

Synthetic Sentience: The Pussification of Biotech

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Abstract

We investigate the potential of lab-grown clitorises created by 3D bioprinting stem cells derived from menstrual fluid. Our approach challenges male-dominated narratives in tech spaces, advocating for a feminist, nonbinary methodology focused on pleasure and eroticism beyond reproductive function. The project is conveyed through video performances, scientific experiments, and digital art, fostering a multifaceted discourse on posthuman pleasure, ethics of sexuality, and the deconstruction of gender norms. We scrutinise the ethical complexities of bioprinted organs capable of neural responses, questioning notions of consent and sentience in bioengineering. The use of social platforms like OnlyFans for disseminating our work strategically disrupts traditional digital consumption patterns. Through this, we address biocapitalism and control of narratives around sex and pleasure, questioning normative uses of technology in spaces that objectify bodies. Our paper calls for a reevaluation of biotechnological advance in its cultural, ethical, and societal impacts, challenging existing paradigms and fostering inclusive scientific exploration.

Keywords

Clitoris, synthetic biology, 3D bioprinting, tissue engineering, sentience, lab-grown, biopolitics, pleasure, stem cells, menstruation

Introduction

When's the last time you had an orgasm? Was it technologically mediated, involving a prosthetic or device? What if you were able to grow your own

fleshy ‘toy’ and your personal connection to it was not just creative but also biological? How would that feel, what would it mean, and what would it look like? The collaborative project we present in this paper, *Synthetic Sentience: The Pussification of Biotech* is an exploration of how biotechnology could be used to facilitate sexual autonomy and pleasure through 3D bioprinting clitorises; these synthetic organs are cultured *in vitro*, embedded with neuronal and heart muscle cells differentiated from our own menstrual stem cells (Figure 1). We are compelled to create these clitorises, using our menstrual fluid as a resource, to engage with technological tools on our own terms and with our own biomaterials.

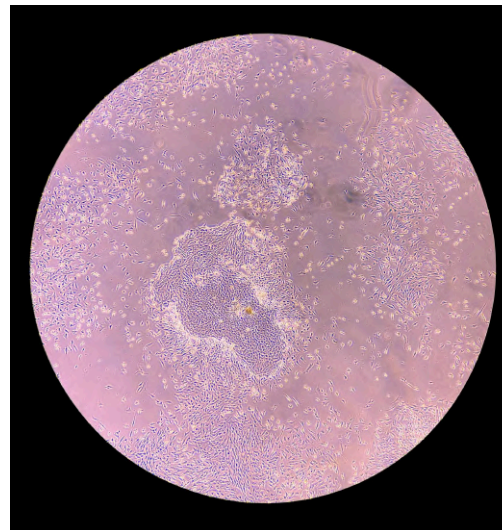


Figure 1. Endometrial tissue explant culture from menstrual fluid, showing cell outgrowth © WhiteFeather Hunter, 2023.

The tech spaces we have worked within were typically saturated with (solutionist) tech-tosterone objectives and approaches that did not always align with our open, exploratory feminist playfulness. Additionally, as feminist technology studies researchers have noted, “vastly more women are “on the receiving end” of technologies than create them,” particularly technologies concerned with our reproductive organs. [1] We are interested in how our creativity can be used to style a femme or nonbinary philosophy and methodology that gives us more agency with our experiments and takes into account our various embodied experiences – not just those concerned with biological reproductive functioning but also with pleasure and erotic play.

We examine possibilities for the above through collaborative creation of technologically mediated artworks, around the idea and production of our *in vitro* clitorises. These works are presented in multiple formats: video/online performance and live engagement, prototyping, digital rendering, and bioengineering (Figures 2, 3). Our modes of presentation are used to facilitate a generative stream of related works throughout the project development.



Figure 2. 3D printed resin clitoris prototype in a petri dish © Jiabao Li, 2023.

