	Name	Collaborator Name and Location	Project Name	Image	Year	Employment of Biology	Description	Evidence of Literature Revealing Relationships and Roles During Projects
One-to-one	Fashion designer Helen Storey	Biologist Kate Storey	Primitive Streak Collection		1997	First 1,000 hours of embryonic process as inspiration	The *Primitive Streak* collection was produced by fashion designer Helen Storey and biologist Kate Storey as part of the Wellcome Trust's Sciart programme. It aimed to demonstrate the embryonic process and the first 1,000 hours of life, in the form of a collection of dresses. Outcomes included: the double DNA dress, anaphase dress and spinal column dress, which are representative in their illustration of the scientific process. For example, the Anaphase dress utilised a breast piece on the front of the garment, to shake when worn, which represented how the cells move as they divide (Helen Storey Foundation, 2008d). Although the collaboration was formed between the designer and biologist, a larger team at London College of Fashion aided in the physical making and production of the garments (Helen Storey Foundation, 2008c). A compilation of diary excerpts offers insights into the roles and methods employed and developed by the practitioners during the collaboration, revealing details such as laboratory and studio visits and how their collaborative approach worked (Helen Storey Foundation, 2008b). Roles and methods are stated, such as collaborative working approaches: 'we went straight into the collection. Both of us stare down again at the floor of sketches. Silences are full of negotiation, a process of teaching, learning, translation and agreed "artistic" representation. From Kate to me and back again' (Helen Storey Foundation, 2008b). However further information regarding the science fashion approach taken, specific roles and working methods and the opinions of the designer would be necessary to understand the mechanisms of the approach.	Diary excerpts (Helen Storey Foundation, 2008b)
	Contemporary artist Donna Franklin	Creative Scientist Gary Cass - Chief Executive Officer and Founder at Cass Materials (Cass Materials, 2020)	Micro'be' Fermented Fashion		2006	Bacterial cellulose as material for garments	*Micro 'be' Fermented Fashion* is a collaboration between contemporary artist Donna Franklin and scientist Gary Cass involving the production of dresses made by culturing bacterial cellulose (Franklin, 2014:23-26). Franklin and Cass began a collaborative residency at artist-led laboratory SymbioticA, where they used acetobacter (bacteria) and a red wine fermentation process to form layers of red cellulosic biomaterial, in the laboratory (Franklin, 2014:23). The artist stated that she chose fashion and the garment as a tool in order to 'draw parallels with its role as a form of cultural identity and social communication' (Franklin, 2014:24). Although Franklin states that she employed Devlin's (2009) notion of interdisciplinary praxis, in which disciplinary roles are maintained (Franklin, 2014:2), her PhD thesis does not make explicit the methods and operational details of the roles and approaches taken during the collaboration by herself and Cass, as this was not the topic of her research.	Focus is towards practice-based modes of dissemination, rather than relationships and roles
Artist or fashion designer-in-residence	Natsai Audrey Chieza	1. Chieza worked as *designer-in-residence* in Professor John Ward's laboratory - Synthetic Biology team at University College London Biochemical Engineering (Chieza, 2013; University College London, 2020). 2. Chieza was creative-in-residence at Ginkgo Bioworks (Ginkgo Bioworks, 2020)	Project Coelicolor (2011-ongoing) Faber Futures (2017-ongoing)		2011-ongoing	Bacteria to make inks for dyeing textiles - *Streptomyces coelicolor* produce actinorhodin to dye textiles (Faber Futures, 2020)	Chieza is a designer and researcher, who has carried out residencies at University College London and Ginkgo Bioworks. She is founder of Faber Futures, a research and development studio looking into biotechnology and biodesign (Chieza, 2013; Chieza, 2020). The *Project Coelicolor* explores dye production using bacteria to produce pigments. Chieza worked with Professor John Ward at University College London using bacteria to produce pigments as a 'by-product of their metabolic activity' (Chieza, 2013), altering the nutrients fed to the bacteria. The microbes are fermented in solid-state on the textiles, the manipulation of which generates the print (Chieza, 2022). In this way, this technique differs from the more extractive process of pigment isolation, as Chieza's approach is less resource-intensive and toxin-free since no further inputs including water and other fixative chemicals are required to create finished prints (ibid.). The potential for generating and painting using bacterial dyes has possibilities for use in textiles and fashion applications in the future although drawbacks could occur in upscaling and industrialising the methods (Chieza, 2013).	Focus is towards practice-based modes of dissemination, rather than relationships and roles
