of some of the methods I have employed, and I have thus been careful to maintain rigour during my fieldwork. At the same time, from the beginning of the study I have valued (and still do) the ability to stay flexible as a researcher. This was the reason why I was deliberately open to adapting my research design in response to the unforeseen elements that I discovered whilst at SymbioticA.

In a qualitative and at times normative study such as this one, I have found it a crucial part of the process to challenge my preconceptions of the world, and in particular my sometime initial acceptance, as a matter of course, of the self-representations of my subjects. Although my research interest in bioart and DIYbio stems from a perception

of these practices as important alternative views on biotechnology in society, I have considered it vital to maintain a critical approach, seeking to consider these activities from several angles.

4. The Context of Bioart

4.1 Terminology of 'Bioart': a Taxonomy

Bioart is often defined under the umbrella of new media art, meaning art that uses media other than those considered traditional (painting, sculpture, etc.). Other branches of new media art include virtual art, animation, computer robotics and interactive art (see e.g. Rush 2005). New media art uses media that most people have become familiar with. Computers and TV screens are part of our everyday life, while paintings and sculpture are more exclusive to artistic objects. Biotechnology is also a well-known component in contemporary society, even if the ways in which it permeates everyday life – through our food, plastics, medicine – are not necessarily noted by the general consumer, and the most advanced technology is still exclusive to professional environments. Mitchell (2010: 116) has noted that “biological media do not seem to be part of *culture* in the same way as media such as photography, television, or computers are”, as they are largely confined to the laboratories.

Why include a taxonomy of bioart-related terms in this introduction? Worthwhile distinctions can be made in a number of ways within any given field, focusing on different properties or levels of similarities, and granting different potential for analytical comparisons. For art’s engagements with biotechnology this is certainly the case, and this is probably part of the reason why so many terms coexist. The same goes for biohacking and community biology, as I stress in Paper II. Therefore, I find it pertinent to address how different actors and scholars have discussed such artworks using diverse terminology.

Often in the past, theoretical terms have been superimposed on artistic activities by theorists and critics, after the fact. In the case of art’s engagement with biotechnology, several artists have been active in concept formation. Eduardo Kac (2004a) presented the term ‘bio art’ in connection to his *Time Capsule* performance

(1997),¹⁹ in which he had a microchip implanted in his leg and registered himself both as dog and owner. The term is not very popular amongst the people working with living materials for the purpose of creating artworks, and various alternatives have been introduced and are sporadically used, particularly ‘biotech art’ (Hauser 2005), ‘wet art’,²⁰ and ‘moist media’ (Ascott 2006), as well as ‘life science art’ (Mooney & Minnett 2006). Adam Zaretsky (2002, 2004, 2012) refers to his practice as ‘vivoarts’. At SymbioticA, they use the plural ‘biological arts’ as a more comprehensive term than ‘bioart’. However, many of the artists involved have expressed dissatisfaction with these descriptions as restrictive. As Guy Ben-Ary put it: “what if I wanna do some work that doesn't include biology? So, I have to go back to the drawing board and see what I define myself as?” This is also a question of what is the defining feature of these artworks: the medium, many feel, should not be elevated to the extent that the concept is secondary.²¹

Artist George Gessert, in *Green Light* (2010), presented an overview of different forms of art engaging with biology and genetics. In the narrower category of ‘genetic art’ (da Costa & Philip 2008; Mitchell 2010), Joe Davis (2001) has proposed ‘genesthetics’ as a term for his art approach, while Dmitry Bulatov (2007) has launched ‘Ars Chimaera’ as a more inclusive, polysemantic version of Eduardo Kac’s ‘transgenic art’ (2004b), meaning art that directly intervenes at the genetic level. Artist duo Oron Catts and Ionat Zurr (2002) have introduced such terms as ‘semi-living’ artworks and the ‘extended body’ for their tissue culture sculptures, both of which comprise non-independent organisms such as cell lines, tissue, stem cells, organs and embryos.

Theorists from a variety of fields have followed up, contributing both neologisms and interpretations of biological artworks. Women’s studies scholar Susan Merrill Squier’s term ‘liminal life’ (2004) has become widely used to describe the life forms

¹⁹ The term is variably spelled in one or two words. I have chosen to follow the same principle as for “biotechnology” and “bioethics”, writing it as “bioart”.

²⁰ Not to be confused with wet paint art or wet canvas art.

²¹ Research interview with Guy Ben-Ary, UWA, Perth, 7 May 2013.

that Oron Catts and Ionat Zurr (2002) call ‘semi-living’. Philosopher Nicole Karafyllis (2008) coined the term ‘biofacts’, a compound of ‘biology’ and ‘artefacts’, in 2001, describing something that is simultaneously a thing and a living system. The question of which terms best describe these artworks is in fact one of the recurring questions within the literature.

Living artworks created using biotechnology are always included in the definition of bioart. This means everything from examining the reactions of *E. coli* bacteria to jazz music (Joe Davis and Adam Zaretsky) to creating flowers and animals containing synthetic or human DNA (Eduardo Kac). The terms ‘biomedia’ (Thacker 2004) and ‘wetware’ (Hauser 2006)²² are both widely used with reference to biotechnological materials adapted to artistic purposes. The contested terrain starts when art that engages *topically* with biotechnology – without a “wet” element – is taken into consideration.

