BIOART ALCHEMY

WORKS BY ANNA DUMITRIU

16TH SEPTEMBER 2022 – 30TH OCTOBER 2022

SPACE A, SPAZJU KREATTIV
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INTRODUCTION

This exhibition by internationally renowned British bioartist, Anna Dumitriu, draws threads across time from the history of science and medicine to cutting-edge research in synthetic biology and genomics. Her strange and affecting objects take the form of relics of Dumitriu’s sublime laboratory-based processes created in contemporary biomedical research settings, interwoven with historic stories of contagion and alchemy.
EXPLORING NEW AVENUES OF THOUGHT AND DISCUSSION THROUGH ARTS AND CREATIVITY

When coming across Anna’s work, one immediately notices the intricate detail that goes into each of her exhibits. Every one of her projects is the culmination of a meticulous research and experimentation process, which seeks to connect the worlds of science and art into one creative expression.

This commissioned exhibition reflects our strategy to be catalysts in our sector by showcasing innovative work that champions artistic excellence, develops opportunities for cross-sectoral collaborations and promotes Spazju Kreattiv, as the National Centre for Creativity, beyond our shores.

In this context, BioArt Alchemy is a prime example of how art can facilitate conversation between different schools of thought. In fact, through the study of biology and genomics, together with her background in fine arts, the artist manages to create intricate narratives of histories of alchemy and contamination in a highly innovative manner. Such practice allows for encounters between experts from different fields and nurtures outlets for collaboration. It also provides the space for those in attendance to explore realities beyond convention from perspectives that can be deeply appealing.

Consequently, the investment made by Spazju Kreattiv, in collaboration with Esplora Interactive Science Centre and Science in the City, is meant to provide a platform for creative discourse and for visitors to view arts and creativity through a vast scope of new opportunities.

As I wish you a nice view of the exhibition, I hope this experience will intrigue you to explore diverse avenues of thought and discussion.

Daniel Azzopardi
Spazju Kreattiv Artistic Director
BIOGRAPHY

Anna Dumitriu is an award-winning British artist who works with BioArt, sculpture, installation, and digital media to explore our relationship to infectious diseases, synthetic biology and robotics. Past exhibitions include ZKM, Ars Electronica, BOZAR, The Picasso Museum, HeK Basel, and MOCA Taipei. She holds artist-in-residence roles with the Modernising Medical Microbiology Project at the University of Oxford, and the National Collection of Type Cultures at the UK Health Security Agency. Current collaborations include the Institute of Epigenetics and Stem Cells at Helmholtz Zentrum in München, The Wellcome Sanger Institute, and the University of Leeds.
My work draws threads across time from the history of science and medicine to cutting-edge research in synthetic biology and genomics. The artworks, made with diverse materials including DNA, bacteria and yeasts, take the form of strange relics of sublime laboratory-based processes created in contemporary biomedical research settings, interwoven with historic stories of contagion and alchemy. I aim to affect audiences through emotions as well as the intellect because science is, at heart, an aesthetics-driven process.
INTRODUCING BIOART

BioArt is an emerging area of artistic practice that brings together art and science, using biological media and scientific as well as artistic methods to create artwork. It explores the relationship between humans, science and ethics.

Bioartists work with living organisms such as bacteria or tissue. They also explore life processes using scientific methods such as biotechnology and genetic engineering and artworks may be produced in laboratories, galleries, hacker spaces, or artists’ studios.

With the impact of biotechnological progress and human involvement in everything from the environment to DNA, far-reaching discoveries have created fertile ground for artistic expression. The work of bioartists can help offer new meanings for our lives in the wake of scientific discovery or raise issues for societal and ethical debate.

Anna Dumitriu is internationally recognised as a pioneer in BioArt and known for her work with bacteria and synthetic biology.
Fermenting Futures Series
Introduction

Fermenting Futures is a recent body of artworks exploring the importance of yeast, from cultural, scientific, ethical and aesthetic perspectives.

Yeast’s ability to ferment the alcohol and make bread rise has played a key role in the development of human civilisation from ancient times, but now these works ask us to consider how yeast biotechnology might help us confront global environmental problems such as climate change and plastic pollution in the future.