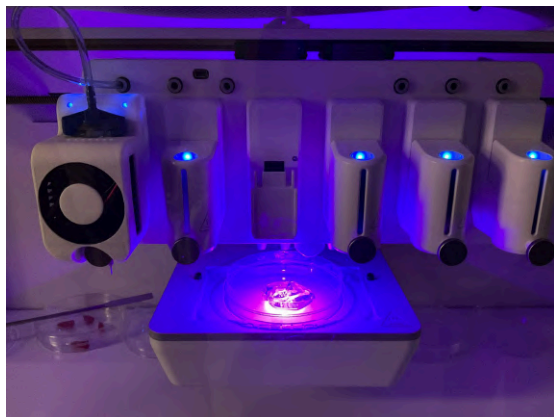


Figure 3. 3D bioprinting process of a clitoris form seeded with cardiomyocytes, in a support gel © WhiteFeather Hunter, 2023.

Some of the conceptual topics we explore include posthuman possibilities for pleasure in synthetically sentient organs and notions of the disembodied self, as well as social considerations such as the biopolitics of pleasure and ethics of sexuality. We also address the ways in which our modes of presentation may challenge normative uses of tech and tech-mediated spaces where they objectify bodies (especially women's bodies); in this regard, we discuss biocapitalism and digital consumption, as well as who controls the narrative around representations and understandings of sex and pleasure.

More-than-human pleasure

Usual ideas about sexual pleasure are human-centric; more-than-human animal sex is conceptualised as perfunctory and base, biologically imperative for reproduction without cognitive sophistication, and often including coercion. [2] Human pleasure is defined as, “the physical and/or psychological satisfaction and enjoyment derived from solitary or shared erotic experiences, including thoughts, dreams and autoeroticism.” [3] Furthermore, the Global Advisory Board (GAB) for Sexual Health and Wellbeing adds that, “Self-determination, consent, safety, privacy, confidence and the ability to communicate and negotiate sexual relations are key enabling factors for pleasure...” [4] If more-than-human sex is relegated to reproductive function and does not include our precepts of consent, can more-than-human animals (or other species) experience sexual *pleasure*? If so, what does it mean? And if not, what would be the purpose of having a clitoris?

The array of clitoral structures in animals is as diverse as the animals themselves, with each species adapting unique features for sexual function and pleasure (Figure 4). Bonobos, our closest primate relatives, are known for frequent masturbation, french kissing, genital-to-genital rubbing, and oral sex. [5] These behaviours are not only a source of pleasure but also play a role in stress reduction and social bonding within their communities. Dolphins, displaying a remarkable level of inventiveness, have been observed using the sandy sea floor to masturbate, occasionally utilising dead fish as tools for sexual stimulation. [6] Such behaviours underscore the complexity and creativity inherent in animal sexual activities. Snakes engage in unique courtship behaviours that involve tactile stimulation of the female's clitoris, an act which appears to enhance reproductive success. [7] In these reptiles, clitoral stimulation is

not merely incidental but a deliberate part of their mating rituals.



Figure 4. Image compilation of various animal clitorises © Jiabao Li, 2023.

Only as recently as 2022, women scientists discovered that female snakes not only have a clitoris, but have two (called hemiclitoris). [8] These organs, replete with nerves and erectile tissue, are indicative of a function that extends beyond mere reproduction, suggesting that mating acts of snakes could be as much about seduction, mutual pleasure, and choice as it is about procreation. In this case, usual evolutionary biology narratives about animal sexual coercion and subjugation of females may be false. [9]

The hemiclitoris in snakes was previously mistaken as scent glands. [10] This mischaracterization is reflective of a historical trend in science, where male-dominated perspectives have overlooked or misinterpreted female anatomy. [11] The human clitoris, a critical organ for sexual pleasure, has also been subject to such neglect. Up until the latter half of the 20th century, it was deemed socially unacceptable to discuss the clitoris openly. Only with a shift towards more inclusive and comprehensive scientific inquiry have we begun to uncover the full scope of clitoral function and its implications for our understanding of sexual behaviour, across species.