Many scholars and artists share William Myers’ (2015: 8) view that this “emerging art is not defined strictly by medium, by the use of living material, but instead by its connection with the reshaping and movement of our concepts of the self, and the definitions of life, nature, and community”. Concurrently, others have separated between artworks that use wet biotechnology methods, and those that comment on biotechnology through other media (see e.g. Andrews 2007; Kac 2007; Rossmannith 2008). Hauser (2005: 182) described the idea “that a work can be ascribed to Bio Art based on the content that it represents” as “an absolutely grotesque state of affairs”, arguing that the topic did not determine the art form more than “Monet’s impressionistic paintings could be classified as ‘Water Lily Art’” (2005: 182). Hauser (2005) noted that this art form was, at that point, no longer synonymous with genetic art, as ‘biotech art’ included numerous other fields and methods such as tissue culturing, neuro-physiology, bioinformatics, transgenesis, xeno-transplants and more (Gessert, 2010: 2, states that Hauser “brought the term into use among artists”). He

²² Adopted from neuroscience, this term makes up a threesome with ‘hardware’ and ‘software’, and to a certain extent reinforces the idea of living materials as engineerable information. It is commonly used also by biohackers, see e.g. Delfanti 2013. Many bioartists engage in a “phenomenological confrontation with wetwork” (Hauser 2008: 87), in an ontologically charged critique of this informational metaphor for life.

drew the line, however, at bio-fictions such as chimera sculptures, a-life, DNA portraits, and chromosome paintings. According to him, in order for an artwork to be included within the term biotech art, which he used interchangeably with bioart, there has to be some high (wet) technology involved.

Robert Mitchell, in *Bioart and the Vitality of Media*, discusses artworks about biotechnology as ‘prophylactic’ bioart, which he contrasts with ‘vitalist’ bioart. Bioart, in his view, always deals with the “*problematic* of biotechnology” (2010: 26, original emphasis). The defining feature, for him, is whether the artworks act to “produce a protective membrane for the spectator through which other elements of this problematic will then be parsed” (prophylactic), or to “forge new connections within this problematic” (2010: 30), exploring “what life can *do*” (2010: 32) (vitalist approach). While these categories make sense and have later been adopted by several scholars, it is notable that Mitchell makes no reference whatsoever to the early twentieth century tradition of vitalist art (Edward Munch, for instance, produced vitalist art in the early 1900s). Rather, Mitchell refers to vitalism in history of science and philosophy of biology, and observes several risks in using this terminology, since biological vitalism has been associated with a “quasi-religious” belief in life forces as well as conservative political beliefs (2010: 32).

George Gessert, building on previous terminological contributions by Kac, Hauser, and others, developed ideas of current conceptualisations of categories within the biological arts.²³ Pier Luigi Capucci (2008) in turn developed these notions into a diagram. In this diagram, biotech art and transgenic art are seen as subgenres of bioart, and transgenic art also as a subgenre of the partially overlapping genetic art.

²³ Capucci explains (2008) that the model was based on a text distributed by Gessert to the mailing list Yasmin. A developed version is found in Gessert 2010. Gessert (2005) has also developed an “Art and Genetics” bibliography.

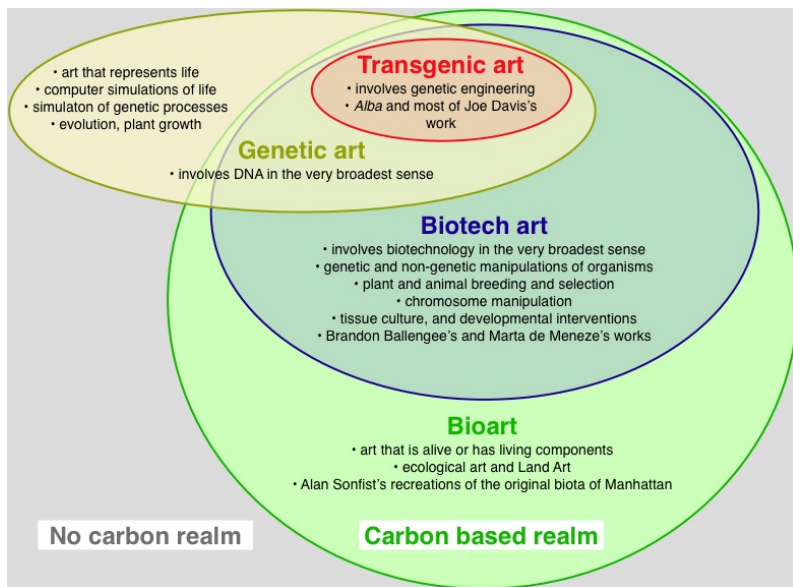


Fig. 1 Pier Luigi Capucci, *Diagram of bioart and related art forms*, 2008. Reproduced with permission from the author.

Other approaches might easily have been included here, for instance biofictions (at the outskirts of bioart, as Hauser would have it). One might have also mentioned body art here. Many artists who have produced bioartworks are body artists, notable examples including Stelarc (who participated in Tissue Culture and Art Project's *Extra Ear 1/4 Size*, and now has a full-size extra ear on his left forearm), ORLAN (who developed the *Harlequin Coats*, using skin samples from individual humans, while at SymbioticA in 2012), and Art Orienté Objet (their *Que le cheval vive en moi* from 2011 involved injecting serum from a horse into Marion Laval-Jeantet's body).

Several established artists who are often described as bioartists, for instance Natalie Jeremijenko and Brandon Ballengee, are equally active within ecological art, which would also be considered by most to be outside of the bioart sphere.²⁴ These artists have a strong ecological engagement, and explicitly seek to engage their audience in a similar level of activism. Activism is quite common among artists working with biotech. Groups such as Critical Art Ensemble, subRosa and Cultural Terrorist

²⁴ Oron Catts, in our research interview at SymbioticA, commented that this kind of activism, conveying a clear message, is a betrayal of the licence one has as an artist; see Paper V, and section 5. in this introduction.

Organisation have all employed tactical media activism, and seek to provoke the audience into thinking more deeply about genetic modification, the impact of pharmaceuticals on the environment, and other issues emerging with the growth of biotechnology. Tactical media practices, according to da Costa and Philip (2008), were formed in the political climate in post-Cold War Europe, and involved “intellectual and experiential exchanges between programmers, artists, activists, and theorists in the search for new approaches to media activism” (2008: xvii), as a consequence of the increased distribution and decreased prices of do-it-yourself media. Although it is a related and often overlapping approach, tactical media is described in a thesis by Hannah Star Rogers as being different from bioart in that such “works are more likely to emphasise a broader range of critiques of political authority and power, while bioarts are more likely to concentrate on critiques of science and scientific power” (2012: 142). According to this definition, works like Nigel Helyer’s *Supereste ut Pugnatis [Pugnatis] ut Supereste*, which deals with issues of migration and biological warfare, could be placed squarely in the tactical media category.