	Oron Catts and Ionat Zurr	SymbioticA	Victimless Leather Project - A Prototype of Stitch-less Jacket grown in a Technoscientific "Body" (part of the ongoing Tissue Culture and Art Project)		2004	Mammalian Tissue Cultures - 'biodegradable polymer connective and bone cells' (Catts & Zurr, 2017)	Oron Catts and Ionat Zurr are active art practitioners working with tissue culture and engineering in order to provoke debate around the problems related to developing areas such as in-vitro laboratory grown meat. They run SymbioticA, an artist-led research laboratory, at the University of Western Australia. Their work *Victimless Leather* is an example of a self-supporting system created using tissue cultures. The artists grew a leather jacket using a scaffold and mammalian tissue cells from mice into the shape of a jacket, keeping the cells alive throughout the exhibition and then staging a public ritualistic 'killing' of the piece at the end of their residency (Catts & Zurr, 2016). The installation is intended as an object to initiate and stir debate about the bioethical concerns for tissue engineering and biotechnology, rather than as a possible future design solution. To do this, Catts and Zurr align their work with art rather than design, and work in an applied way - making use of living cells. The aesthetic of working with living matter was termed by Catts and Zurr as 'the aesthetic of disappointment' (Ross, 2015). In working with mammalian tissue and growing objects such as their *Victimless Leather* project, the hype and spectacle meant that the actuality and the physicality of the piece led to disappointment for the spectators and viewers, within an exhibition (Catts & Zurr, 2016). The primary aim of the artists, however, was not to make the piece aesthetically appealing but rather to ask society to look critically and to question acceptance of leather and growing in vitro meat, asking which one would be more acceptable to our human ethical and moral codes. Is it better to grow meat and textiles such as a 'Victimless' leather in a laboratory in order to sustain earth's human population in the future? And can this way of working ever be truly victimless? Catts and Zurr create contestable objects and artworks, including an in-vitro grown meat project called *Disembodied Cuisine* (Catts & Zurr, 2007:242), in order to critique and question these developments within the areas of synthetic biology and tissue engineering. In describing their works as 'semi-living sculptures' (Catts & Zurr, 2007:233) they liken ingesting as the 'form of the ultimate exploitation: that of consumption, of eating' (Catts & Zurr, 2007:242). Although they make visible the working of the scientific apparatus required to sustain the work, the way in which the artists work together and with technicians or applied scientific knowledge is not made explicit.	Focus is towards practice-based modes of dissemination, rather than relationships and roles
	Anna Dumitriu	Modernising Medical Microbiology Project, Public Health England, The University of Oxford, The University of Hertfordshire, Brighton and Sussex Medical School, and Alex May (Dumitriu, 2018)	Sequence Dress - part of the ongoing Sequence Project (Dumitriu, 2018)		2015-ongoing	Bacteria - DNA from Staphylococcus aureus bacteria	Dumitriu is an artist who works directly in laboratories and uses bacteria in her work. Her artworks explore humanity's relationship with bacteria and the microbial world, biomedicine, technology, and synthetic biology and she was artist-in-residence at the University of Oxford, on the Modernising Medical Microbiology Project (Dumitriu, 2018). The *Sequence* Project made use of the form of a dress combined with Dumitriu's own DNA. The project was a collaboration between microbiologists, bioinformaticians, computer scientists and ethicists from the Modernising Medical Microbiology Project, Public Health England, The University of Oxford, The University of Hertfordshire, Brighton and Sussex Medical School, and artist/programmer Alex May' (Dumitriu, 2018). The artist used a type of bacteria (Staphylococcus aureus) from a sample taken from her nostril, describing it as the 'non antibiotic resistant form of the MRSA 'superbug' (ibid.). Dumitriu then mapped the entire sequence of this bacterial DNA and projected it over the dress. 'The dress itself was stained with and patterned using the same bacteria, which she grew on colour changing agar, as well as with antimicrobials (ibid.).	Focus is towards practice-based modes of dissemination, rather than relationships and roles