Future of Gender and Sex Norms

Regarding our project, the creation of sexual organs (such as a clitoris) outside the context of a human body has implications for the future of gender norms and the binary constructs of sex. It propels the discussion of gender fluidity into a new realm, where the biological basis of sex can be deconstructed and reassembled at the cellular level.

One existing microorganic model we can look to in formulation of new conceptualizations beyond binary sex distinctions is in the spectrum of fungal reproduction. Fungal reproduction diverges substantially from the mammalian binary system. In contrast to the two sexes found in mammals, fungi can possess numerous mating types, which are not confined to 'male' nor 'female'. [12] These mating types are determined by specific genes that encode for compatibility, rather than distinct sexual organs. Some fungal species can have thousands of different mating types, ensuring genetic diversity and adaptability. [13] In this context, biological sex is a spectrum, with an emphasis on genetic compatibility rather than predetermined roles.

The ability of fungi to engage in sexual reproduction with multiple mating types challenges traditional notions of gender and sex norms. It underscores the idea that nature is inherently diverse and adaptable, not confined by binary constructs. This adaptability allows us to explore biological systems outside their typical substrate, such as propagating cells in bioprinted forms and observing their behaviour.

Ethics of sexuality

The creation of a 3D bioprinted clitoris that is possibly capable of neural processing introduces profound ethical questions around the concept of consent. As previously indicated, consent is understood as a voluntary agreement to engage in a specific sexual activity. However, the parameters of consent become deeply complexified when we consider a bioengineered organ that has the ability

to 'perceive' and perhaps even 'feel' in response to stimuli, in a manner akin to sentient beings.

If a bioprinted organ possesses neural capabilities that mimic awareness or decision-making processes, how does this affect its autonomy? Can such a construct have preferences, make choices, or possess a form of will? And if so, how do we respect and ensure consent in interactions with it?

As earlier described, traditional frameworks of consent apply to human interactions where both parties are capable of understanding and communicating their willingness to participate. How do we adapt our understanding of consent when one party is an only partially human or human-derived, bioengineered tissue form? In medical ethics, when an individual is unable to give consent, a surrogate decision-maker is appointed. [14] Could there be a situation where proxy consent is considered for a bioengineered organ, and if so, who would be qualified to provide it? The tissue donor?

Philosophers have long debated the nature of consciousness and experience. [15] If a bioengineered construct can feel and process information, does it have a form of consciousness? Is it sentient? (Figure 5) What ethical theories could guide our interactions with such speculative entities, and how would they inform our understanding of consent?

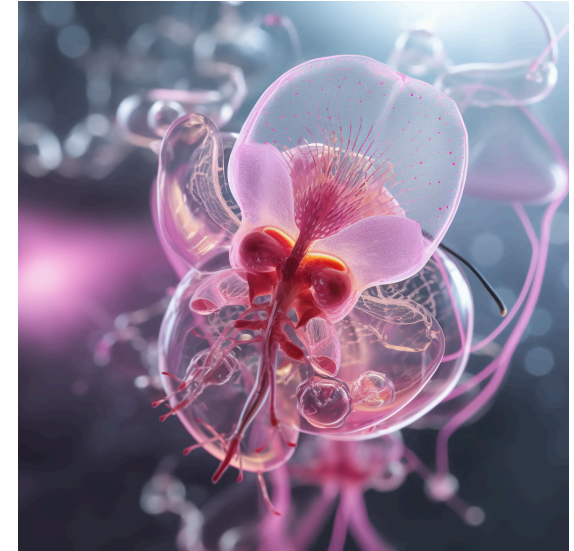


Figure 5. Digital rendering of a speculative synthetic sentient form © Jiabao Li, 2023.

Is it a sentient being?