Bioart is thus not a stable term. W. J. T. Mitchell (2005) argued that although different artworks engaging with biotechnology do have this topic as a unifying factor, this does not in fact constitute a new genre of art, rather a new mode of conceptual art, art that deals predominantly with ideas. In the last few years, however, bioart has become established as a descriptive term used by the media, scholars, and practitioners alike. Other scholars such as Gessert and Hauser have emphasised its aesthetic and ontological potential.

All bioartworks relate, somehow, to living materials, and biotech art always relates to biotechnology. The topicality of the art form’s definition means that bioart can, simultaneously, be feminist art, activist art, body art, installation art, or sound art, to mention just a few of the overlapping categories. This characteristic of being always superimposed on something else, often several other forms, also stretches further: some bioart can also be defined as design, or do-it-yourself, or hacking. In the last few years, in addition to connecting bioart to other new media art approaches, an

increasing number of scholars have also acknowledged the close connection between these art forms and DIYbio communities (see Paper II).

Several artists and scholars have stressed the importance of incorporating creatures made with biotechnology (whether for art, science or the market) in our taxonomies of the world (Anker et al. 2008; Kac 2004a), and of considering how one should care for such creatures (Catts & Zurr 2006; Kac 2004a). It is far from easy to distinguish between “natural” and “cultured” entities in the first place, considering the human tendency to transform our environments to suit our needs and desires. What is considered natural in our time is a recurring topic in connection to synthetic biology. This point is a theme within the exhibition *GYO*, discussed in Paper IV, a theme which recurs in many bioartworks. Bioartworks speak to the ethical aspects of the question of what is natural, as I discuss in Paper V.

4.2 Literature

Bioartists are themselves quite prolific also in the area of text production, as demonstrated by edited volumes such as Bulatov (ed.) *Biomediale* (2004),²⁵ Kac (ed.) *Signs of Life: Bio Art and Beyond* (2007), da Costa and Philip (eds.) *Tactical Biopolitics: Art, Activism, and Technoscience* (2008), Beloff, Berger and Haapoja (eds.) *Field Notes* (2013) and books such as Anker and Nelkin (2004) *The Molecular Gaze: Art in the Genetic Age*, Critical Art Ensemble (2012) *Disturbances*, Gessert 2010, Kac (2004a) *Telepresence & bio art*, and Salter (2015) *Alien Agency: Experimental Encounters with Art in the Making*. A number of these artists are active academics, writing about their own projects and their relationship to the methods used, society, and life itself (see for instance Catts et al. 2000; Catts and Zurr 2002, 2005, 2006, 2008, 2013, 2014; Davis 1996, 2007; De Menezes 2003, 2007; Dumitriu 2013; Dumitriu & Farsides 2014; Dumitriu, Tenetz & Lawrence 2010; Gessert 1993, 1996, 2007, 2010; Kac 2004a, 2004b, 2007, 2013; Vanouse 2007, 2008; Wilson

²⁵ Although this publication accompanied an exhibition of the same name in Kaliningrad, its scope and the format of the texts qualifies it for mention with the other edited volumes.

2002, 2010; Youngs 2000; Zaretsky 2002, 2004, 2012; Zurr 2008). Their exploration of the material aspects of emerging biotechnologies have been followed “step by step” by theorists from various fields.

As the concept of ‘art’ has broadened in the course of the last century, so too have artworks been examined from increasingly diverse angles, often with more concern for their content than their formal execution. The art approaches discussed within this thesis has raised scholarly interest far beyond the disciplines of art and visual studies. Writings about bioart have been produced by scholars from media studies (Ozóg 2009, Thacker 2005, Zylinska 2014), human geography (Dixon 2008, 2009; Hawkins & Straughan 2014; Lapworth 2015a, 2015b), anthropology and sociology (Bardini & Boucher 2010; Boucher 2015), performance and theatre studies (Murphy 2013; Rossmanith 2008; Senior 2014), philosophy (Bakke 2008; Michaud 2007; Puncer 2008), law (Andrews 2007), cultural and gender studies (van den Hengel 2012), language and literature (Mitchell 2010), science and technology studies (Rogers 2012), as well as art history (Boulboulé 2012; Johung 2014, 2015; Kelley 2009;²⁶ Leth-Espensen 2013; Reichle 2009,²⁷ 2014), reviews by scientists (Yetisen et al. 2015), and many stories by journalists and bloggers (Krakauer 2012; Miranda 2013; Voigt 2009).²⁸ These writers can and do contribute very different perspectives on the same topic.

Edited books by (non-artist) academics include *Meta-Life: Biotechnologies, Synthetic Biology, ALife and the Arts* (Bureaud & Malina 2014), Poissant and Daubner (2005) and Daubner and Poissant (2012). William Myers’ coffee table book *Bio Art* (2015) discusses artificial life pieces, robotics, digital, and land art in addition to living artworks (his previous book, *Biodesign*, 2012, also features many bioartworks). Exhibition catalogues and artists’ books are far too numerous to list here. Several

²⁶ Kelley’s thesis has also been developed into a book, to be published in 2016, and Boulboulé’s is in review for book publication.

²⁷ Based on Reichle’s PhD thesis, published as a book in German, “Kunst aus dem Labor. Zum Verhältnis von Kunst und Wissenschaft im Zeitalter der Technoscience”, in 2004.

²⁸ Given that bioart is in itself a hybrid, interdisciplinary field, it tends to attract interdisciplinary scholars. Some of the academics listed here are active far outside of their original and/or official fields. The works listed here do not make up an exhaustive list of scholarly treatments of bioart.

books are coming out in 2016, including a *Routledge Companion to Biology in Art and Architecture*, edited by Charissa Terranova and Meredith Tromble.