Team	MIT BioLogic Project	MIT Media Lab - Tangible Media Group, MIT department of chemical engineering, Royal College of Art and New Balance (Yao et al., 2015)	'Second Skin'		2015	Bacteria - Bacillus Subtilis (natto) cells	*Second Skin* and the *BioLogic* project is an interdisciplinary team project involving designers Oksana Antillonyte and Helene Steiner, the MIT Media Lab - Tangible Media Group (who led the collaboration), MIT department of chemical engineering, Royal College of Art and New Balance. The team produced 'second skin' performance garments using bioreactive processes whereby natto fabric opened, peeling back when in contact with moisture and perspiration (Yao et al., 2015). The team used a bacterial microorganism found in the Japanese fermented soya bean food Bacillus Subtilis (natto) – which reacts to moisture by shrinking and enlarging. They printed the natto cells which were then assembled onto strips of fabric allowing the material to take on these expansion and contraction properties. The final garment consisted of laser-cut diamond gaps which contained the strips of natto covered fabric. Once the wearer started to perspire, and the humidity increased, the flaps opened creating a cooling system, integrating this bacterial process within the garment design (Yao et al., 2015). Details of the team members and their key roles included Lining Yao, who led the concept and worked on interaction design and fabrication, Alana Solá who provided additional support in trend forecasting and fashion concept development, and fashion designer Oksana Antillonyte who was brought into the team at a later stage to create the garments using the technology produced and developed by the team (Yao et al., 2015).	Focus is towards practice-based modes of dissemination, rather than relationships and roles
	Sputniko!	Commisioned by Gucci for Gucci Art Gallery, Tokyo. Produced in collaboration with the National Institute of Agrobiological Sciences (NIAS), Masataka Hosoo weavers, and fashion designer Masaya Kushino	Trancelflora – Amy's Glowing Silk		2015	Silkworms engineered to incorporate fluorescence, using synthetic biology	*Trancelflora – Amy's Glowing Silk* is a project developed by Sputniko! and commissioned by Gucci specifically for display at the Gucci Art Gallery in Tokyo, in 2015. Synthetic biology is used in the project as the transgenic silk used incorporates fluorescence, a technique which was developed and genetically engineered by the National Institute of Agrobiological Sciences (NIAS) in Japan in 2008. The scientific laboratory engineered fluorescent proteins, originally extracted from forms of jellyfish and coral, and injected them into the eggs of silkworms. This produced a genetically engineered form of glowing silk using synthetic biological processes. The use of green and red fluorescent proteins ensured that the silk glows under ultraviolet light. During the exhibition, the garments were shown under blue light-emitting diode (LED) lights and glasses were given to exhibition visitors, which contained orange filters as the lenses, in order to view the green glow from the transgenic silk. Sputniko! worked directly with the laboratory and genetic engineers, and researcher Professor Sezutsu at NIAS, as well as craftspeople such as the traditional kimono silk producers. The silk was produced by weavers at Masataka Hosoo and then made into garments and shoes designed by fashion designer Masaya Kushino. The collaborators are all credited, and the project was created under the name of Sputniko! – designer, artist and researcher Hiromi Ozaki (Sputniko, 2019). Sputniko!'s methods of production are often collaborative and interdisciplinary, encompassing elements of pop culture, technology, art, design and research. The work, *Trancelflora – Amy's Glowing Silk* is one of the few examples of an applied project, where genetic engineering has actually (rather than speculatively) been used in order to create the transgenic silk, and thus acts as an example of an interdisciplinary synthetic biology and design project. The applied nature of the project is made possible by access to the research and genetically engineered silkworms and cocoons of the scientists, which otherwise would have remained unseen by a wider audience and public, and may just have been viewed by the laboratory itself. What remains hidden are the shared methods and processes behind the collaboration, with a focus instead on the final art installation as a cultural artwork, blending aesthetics, storytelling and biotechnology.	Focus is towards practice-based modes of dissemination, rather than relationships and roles
Research	Amy Congdon	Congdon conducted the *Biological Atelier: SS 2082 'Extinct' collection* as a critical design project for her final masters at MA Material Futures, Central Saint Martins. Congdon later carried out applied research projects working directly with tissue culture for her PhD, such as *Tissue Engineered Textiles*, in collaboration Professor Lucy Di Silvio, Tissue Engineering department at King's College London (Ward, 2019; King's College London, 2020)	Biological Atelier: SS 2082 'Extinct' collection		2011	Speculative design probe	Amy Congdon is a textile researcher and designer who looks at tissue engineering and its integration with textile design practice, to analyse implications and potential applications within the context of living materials (University of the Arts London, 2018). Her practice has spanned speculative as well as applied research methods, in conjunction with the tissue engineering department at King's College London. Congdon's *Biological Atelier: SS 2082 'Extinct'* collection is a critical design project taking the concept of new luxury to speculate on the future potential for biotechnology within luxury textile products (Congdon, 2016). The project takes the notion of growing new materials or material hybrids, to produce a speculative design collection of grown-to-shape wearable jewellery pieces that could