Scientists have defined cellular synthetic sentience as, "being able to perceive and respond dynamically to sensory information." [16] This definition provokes a nuanced examination of the distinctions between sentience and consciousness. Sentience, as described, refers to an entity's ability to have subjective experiences and sensations, whereas consciousness implies a higher level of self-awareness, introspection, and the ability to contemplate one's existence. [17]

In drawing parallels, cellular sentience can be likened to a state of unconsciousness or 'dreaming', wherein there is perception and response to stimuli without full awareness. This comparison naturally leads into discussions around phenomena such as wet dreams, which occur in a state of unconsciousness yet involve physiological responses and sensations.

By conceptualising cellular sentience as a form of unconscious perception (Figure 6), we can explore how cells, while not conscious, might still

experience a form of ‘dreaming’. This perspective allows for intriguing debates around the boundaries of sentience and how we interpret and understand the experiences of cellular life.



Figure 6. Digital rendering of a speculative synthetic sentient form © Jiabao Li, 2023.

Wet (lab) dreams

A “wet lab” is a hands-on laboratory experiment space designed for the use of wet materials such as biological samples, chemical fluids, gels, and enzymes (Figure 7). Its design and operation includes measures to avoid wet hazards such as spills, leaks, and slips. Biotech and life science protocols require specialised wet labs wherein juicy and slippery, fleshy and leaky things can be ‘safely’ tested and manipulated. Procedures determine not only what is handled, but also requirements for how it is to be handled *and* considered: contained and under control.

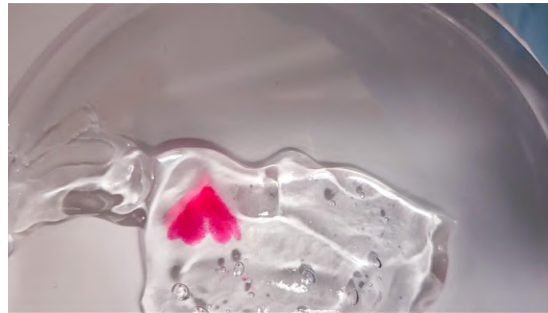


Figure 7. Video still, 3D bioprinted clitoris form in support gel © WhiteFeather Hunter, 2023.

When working with materials such as cells that have been differentiated along the neuronal pathway, and which have potential for ‘synthetic sentience,’ the concepts of containment and control are complexified. What if a neuron in a petri dish exhibits some kind of neuro-autonomy in response to its conditions? In vitro neurons have learned to play video games; can a 3D bioprinted clitoris seeded with neuronal precursor cells possibly dream? [18] In its ‘wet’ environment, is it wet-dreaming? In our project, we imagine the capacity of our differentiated menstrual stem cells for sensory perception linked to pleasure.

Female wet dreams have not as robustly penetrated the cultural dialogue around “nocturnal emissions” as those associated with penises; typically a wet dream is explicitly synonymous with the involuntary ooze of teen boys, likely due to more observable evidence. [19] Within the wet observatory of the tissue culture lab, could we witness evidence of an *in vitro* dreaming clitoral spasm?

Our 3D bioprinted clitorises, in their final iteration, will be a co-culture of both neuronal cell types (Figure 8) and cardiomyocytes (heart muscle cells) that have been differentiated from our menstrual stem cells. “Cardiac cells have a unique feature - they are able to contract without input from the nervous system.” [20] Since each individual *in vitro* heart cell will contract with a

‘heartbeat,’ our clitorises will not only potentially rhythmically pulse but also conceivably respond to the pulsing with electrochemical signalling by the neurons. Is this a form of synthetic pleasure for the externalised self?