4.3 Reflections on the Situation of Bioart

The institutional “art world” has been lukewarm in its reception of bioart. These pieces have, of course, been exhibited in galleries and art museums, but there seems to be a feeling that artists working with biology are doing “something else” than contemporary art as such. For instance, members of the regular staff at SymbioticA have stated that there is little contact with the art scene in Perth, or interest in their work.²⁹ This, however, does not seem to be the case for artists that are established with an *oeuvre* beyond the biological, as is the case for (among many others) ORLAN, Mark Quinn and Stelarc.

Despite this uncertain status, artists and designers working directly with biotechnology now number in the several hundreds. Artist and theorist Stephen Wilson observed in 2002 that “even after the 1960s revolution opened up the possibility that anything could be art material, most artists have not chosen to work with living entities” (2002: 111). He suggested several possible reasons, regarding the decay of living materials as incompatible with the artists’ desire for permanence; the lack of control over the materials, and ethical resistance. However, at the time that he was writing, several artists were just discovering the potential applications of biology for art.³⁰ In the decade that followed, that potential has been explored by an increasing number of people.

Perhaps naturally, given the curiosity, perseverance and technical affinity needed to relate to another field, these artists are often based within academia. Practice-based research is a growing phenomenon in many institutions around the world, and in the

²⁹ Personal conversations at SymbioticA, March-April 2013.

³⁰ Some of the pioneers of the field, notably Joe Davis, who has been a research associate at MIT since the 1980s, had been working with biotechnology for decades, but the early 2000s was the time when it became known to more than a select few.

case of art that engages directly with scientific research environments, this definition is stretched in interesting ways (see e.g. Scott 2006).

The evolving technologies that to a large extent enable scientific research in our time represent interesting new media also for artists. They make it possible to engage with topics that define the world we live in and to make sense of these topics, in alternative ways. Eduardo Kac writes in his introduction to the edited book *Signs of Life*: “it is impossible – and unacceptable – to circumscribe the questions raised by biotechnology within the realm of scientific research or industrial production, precisely because they also take place in society at large” (2007: 3). This observation, of course, has been made by sociologists of science and also by philosophers such as Martin Heidegger:

Because the essence of technology is nothing technological, essential reflection upon technology and decisive confrontation with it must happen in a realm that is, on the one hand, akin to the essence of technology and, on the other, fundamentally different from it.

Such a realm is art. But certainly only if reflection on art, for its part, does not shut its eyes to the constellation of truth after which we are *questioning*.³¹

This idea of art as a venue for reflection upon technologies is predominant in bioart (see e.g. Andrews 2007; Bulatov 2007), although many also stress that this should not be seen as its only or even primary function. As expressed by Benjamin Forster, “artists are given the right to think”,³² and they make that thought manifest in their artworks.

4.3.1 Ontology and Materiality

Several of the artists I discuss in this thesis relate to ontological questions such as ‘what is life?’ For Oron Catts and Ionat Zurr, this question is a prevailing one, and one which they explore from different angles in their artworks. Another question

³¹ Heidegger 1977: 35, original emphasis.

³² Research interview with Ben Forster, UWA, Perth, 29 April 2013.

along the same line of enquiry is ‘what is our relationship with the living things around us, and what should it be?’ Performance philosopher Shannon Bell (2004) has referred to these artists as ‘artist-philosophers’, artists who address the ontological question, fundamental to philosophy: ‘what is Being?’ Many scholars, too, are interested in such questions, as I mention in Paper V (see e.g. Torriani 2008; van den Hengel 2012; Zylinska 2014).

Bioart is often described as “presentation”, rather than “representation”, of the living and of the concepts it engages with (Capucci & Torriani 2007; Hauser 2006, 2008). Since the mid-2000s, theoreticians have referred to a “rematerialization” of bioart (Hauser 2005, 2006; Karafyllis 2008). As Jens Hauser has pointed out, “The former fascination with the ‘codes of life’ in computer art inspired by biology is receding and making way for a phenomenological confrontation with wetwork” (2008: 87). Bioart in the first decades of the twenty-first century has largely veered away from the bioengineering ideas that life can be “cut-and-pasted”, towards emphasising the messy, murky character of biological beings.

Similarly, Morgan Meyer recently proposed the term “amaterialization” as “the combination between amateurization and re-materialization of scientific equipment” in DIYbio, manifesting through “concrete, local, material and tangible processes of transforming and building equipment” (2015: 143). In this sense, as well, the phenomena of DIYbio and bioart appear to be developing in parallel. However, the material manifestations of art and DIYbio are among their relevant differences, as I discuss in Paper II: whereas biohackers typically seek to develop useful products, often for entrepreneurial (but also idealist) purposes, bioartists create their pieces primarily for exhibition and interaction.

4.3.2 Funding, Commodification and the Innovation Economy

The products of advanced biotechnology increasingly appear on the open market, and can be bought and sold like other consumer items. DNA tests of paternity are one of the more familiar products of this development. Pharmaceutical drugs, as mentioned,

are an important biotechnological product, and some are now being produced using synthetic biology (see Paper IV).

As this thesis is going into print, artist Jeroen van Loon is selling his full genome, 380 GB of DNA data, in an online auction that started 27 September 2015 and will end on 27 September 2016. The artwork, called *Cellout.me*, seeks to show some of the ethical issues of the commodification of DNA sequencing technology. Similarly, in what Wythe Marschall (in Myers 2015: 80) also defines as “Bio Art”, Giuseppe Licari’s *Registered: Il Paesaggio Oggetto (Landscape Subject)*, 2013, carved the symbol ® into the hills of Tuscany, pointing to questions of how long humans have been shaping and reshaping those hills, their status as “natural”, and who actually owns them. Commodification is not a major theme in my papers, as such, but features as a topic in several of the artworks discussed, notably in Benjamin Forster’s *Kynic*, in which a human cell line was purchased from Billy Apple, an artist who has devoted decades to the commercialisation of his bodily waste (see Paper III), and BCL’s *Common Flowers / Flower Commons* (see Paper IV). In Paper II, I discuss how the decreasing prices of biotech equipment are both a contributing factor and a result of biohackers’ and artists’ involvement.