be formed from leather and scales in the laboratory. If products could be designed and grown to certain specifications such as colour, size and shape in the laboratory then this could offer potential for more sustainable methods for design production. The project speculates that engineered biomaterials might one day be used to grow fashion and textile pieces, potentially using human skin cells or the body (Congdon, 2016). Congdon thus utilised the medium of textile design, posing the collection as a critical design project, to ask questions about our acceptance of human or animal skin cells and methods of biotechnology for future textile and object design. As with Chieza's collaboration with Professor John Ward at University College London, Congdon's scientific collaboration with Professor Lucy Di Silvio at King's College London for projects such as *Tissue Engineered Textiles* is not explicated, and thus the workings of the roles, approaches and methods remain a hidden part of the process (Congdon, 2020). The scientists become a silent part of the process, assuming a role of silent collaborator. It is the final outcomes and objects which are made public in the practitioners' work, shared and publicised in photographs and videos, in the press and at exhibitions.	Focus is towards practice-based modes of dissemination, rather than relationships and roles
	Modern Meadow	Company comprising teams of engineers, materials and design research and development (Modern Meadow, 2020)	Zoa™ (Modern Meadow, 2020)		2017	T-shirt incorporating Zoa™ material made using collagen protein	Modern Meadow is a material development, design and research company focusing on the industrialisation of biomaterials (Lee, 2019a). It is an interdisciplinary company merging designers, research and development, material scientists and engineers (ibid.). Companies such as Modern Meadow are looking towards synthetic biology and engineering practices to research future applications for industrialised biomaterials. These materials may have future applications for: materials and clothing, architecture and (for example) industrial water purification membranes (Flórea et al., 2016). Modern Meadow develops new biomaterials such as Zoa™, described as 'the first ever biofabricated leather material made using collagen protein' (Modern Meadow, 2020). The first garment that Modern Meadow launched incorporating Zoa™ material was a t-shirt which was shown at the Metropolitan Museum of Art, during the *Is Fashion Modern* exhibition in 2017. The t-shirt operates as a democratic and accessible form. Its placement in an exhibition enables the garment to operate as an educational tool highlighting concepts surrounding biotechnology. The decision to showcase in an exhibition allows the focus to be on the innovative nature and construction of the material. Within a commercial fashion environment, the novelty and story of the biomaterial may have been distilled and the material might be considered instead for its aesthetic, physical and tactile qualities. The material is not yet commercially available (Modern Meadow, 2020). The focus reamins on final outcomes or prototypes, such as the Zoa™ t-shirt shown at the Metropolitan Museum of Art in 2017, rather than on publicly sharing the workings and nuances of collaboration within a commercial setting, such as at Modern Meadow.	Focus is towards practice-based modes of dissemination, rather than relationships and roles
Speculative	Carole Collet	Living Systems Lab at Central Saint Martins, London	BioLace project: Biolace, Design and Biofacture, Horizon 2050 (Collet, 2015b)		2010-2012 (Collet, 2015b)	Speculative scenario - design project speculating on design possibilities using synthetic biology	Professor Carole Collet, Professor in Design for Sustainable Futures at Central Saint Martins, is an example of a pioneer particularly in projected research for textile futures (University of the Arts London, 2019b). Her practice looks at long-term probes to design textile futures, incorporating speculative and applied research methods, and she frequently integrates fashion and textile practice with scientific and, in particular, notions and theories surrounding biological design, biology and synthetic biology. Her own interests and research stem from sustainability and the potential for biological design towards sustainable textile futures. For the *BioLace* project, Collet researched and produced speculative design probes imagining how plants may be adapted and engineered in order to produce fruit, as well as textiles such as lace. In this way, Collet contemplates how biotechnology could aid in creating sustainable manufacturing processes by combining food and textiles production, through the use of synthetic biology, by genetically programming plant roots (Collet, 2012a; Collet, 2012b). Collet states that 'with synthetic biology, we can now 'biofabricate' like Nature does' (Collet, 2015a:12). In this context, Collet suggests that innovations in biotechnology, such as those involved in synthetic biology, will enable scientists and practitioners to grow, engineer and produce hybrid biological materials in a similar way to the processes already carried out in biology.	Focus is towards practice-based modes of dissemination, rather than relationships and roles