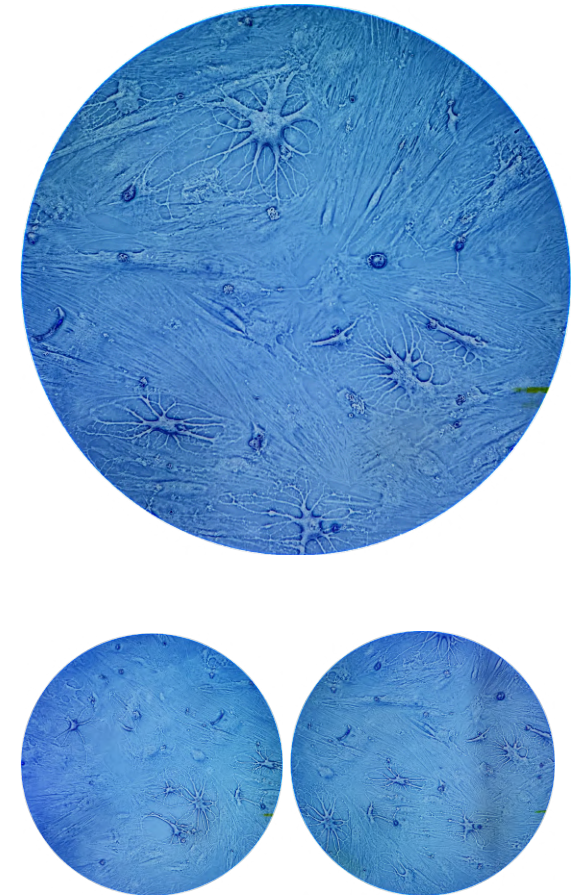


Figure 8. Menstrual cells in the process of differentiation on the neuronal pathway © WhiteFeather Hunter, 2023.

Externalised orgasm

An organism is typically defined as a living entity that maintains homeostasis, undergoes metabolism, has the capacity to grow, adapt to its environment, respond to stimuli, and reproduce. [21] When cells

are cultivated in a lab, away from their native environment, they continue to exhibit these characteristics autonomously, leading to questions about their identity and sentience. The ability of cells to function autonomously outside their source organism raises philosophical questions regarding the distinction between the body and the self, challenging the notion of a unified, indivisible entity.

In producing lab-grown clitorises, we open the possibility for disembodied pleasure, a sensual experience not confined to the limits of the human body. The fundamental requirements for achieving an orgasm have long been debated and are now understood to be a complex dance between psychological stimulus and physiological response [22]. The emergence of technologically mediated stimulation expands this notion by enabling physical pleasure to be elicited through devices and methods that do not rely on direct human contact.

As we delve into the capabilities of a lab-grown clitoris, we must question whether it too can “sense” arousal and derive pleasure. If pleasure is the product of neural responses to stimuli, and if a co-culture of neurons and cardiomyocytes can mimic some of the bioelectrical and biochemical events that occur during sexual stimulation, could we engineer a synthetic organ capable of producing a similar occurrence of arousal and climax? (Figure 9)

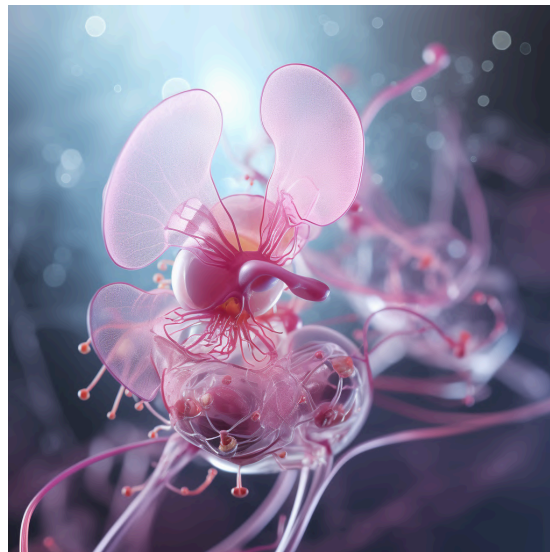


Figure 9. Digital rendering of a speculative synthetic sentient form © Jiabao Li, 2023.

By using our own cells to grow such an organ, we blur the lines between the self and the other, raising the possibility of experiencing pleasure from an external source that is nonetheless intimately connected to us. This brings us to the concept of the externalised self: Is an organ grown from one's own cells an extension of oneself? And if so, could engaging with this externalised tissue for sexual gratification be equated to a form of masturbation? The outside-of-body 'orgasm orchestra' not only challenges the normative one-body, one-orgasm paradigm but also invites us to consider the multiplicity of pleasure and the different ways it can manifest.