Robert Mitchell argues that most of the bioartworks he discusses (including Tissue Culture and Art Project’s *Disembodied Cuisine*, and the Critical Art Ensemble’s *Free Range Grains*) do not critique “biotechnological innovation per se. Instead, the experimental nature of these works of art suggests that what these artists desire is more, rather than less, innovation” (2010: 61). He suggests that this seems to concur with “the apparently shared consensus that bioart addresses a public sphere” (ibid.) of different stakeholders, which inscribes the artists neatly into the innovation economy. Mitchell emphasises, however, that these “are not necessarily intractable problems or evidence of bad faith on the part of the artists. Rather, these interests, desires, and goals can serve as the vectors through which vitalist bioart produces new folds” in the fabric of social space (2010: 62). Although bioartists may not “pursue research science or business careers”, this does not mean, Mitchell argues, that they do not “exploit their links with research scientists for their own artistic career advancement, begging the question of why this ought not to count as itself a kind of ‘interest’”

(2010: 61). He does not see this as necessarily negative, but states that these interests and goals should be acknowledged in order for scholars to observe how such artworks work in society.

The innovation that the artists seem to be envisioning is often at the societal and institutional level, so I would argue that some of them do wish to influence the systems to develop in a certain direction – but they do pragmatically accept and to a certain extent subscribe to the status quo, in order to continue their academic affiliations and collaborations, as well as obtaining further funding. The subtlety of the institutional and societal commentaries by artists like Catts, Zurr and Forster makes their critique seem, at times, half-hearted. However, they do seek to avoid hypocrisy, acknowledging that being embedded in the academia carries with it both advantages and compromises, and that pragmatic interests influence what they show in the galleries (I discuss this in Paper III, and also in Paper IV). They do, as Mitchell points out, exist within the innovation economy, and are dependent on grants as well as collaborations with scientists. However, their artworks can, at their best, move beyond this economy and suggest alternative modes of existence. After discussing Jun Takita's decade-long project to create a bioluminescent moss garden, whose first exhibited piece was a faintly glowing moss "brain" sculpture at the 2008 Article biennial in Stavanger, Norway, George Gessert suggests that the weakness of the luminescence "may be exactly what we need to see. The greatest marvels that biotechnology bring us are patience and humility" (2010: 118).

5. (How) Should Art Frame Science?

Both the man of science and the man of art live always at the edge of mystery, surrounded by it, both always, as the measure of their creation, have had to do with harmonization of what is new with what is familiar, with the balance between novelty and synthesis, with the struggle to make partial order in total chaos. They can, in their work and in their lives, help themselves, help one another, and help all men

- Robert Oppenheimer³³

Bioart's relations to biotechnology, to science, and to engineering have in different ways been discussed in this thesis. In Paper IV, I discuss how artists may be used by the actors of synthetic biology, to create public acceptance for the emerging technology. Oron Catts is quoted on saying that this is explicitly stated in meetings, but also that artists may attempt to manipulate this aim in their contributions to the scene. I refer to this as a 'subterfuge' approach (Paper IV). Artists may seek to unsettle the audience, *rupturing sense*, as opposed to 'tame' artists promoting a clear message that this science is desirable. There are also many instances of 'fellow travellers', artists who are enthusiastic about science and therefore portray it in a positive light. Among the bioartists I have studied, however, it is by far the more common for artists to take the 'subterfuge' approach, expressing subtle criticisms either of the scientific technology itself or of its institutional conditions. 'Activist' artists such as Critical Art Ensemble, on the other hand, seek to convert the audience to their view about a scientific practice or technology, in a critique of the status quo.³⁴ The 'aesthetics of disappointment' and 'aesthetics of failure' cultivated by Catts and Zurr, and several of the other artists discussed in this thesis (see Papers III and V), do not work to "sell" science to the public.

What, then, do artists communicate about how their work in this field relates to science? Artist Gail Wight calls herself an 'artist of science' in the same way that

³³ Oppenheimer 1961: 47.

³⁴ This conceptualisation of different artistic approaches was developed in consultation with Silvio Funtowicz, who has used the term 'tame' in the context of governance. I greatly appreciate his allowing me to develop it in the context of art, and his input on the terms chosen.

there are historians and sociologists of science (Weidenbaum 2009). This would not, however, go for all bioartists: many would say that denotation exaggerates the focus on science in their art: they use scientific methods and technologies, but do not feel themselves to be making art *about* science, as such (interviewee 27, 28, 42, 44, 60, 66). Oron Catts has stated that “about 80% of our projects are really about artists using scientific technology; it is not about an involvement with science as such” (2011: 78). This is an interesting contrast to the fact that the relevant figures of origin listed by Catts and Zurr are predominantly scientific:³⁵ early 20th century figures such as Alexis Carrel, Jacob Loeb and Stéphane Leduc are referred to in order to show that the view that biology can be approached from an engineering perspective is not a new invention (see e.g. Catts & Zurr 2010).

A central tension occurs between the creators of bioart and policymakers and scientists who consider their artworks predominantly in relation to scientific practices, norms and goals. In particular when artists’ use of irony tip over into actual hoaxes, they transgress some people’s view of what art engaging with the sciences should be, as I discuss in Paper V. Catts and Zurr have in the last decade compensated for this through emphasising the artistic element of their work, and that of the work they curate, over its technoscientific components (see Paper III).