Through fashion	Suzanne Lee	Dr David Hepworth, Co-Founder, Biologist and Materials Scientist at Cellucomp (Lee, 2005:64)	Biocouture		2004 (Lee, 2019a)	Bacterial cellulose as material for garments	Suzanne Lee founded *Biocouture* in 2004, before working as Chief Creative Officer at Modern Meadow from 2014-2019 (Lee, 2019a). Lee is founder and Chief Executive Officer at Biofabricate - running the annual Biofabricate conference which brings together companies, researchers, designers and scientists at the intersections of biology and design. The conference allows Lee to convene the key members of the biodesign community and to share knowledge and opinions within the area. During *Biocouture*, Lee looked at the potential for using the fermented skin of the kombucha production process (Katz, 2012:171) and using dried Symbiotic Colonies of Bacteria and Yeast (or SCOBYs) as biomaterials for garments. Bacterial Cellulose is the by-product of a fermentation process used to produce a kombucha tea (Childs & Childs, 2013:27). Lee was interested in its material properties, as bacterial cellulose is biodegradable and compostable, although identified setbacks in its ability to be upscaled in terms of economic viability (Lee, 2022). However, it is the idea of 'organisms [... and] microbes as the factories of the future' (Fairs, 2014), which interested her about working with bacterial cellulose. As part of the *Biocouture* project, Lee developed home-brew fermentation experiments which led to the production of cellulose for items such as bespoke skirts, shoes and shirts using the dehydrated microbial cellulose. This biomaterial has a similar look and feel to leather (or paper) but provides the prospect of a vegan alternative. The key problem isolated by Lee through her research and experiments with the bacterial cellulose material were in terms of technological scalability (Lee, 2022). Again, specific information regarding the working mechanisms of the team behind *Biocouture* and the modes of collaboration between Hepworth and Lee is not disclosed.	Focus is towards practice-based modes of dissemination, rather than relationships and roles
Competitions	BioDesign Challenge (founded by Daniel Grushkin)	Chief Innovation Officer: Tessa Callaghan, Chief Executive Officer: Aaron Nesser, and Chief Operations Officer: Aleksandra Gosiewski, Co-Founding Technical Advisor: Asta Skocir and Co-Founding Scientific Advisor: Theanne Schiros (Bonime, 2018; AlgiKnit, 2020)	AlgiKnit		2016-ongoing	Kelp (seaweed) to produce biopolymer yarn through extrusion processes for knitting (Bonime, 2018)	Biodesign Challenge was founded by Daniel Grushkin in 2016, growing from a competition between nine teams from universities based in America, to 2021 when over fifty teams competed (Biodesign Challenge, 2022). Biodesign Challenge has acted as a springboard, leading to new start-ups, commercial ventures and companies - echoing the model of the International Genetically Engineered Machine (iGEM) competion for students and teams in Synthetic Biology. As with the iGEM competition, each of the Biodesign Challenge projects are available to view online (ibid.). The Biodesign Challenge offers a platform for artists and designers to work on a project as a team incorporating biological or biotechnological elements, towards design applications. These values and drivers show an intention to accelerate opportunities for designers in developing a larger biological design community, and in engaging with the public. Criticality, ethics and debate are all central foci, which are especially important due to engaging with living systems and biotechnology. Biodesign Challenge has lead to new opportunities competitors, although the project is still at an early stage to understand its full impact. One example emanating from Biodesign Challenge is AlgiKnit. The team members won the 2016 Biodesign Challenge and have since gone on to found and run their own start-up company focusing on the production of a biopolymer created using kelp, with the aim to produce sustainable yarns due to their rapid degradability (especially in comparison to plastic polymers). After winning Biodesign Challenge, AlgiKnit won a series of funding from accelerators in order to create their start-up (Bonime, 2018). Their backgrounds in knit (the team worked from the Fashion Institute of Technology during the Biodesign Challenge) led to the production of polymers in yarn to enable knitting. The company are researching and developing the manufacturing process to scale-up and the team have constructed a proof-of-concept prototype trainer, made using AlgiKnit yarns. Again, the focus of AlgiKnit is centred on commercial drivers through the production of innovative materials (in this case biopolymers for yarns) rather than on sharing collaborative working methods, processes and revealing how the team interacts. The proof-of-concept provides an example of a tangible product (here a trainer) which can allow people to view the potential of the yarns, and to showcase how the biotechnology may be used in applications.	Focus is towards practice-based modes of dissemination, rather than relationships and roles