Ownership of this bioengineered organ becomes an intriguing philosophical question. If one derives pleasure from a clitoris grown from their own cells, the experience could be viewed as a personal and self-contained act. However, if the tissue is grown from another's cells, such as a friend's menstrual stem cells, the dynamic shifts. The act may not constitute infidelity in a traditional sense, yet it introduces a new dimension to the

discourse on sexual ethics and fidelity. It raises questions about the nature of sexual interaction and where the lines are drawn between self-pleasure, sexual activity with another person, and the use of bioengineered tissues for erotic gratification.

These questions compel us to confront not just the science of pleasure, but also the deeply personal and societal constructs that frame our understanding of sexual ethics. As we engage with these bioengineered organs, we are urged to examine the essence of our sexual selves, the fluidity of physical pleasure, and the profound implications of these technologies on the future of human intimacy.

Is it the same as lab-grown meat? The Biopolitics of Pleasure and Consumption

Ideally, both a lab-grown piece of meat, and a lab-grown clitoris would be ‘eaten’ in certain ways so... *what's the difference?*

So-called “lab-grown” meat, or “clean meat” is a would-be technoscientific industrial product of “cellular agriculture” wherein animal cells are grown *in vitro* into an edible form for human consumption [23]. Marketed (to solicit investor and public buy-in) as ‘ethical,’ ‘revolutionary,’ ‘ecological,’ and even ‘vegan,’ the concept of lab-grown meat is entrenched in *moral purity*.

Patriarchal attitudes towards women's sexuality often associate pleasure with immoral behaviour, one of the premises behind cultural practices of female genital mutilation. Since the time of the European witch hunts, the clitoris has been perceived as an embodiment of evil. Possession of a so-called “witch's teat” (clitoris) was offered as evidence of demonological witchcraft, since Lucifer supposedly suckled from it. [24] More contemporarily, clitoridectomies (surgical removal of the clitoris) have been performed to ‘cure’ masturbation in women; some

believe the procedure promotes “cleanliness.” [25][26]

While our laboratory protocol for culturing 3D bioprinted clitorises is similar to some of the tissue engineering methods used to cultivate lab-grown meat, it has not been industrially scaled for mass consumption but rather maintained as a small, personalised, synthetic hybrid tissue form designed to investigate notions of (female) erotic pleasure (Figure 10).



Figure 10. 3D bioprinted clitorises seeded with cardiomyocytes © WhiteFeather Hunter, 2023.

“The clitoris is the only known human organ that has the singular purpose of providing pleasure.” [27] Our *in vitro* clitorises could inspire the design of prosthetic organs for transplant into bodies that have been subject to removal procedures such as female genital mutilation/cutting, but what if they were implanted elsewhere? What if everyone had access to the experience of a clitoral orgasm? Alternatively, could the clitoris itself experience orgasm within the fluid environment of its petri dish? What might an *in vitro* orgasm look like?



Figure 12. Video still from *Sentient Clit* showing *in vitro* masturbation. Video edited by Jiabao Li, 2023.

OnlyFans

To represent an *in vitro* orgasm, we produced an evocative collaborative performance video that features a 3D printed prototype of the clitoris; our chosen platform for its premiere was OnlyFans (Figures 11, 12). The intent behind selecting a platform predominantly characterised by its adult content and intimate creator-audience interaction is to foster direct dialogue around the nuances of this work. Moving forward, OnlyFans will serve as the digital stage where we chronicle the developmental journey of the lab-grown clitorises. It will not only be a space for sharing the biological progress of this synthetic organ but will also be the canvas for the unfolding narrative that surrounds it. Through visual storytelling and regular updates, we aim to engage our audience in a continuous conversation about the convergence of art, science, and sexuality.

This platform choice represents a deliberate strategy to provoke thought and challenge preconceived notions about the intersection of scientific advancement and sensual expression. It's an invitation to our audience to witness the interplay between creation and sensation, to engage with the ethics of such innovation in an open exchange, and to consider the future implications of biotechnology in our understanding of pleasure and the human experience.