Art, although similar to science in being based on trial and error, is freer in its process (Wilson 2002). This idea goes back at least to Immanuel Kant who, in the eighteenth century, stressed that only “production through freedom, i.e., through a capacity for choice that grounds its actions in reason, should be called art” (Kant 2000 [1790]: 182). This idea is still present in the formation and reception of bioart, resulting in open-ended artworks (see Papers III-V). Kant also argued that the judgment of artworks should be disinterested, not steered by wishes and desires. Disinterestedness is today no longer considered an important goal in the evaluation of the artwork (see e.g. Gessert 2010; Mitchell 2010). However, the idea created by the Kantian

³⁵ Catts stated in a research interview with the author that he found “some very problematic figures within the history of science much more interesting to explore than within the art world”. Research interview with Catts, UWA, Perth, 24 April 2013.

philosophical tradition, that we judge works of art using a different kind of perception than we use on “normal” objects, still seems to be prevalent. Perhaps this is part of the reason why objects or happenings received as ‘art’ seem to have more potency than similar occurrences without this tag. Robert Mitchell (2010) has suggested that the *framing* of bioartworks as ‘art’ can place the audience in a receptive state in which they can experience affect, not just in the moment, but as a prolonged experience of intensive interest.

Disinterestedness, however, was one of the scientific norms proposed by sociologist of science Robert K. Merton (1973 [1942]), and the ideal of objectivity has to some extent persevered in scientific discourses until our own time. Despite being heavily criticised and discredited by later scholars as being impossible to achieve (see e.g. Rudner 1953; Ziman 2000) striving for objectivity remains a scientific virtue, a genuine value cultivated for centuries as an ideal for scientific work (Daston & Galison 2007). Although Jane Lubchenco has proposed that the challenges of our time demand “a new social contract for science” (1998: 491), in which all scientists should commit to “address the most urgent needs of society, in proportion to their importance” (1998: 495), most scientific research presupposes that scientists distance themselves from the *emotional* aspects of their work. One of the worst charges to bring against a scientist is still that of subjectivity. The artist, on the other hand, is free not only to explore the issues inherent in young fields like biotechnology, but also to broadcast alternative modes of exploration to the general public. In the ensuing debate, we may be encouraged to re-examine notions of life, creativity, science, and what we want for our society.

What, then, should be the role of scientists in bioart? Frances Stracey, in an article in *Nature Reviews Molecular Cell Biology*, stressed that scientists should be more vocal about their part in and their views of bioart. As she saw it, scientists who refrain from public discussion of the bioartworks they have helped create “risk mirroring a limiting art-for-art’s sake attitude held by some artists with a science-for-science’s sake approach that is seemingly uninterested in the broader, cultural applications of collaborative developments” (2009: 496). The reasons for scientists’ lack of explicitness when it comes to their views and roles in relation to bioartworks are

clearly complex and heterogeneous. In my research interviews with artists and scientists at the University of Western Australia (the School of Physiology, Anatomy and Human Biology, to which the SymbioticA Centre belongs), a recurring explanation was that scientific researchers do not have the time to write about art – they barely have the time to participate in artistic projects (interviewees 45, 49, 53, 60, see Paper III).

Some few scientists have included artworks they have contributed to in their scientific papers (see e.g. Bakkum et al. 2004); however, this is apparently perceived as quite “risky” (interviewee 49), as such endeavours might be seen as frivolous, and leave other scientists with the impression that the paper authors are “less than serious” (ibid., and interviewees 44, 56) or “trivial” (interviewee 53). This may be part of the reason why scientists, as I also mention in Paper III, have not been very active in the public discussion that bioart has enabled. A news feature in *Nature* in 2000 on artists working in bioscience labs noted that two labs that accepted artists as residents were among the world leading in their fields,³⁶ and consequently did not “have to worry about whether the scepticism voiced” by some of their fellow researchers would have negative effects on their “career prospects” (Nadis 2000: 670). W.J.T. Mitchell commented on this report that it “suggests that those artists who wish to work in close proximity to actual scientific research are tolerated by the scientists as amusing distractions at best, and annoying pests at worst” (2002). Although this statement does not accurately reflect my findings at SymbioticA, it appears clear that it takes a self-confident scientist to engage with artistic projects.

However, hybrid educations emerging in the US, Australia, Europe and Asia suggest that the idea of artistic approaches to science may, in time, be more common. Many current actors and scholars are true hybrids, with a deep understanding of several fields and wide-ranging interests. Networks have been established to further

³⁶ The labs in question were Joseph Vacanti’s Laboratory for Tissue Engineering and Organ Fabrication at the Massachusetts General Hospital, which hosted Oron Catts and Ionat Zurr as research fellows for a year, and Alexander Rich’s structural biology laboratory at Massachusetts Institute of Technology (MIT), in which Joe Davis had been an (unpaid) research affiliate since 1990 (he is now working in George Church’s lab at Harvard).

collaborations across fields, such as “SEAD” (sciences, engineering, arts and design”), presented as an intermingling, ideally transdisciplinary field that is joined by a common focus on creativity and innovation (Blassnigg & Punt 2012; Malina et al. 2015). Others put their faith in the move from “STEM to STEAM” (science, technology, engineering, art and medicine, proposed by the Rhode Island School of Design) as being the relevant combination of fields (STEM to STEAM 2016). The products of such hybrid endeavours, whether an artwork, new terminology, new knowledge, or new relationships, can be seen as *boundary objects*, concepts that are “both adaptable to different viewpoints and robust enough to maintain identity across them” (Star & Griesemer 1989: 387). Because they are created in an interdisciplinary context and speak, in a sense, several languages, often those of art, design, science and technology concurrently, they can serve as an entry point for discussion across fields. Biotechnology can itself be considered a boundary object in this sense.