Figure 11. 3D printed resin clitoris prototype in a petri dish © Jiabao Li, 2023.

Digital Consumption

The digital consumption of our *Sentient Clit* video on OnlyFans navigates a complex cultural landscape, where viewers engage with content that straddles the lines between art, technoscience, and eroticism. As feminist performance art scholar, Amelia Jones has pointed out, feminist body artists disrupt and reframe traditional Western codes of female objectification. [28] They confront and subvert these codes, not only by representing the female form in unexpected ways but by reclaiming agency over how this representation occurs. Our project embodies these objectives.

In the digital space, especially on platforms like OnlyFans, content is consumed rapidly and often uncritically. However, our intention is to interrupt the passive consumption of erotic imagery. By bringing a biotechnologically crafted clitoris into the arena of OnlyFans, we provide content that is not only sensual but deeply enmeshed with layers of scientific and feminist discourse. We compel the audience to engage with the material not only on a visual or erotic level but also intellectually and ethically.

This act of digital display is not a passive surrender to the voyeuristic tendencies of the internet but meant as a bold statement of control. It embodies our reclamation of the narrative surrounding female sexuality and a redefinition of what can be considered erotic content. By holding the reins on how the lab-grown clitoris is depicted and shared, we are not only critical contributors to the digital ecosystem but also commentators and regulators of how sexuality, especially female sexuality, is consumed in the digital age.

Through our project on OnlyFans, we invite viewers to partake in a dialogue about the role of technology in sex, the power dynamics inherent in viewing versus creating, and the broader ethics of biotechnological art.

By controlling the narrative, we reiterate the clitoris — and by extension, female sexuality

— as a site of power, agency, and artistic expression, redefining digital consumption in a way that emphasises the creator's intent and the audience's active engagement with the content.

Biocapitalism

Some adult film actors sell “fleshlights” (a kind of sex toy) that are moulded from their vaginas to give their fans a more personalised experience. With a lab-grown clitoris, sex workers could potentially grow multiple clitorises from their menstrual stem cells and commoditize them. What would we be selling if we consider them ‘living’ beings with limited autonomy? Who has the right to capitalise on them as a surrogate orgasm product?

The potential for patenting and profiting from biologically derived materials implicates concerns of biocapitalism. Should biotechnological advancements derived from one's own body be considered personal property, and how do we address the commercialization of such intimate aspects of our biology? (Figure 13)

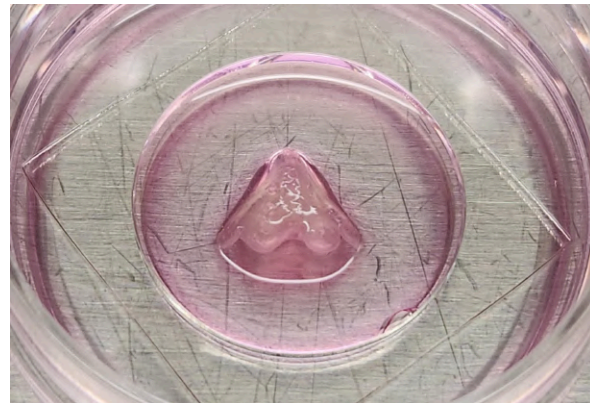


Figure 13. 3D bioprinted clitoris seeded with cardiomyocytes © WhiteFeather Hunter, 2023.

DIY Biohacking and Accessibility

In the next section, we openly offer a protocol for culturing cells derived from menstrual fluid, and

differentiating them into neuronal cell types for 3D bioprinting.¹

Although the provided protocol does presume some technical experience with basic cell culture, we offer it as a recipe for your TechnoFeminist ‘cookbook.’ Part of our working (feminist) ethos is the democratisation of biotechnological tools, including information about/ instructions for what we have found success with. For us, this also raises questions about access and the potential for misuse. What ethical frameworks must be established to ensure responsible use, and how do we secure equitable access to these technologies?