As I mention in Paper I, Caroline A. Jones and Peter Galison, in their introduction to *Picturing Science, Producing Art* (1998), describe what they call a “binary economy” between art and science. Martin Kemp and Deborah Schultz (2000) have engaged with this problem through emphasising our human propensity for dichotomisations and showing how such binary divisions are, importantly, context-dependent. They argue that the concepts of “art”, “not art”, and “science” are of the same “protean nature of us and them, here and there, now and then” (2000: 85). They posit from this that hybrid, creative work is not binarily opposed to such classificatory categories, but rather that it serves to “re-classify so that we can look afresh”. Such “acts of re-ordering can exercise profound and creative effects on how things are seen, and can themselves result in new discoveries” (2000: 101). Although I am less comfortable than Kemp and Schultz with accepting existing categories, as seen in Paper I, I do agree as to the liberating potential of new terminology, and my proposed term, ‘fringe biotechnology’ (Paper II), seeks to create such a new space for thinking and seeing connections.

The philosopher Knud Ejler Løgstrup (1983) expressed his conviction that the artist can decipher the theoretical thinking of scientists and philosophers, and discover how their theory, when carried out, can change how we view our existence:

It is no rare occurrence that the scientist and philosopher does not know what is entailed in what he is saying, as he stays on the theoretical, and therefore harmless, level of thinking, whereas the artist deciphers it and discovers how things and our very existence will look, when one carries out what the scientist and philosopher, in the great innocence of his theory, has thought.³⁷

Løgstrup was writing before the emergence of bioart. However, like similar statements made by Dewey (2005 [1934]), Heidegger (1977), and Mumford (1952), this quote captures some of the potential of art to decipher technology and show its potentialities, in an embodied way, to the audience.

For artists, being based within the scientific system brings both responsibilities and advantages. Oron Catts has stated that, although restrictive, and a troubled procedure for several reasons, having an ethical committee judging prospective artistic projects does give the artists at SymbioticA “a licence to do things that might otherwise be illegal” (2011: 77). In a recent interview about their one-year visiting professorships in the School of Design, Royal College of Art, Oron Catts and Ionat Zurr, who have previously stressed that the license that they have to make their works is also founded in their status as art, stated that they were now defining their practice as “contestable design”, suggesting that the relationship between art and design is also in flux (Reeve, Catts & Zurr 2016). In the exhibition *Grow Your Own*, it was not explicated which parts of the exhibition were made by designers, artists or iGEM contestants, as I discuss in Paper IV. The increasingly blurry boundaries between art and design, design and engineering, engineering and science, as well as science and art, means that existing terminology (not just of ‘arts science’) struggles to make sense of the current reality. Beyond terminology, the practices of art and other fringe biotechnologies can contribute to such sense making in embodied ways – but not necessarily through providing clear answers with regard to how to proceed.

³⁷ In the original Danish: “Ikke så helt sjældent sker det, at videnskabsmanden og filosofen ikke ved, hvad det, han siger, indebærer, fordi han bliver på den teoretiske og derfor harmløse tænkings plan, medens kunstneren omsætter det og opdager, hvordan tingene og vor egen tilværelse kommer til at se ud, når man gør alvor af, hvad videnskabsmanden og filosofen i deres teoris store uskyld har tænkt”. Løgstrup 1983: 17, *my translation*.

6. Ethics of Fringe Biotechnologies

Whenever there is a discussion of biotechnology, ethical issues become apparent. In the case of bioart, the discussion of ethics takes on an added urgency. Artists cannot point to an outcome that will be for the greater good of humanity, as researchers often do, in order to justify creations that are ethically questionable. They can, however, through their artworks point to ethical issues in science and technology and their relations to society (see Paper V). The extent to which this justifies the manipulation of life forms for art has been the topic of extensive discussion (see Catts & Zurr 2008; Levy 2006; Mooney & Minnett 2006; Stracey 2009, and Paper V).

As I point out in Paper II, given their close interrelations in practice, discussions of bioart have been kept surprisingly separate from those of DIYbio and related approaches. When it comes to ethics, there are good reasons for discussing ethical issues of art separately from those of biohacking and community biology: Audiences relate differently to objects or events presented as ‘art’ than the same objects or events presented as ‘design’ or ‘biotechnological product’ (Mitchell 2010; Wohlsen 2011). The status of artworks *as art* makes the issues they refer to stand out in isolation, unprotected by monetary or medical *raison d’être*. For this very reason, it is important to consider their ethical and moral status. In Paper V, I do this through drawing on existing theory of art and morality as well as bioethics.

As I also suggest in Paper II, there is need for a more complete ethics for fringe biotechnology: what is its potential to shape the social world, and visions of the future? These questions need to be considered ethically, similarly to what is currently the case for bioart. Issues of biosecurity and biosafety appear, at present, to be overshadowing such concerns. However, as these practices mature, a more nuanced ethical framework will be urgently needed. Although I have in this thesis prioritised developing an ethics for bioart, I consider it of equally high importance that an ethics assessing DIYbio in relation to other fringe approaches as well as institutional and industrial biotech be developed in the near future. Not least, an ethics for fringe biotechnology should take into account how art, design, hacking, and science

communication in different ways work upon social imaginaries and future visions, as well as the concrete products of these endeavours.

7. Ambiguities Aplenty

The bioartworks discussed in this thesis are often open-ended, and do not convey a clear message with regard to what the viewer should think. Nevertheless, these artists typically wish for their work to have a critical potential. Etymologically “ambiguous” means “of double meaning”, being derived from *amb-* (both ways) and *agere* (drive) (Onions 1966). Ambiguity is often considered as a negative term within the sciences: when something is uncertain or unclear, we lack in “certain knowledge”. However, in the arts ambiguity has more positive connotations.³⁸ Umberto Eco, in *Opera Aperta* (1962), insisted on the element of multiplicity, plurality or polysemy as positive potential in art, and emphasised the role of the reader (or, in art forms other than literature, the audience member, spectator, or participant).³⁹

As David Robey writes in his introduction to an English translation of *Opera Aperta*: “Ambiguity, for Eco, is the product of the contravention of established conventions of expression: the less conventional forms of expression are, the more scope they allow for interpretation and therefore the more ambiguous they can be said to be” (1989: xi). Dario Gamboni has suggested that ambiguity and indeterminacy together cover the pluripotency of images. Ambiguity, in his view, is a quantifiable characteristic: “two, three, four or *n* images or meanings”, whereas indeterminacy is essentially irreducible, meaning that “images and forms multiply to infinity”. Where indeterminacy, he argues, risks “evaporation”, ambiguity is in danger of “crystallization”. This distinction is meant to indicate “two poles”, and he uses the term ambiguity more generally as underlying both the concept of indeterminacy and ambiguity (Gamboni 2002: 19-20). Gamboni’s study of “potential images”, images that “become actual during the act of contemplation in a creative way; they are not predetermined” (2002: 19), seems to connect ambiguity in images mostly to what he

³⁸ Of course, not all theorists agree on this. Monroe Beardsley referred to “bad style” in literature as occurring when “the diction and syntax of a discourse are such as to produce an incoherence between the primary and secondary levels of meaning, or such as to produce ambiguity or obscurity” (1958: 227).