With these tools, what could be our next steps, towards further promoting bodily autonomy and lubricating attitudes towards female pleasure? Can we undermine the possible capitalist thrust to profit off of our bodies?

Menstrual stem cell culture and differentiation protocol

1. Using a medical grade silicone menstrual cup, collect menstrual fluid for the first two days of menstruation.
2. Pour collected menstrual fluid directly from the menstrual cup into sterile 15mL centrifuge tubes for transport to a lab. Label each tube with name, date, contents and keep refrigerated at 4°C until ready for transport.
3. Place tubes on ice blocks in a labelled styrofoam box for transport to the lab.
4. Centrifuge the tubes at 3500 rpms for 15 minutes to separate blood components: serum, tissue, red blood cells.
5. Pipette off the serum top layer and discard in a biohazardous waste container.

¹ Developed by WhiteFeather Hunter as part of her PhD research at the University of Western Australia.

6. Using a pipette, carefully extract a small amount of the middle tissue/mucus layer.
7. Explant the extracted tissue into sterile T-75 flasks filled with 20mL regular cell culture nutrient media: DMEM + 10% foetal calf serum + 1% Penicillin/Streptomycin antibiotics.
8. Incubate culture flasks overnight and then change nutrient media after 24 hours to flush out remaining red blood cells. Most tissue cell types such as stem cells will be firmly adhered to the flask.
9. Culture cells until flasks are confluent (70-80% coverage on the bottom surface of the flask).
10. When flasks are confluent, use 2-3mL Accutase to dislodge the cells. After cells are dislodged (may take up to 10 minutes in incubation), add 10mL nutrient media to each flask and pipette total cell suspension into a 15mL centrifuge tube.
11. Centrifuge tubes at 1500 rpms for 3 minutes to create a cell pellet at the bottom of each tube.
12. After centrifugation, pipette supernatant from the tube and resuspend the cell pellets in 1mL nutrient media.
13. Divide (subculture) the new cell suspension into new flasks filled with 20mL nutrient media, leaving aside a few tubes in liquid suspension for cryopreservation.
14. Use remaining cell suspension to prepare cryovials (add to 1mL neat foetal calf serum with 10% dimethyl sulfoxide) and store in a -80°C freezer.
15. Revive frozen cells for differentiation: thaw cells at 37°C and resuspend in 5mL cell culture nutrient media in 15mL centrifuge tubes.
16. Centrifuge tubes at 1500 rpms for 3 minutes.
17. Aspirate supernatant from tubes and resuspend cell pellets in 1mL cell culture nutrient media.
18. Culture revived cells (cell suspension) in 1:1 regular cell culture nutrient medium : prepared neural induction medium x 3 days.
19. Replace mixed medium with 100% induction medium x 4 days.
20. Replace induction medium with prepared differentiation medium x 8-14 days for neuronal cells.
21. Differentiated cells can be 3D bioprinted inside prepared gelatin methacryloyl (GelMA) and cultured longer-term into a clitoris-like “organ” or other forms.

Future works

As we mentioned earlier in this paper, scientists have proven that brain cells in a petri dish can play the video game, *Pong*. If this is the case, what could a cardio-neuronal clitoris in a dish do? We will experiment with the possibilities of the clitorises’ play on a dating app like Tinder, allowing it to make Yes and No choices. We plan to explore the notion of thinking with our female-originating equivalent of a “dickhead.” However, given that it will still have a heart-like resonance through the inclusion of cardiomyocytes, could it make choices based on some kind of ‘feeling,’ too?

Exhibition history

Iterations of this work have previously been shown at the Taboo–Transgression–Transcendence in Art & Science conference at Malta Society of Arts (27-29 September 2023); the Romaeuropa Festival as part of the DIGITALIVE program with Erinni (6 October 2023); Duende Art Museum (15 Dec 2023 - 15 Mar 2024); and the Museum of Witchcraft and Magic (1 April - 31 October 2024).

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