³⁹ I have chosen, in Paper IV, to also use the term pluripotency, drawn from the language of cell biology, in this metaphorical sense, meaning with power and potential to develop in different directions.

calls “imaginative perception” (2002: 24). The image makes us *imagine* the parts of it that aren’t visible (Lechte 2012).

The ambiguities I discuss in this thesis (particularly in Papers III and IV, and also V) concern the ways in which an artwork can be interpreted in diverse directions, at multiple levels. The material and visual quality of these artworks leaves them more open-ended than writing tends to be, more widely open to interpretation. Rarely is a bioartwork found in which the “message” of the piece is unequivocally clear. This open-endedness, however, can sometimes slide over into equivocation, a deliberate vagueness that is directly misleading. This problem is discussed in Paper IV.

Ambiguity is related to, but decidedly different from complexity, which applies to a situation “if things relate but don’t add up, if events occur but not within the processes of linear time, and if phenomena share a space but cannot be mapped in terms of a single set of three-dimensional coordinates” (Mol & Law 2002: 1). Complexity also features importantly in this thesis, particularly in consideration of the complex relationalities between bioart, DIYbio synbio, design, engineering, and science (see in particular Papers II and IV). In this sense, the thesis might also have been entitled “Chasing Complexities” or “Pursuing Potentialities”. The idea behind the project is not at all to provide “a complete picture”, but rather coming at the problematic of bioart and its positioning in the world from different angles: here an ethical angle, there a spatial orientation, seeing how it overlaps and exchanges with biotechnology at large and with other “fringe” endeavours, then zooming out to consider the terminology and discourse of the larger category of ‘artscience’, of which bioart is a part.

In writing about any social phenomenon, the norm is to try and find patterns, categories. However, real life tends towards the messy, chaotic, unorganised. And as the subject of this thesis is, precisely, *living* artworks and their role in contemporary societies, I have walked a tightrope, seeking to make meaningful observations while not disguising the messiness of these contexts. In all five of the papers I have sought to move down various paths inherent in these ambiguous, complex endeavours

without being overly reductive, to preserve their critical potential, and also to point out when that potential stands in danger of being lost.

Bioartworks consist of more than the living organism (and, as discussed in section 4., do not need one in order to fall within the category). The social context is just as important, as well as the philosophical implications of their existence. It is the combination of these parts that makes up the totality of the artwork. The activities of DIYbio constitute contrasts to the artistic approach, but are similarly complex. In Paper II, I discuss how the artists at SymbioticA take a more critical approach to scientific practices than many DIYbio members, but in Paper IV, I discuss how this may be difficult to reconcile with their desire to leave the artworks open-ended.

8. Closing Discussion and Opening Up for Further Questions

8.1 In Closing

This thesis discusses, primarily, works of art. The works of art it treats are of a peculiar kind, taking advantage of new media and future visions offered by the biotechnosciences. Therefore, I have found it relevant to discuss, in this introduction, what this kind of ‘art’ may be. In my thesis, the artworks are considered as something *other* than the mundane world – but not so very different. I discuss these artworks alongside DIYbio activities, (speculative) design pieces, and biotechnoscientific endeavours, and in the comparison, the relevant similarities are as important as the differences.

The phenomena that I have studied involve inherently complex social interactions and open-ended material manifestations. This kind of art, far from being apart from the world, engages with it in complex and multifaceted ways. As far as possible, I have tried to emphasise and give nuance to the interactions involved, and correlate activities perceived by many to be very different. However, as my long bouts with papers in which I wanted to include too much material have made painfully clear, simplification and reduction is a necessary part of academic work. I do believe, however, that a sustained awareness of the risk of leaving out important parts of the picture is a component to a rigorous humanistic writing process.

8.2 Further Questions

As is wont to be the case with research projects, multiple questions have emerged along the way, which were deserving of further discussion. An article-based thesis does not offer a format that allows mention of anywhere near the number of relevant approaches, institutions and individuals that might fruitfully have been included in order to give a more elaborate picture of the relationality of bioart. The sphere of ‘fringe biotechnology’, as I observe at the end of Paper II, is envisioned as

encompassing a wide range of practices and spaces outside of the ones I discuss in the paper. Science centres, outreach projects and university satellites with public engagement elements could productively be included for comparison. As mentioned, the ethics of this wide sphere should be developed further.

The close connections between speculative design and bioart have been mentioned in Papers IV and V. While bioart, according to Oron Catts, produces “contestable”, real objects rather than the “speculative” models that have so far been typical of speculative design (Reeve, Catts & Zurr 2016), this distinction is increasingly blurry, a development that deserves scholarly attention. Design involves the creativity and innovative spirit of art, but traditionally with a more instrumental aim: to create something that is fit for its purpose (Norman 2002). However, in the speculative approach developed by Dunne and Raby (2013), design takes on different roles of envisioning futures and inspiring thought. In this capacity, design and socially and technologically engaged art such as bioart blend into each other. Further empirical as well as theoretical work is needed in order to consider the interconnections between art and design, particularly if designers increasingly develop real models rather than speculative prototypes.

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