Credit: Anna Dumitriu and Alex May, in collaboration with Professor Diethard Mattanovich, Professor Michael Sauer, Dr Özge Ata and Dr Martin Altvater at the Institute of Microbiology and Microbial Biotechnology of the University of Natural Resources and Life Sciences Vienna, Austria. Curatorial support for the project has been provided by Wolfgang Giegler and Sonja Schachinger.

The Fermenting Futures project was supported by the Federal Ministry for Digital and Economic Affairs (bmdw), the Federal Ministry for Transport, Innovation and Technology (bmvi), the Styrian Business Promotion Agency SFG, the Standortagentur Tirol, Government of Lower Austria and Vienna Business Agency through the COMET-Funding Program managed by the Austrian Research Promotion Agency FFG. The funding agencies had no influence on the conduct of this work.
FERMENTING FUTURES SERIES: FERMENTING FUTURES

Materials: Glass, silicone tubing, 3D printing, acrylic paint, pump, horse chestnut, liquid containing killed yeast

Year: 2021

Fermenting Futures contains yeast that has been genetically modified using a technique called CRISPR. It is simultaneously able to capture carbon from the environment and output lactic acid, which can be used for the manufacture of biodegradable plastic for 3D printing.

The bubbling modified Pichia pastoris yeast is housed in a glass vessel which is sustained by a mass of tubes. 3D printed yeast forms swarm across the container, including one made using yeast-produced plastic. The work sits atop a block of horse chestnut wood, referencing how the wild Pichia pastoris yeast was originally found in the sap of this tree.

FERMENTING FUTURES SERIES: CULTURE

Materials: Foamcore, breadcrumbs, 3D printing, electrical components, acrylic paint, soil

Year: 2021

Culture investigates the co-evolution of yeasts and humans, through the intertwined relationship of fermentation, bread, beer, and human settlement.

Since ancient times yeast has been integral to human life and some historians believe that the ability of Saccharomyces cerevisiae yeast to ferment alcohol and leaven bread has directly resulted in the development of human settlement, as people needed to stay in one location to grow crops in order to brew beer and make bread.

Nowadays it is possible, through biotechnology, to give a non-fermenting Pichia pastoris yeast the ability to make bread rise. In the installation, a jumble of breadcrumb-encrusted architectural models coated with this novel genetically modified yeast, emerge from a bed of earth. The buildings are piled one on top of the other, or side by side, representing the development of culture. They are furnished and wallpapered, wired with electric lights, and illuminated by the glare of tiny screens, visible through 3D-printed windows and doors.
FERMENTING FUTURES SERIES: THE BIO-ARCHAEOLOGY OF YEAST

Materials: Plaster of Paris, acrylic paint, glue
Year: 2021

The Bio-archaeology of Yeast investigates the field marks created by yeasts on antiquities, artworks and sites of cultural heritage. The work explores these bio-deteriorative, extremophile microorganisms, known collectively as ‘black yeasts’, not as dirt, but as objects of aesthetic appreciation in their own rights, a perspective usually only available to the researchers in the lab in their more reflective moments. The artists have cast the intricate sculptures using moulds derived from 3D photogrammetry scans of minute living ‘black yeast’ colonies made in the lab, and the pieces have been hand-painted and augmented with dried yeast.

FERMENTING FUTURES SERIES: PIGMENTS SERIES

Materials: Sterilised yeast pigments, embroidery, calico, silk and linen lace
Year: 2021

Pigments is a series of textile works that explore how yeasts naturally produce pigments such as melanin to protect themselves from sunlight, just as humans do. Microbial pigments are being studied as a sustainable alternative to chemical dyes for use in the fashion and food industries.
HYPERSYMBIONT DRESS

Credit: Anna Dumitriu in collaboration with Professor John Paul, Kevin Cole, Dr James Price, Dr Rosie Sedgwick, Dr Daire Cantillon, Dr Simon Waddell, Professor Martin Llewellyn and Alex May. With thanks to Modernising Medical Microbiology and Brighton and Sussex Medical School. Originally commissioned by The Museum of Contemporary Art Taipei and developed for the Technology and Emotions Conference, Oslo.

Materials: Silk dress, with bacteria, DNA and video-mapping

Year: 2013 - 2017

The Hypersymbiont Dress is stained and video mapped with bacteria that may have the potential to enhance us. It draws attention to ways in which our own bacterial flora or even foreign pathogens, could be enhanced to turn us into human super-organisms, with improved creativity, improved health and even improved personalities. The concept of this artwork comes from new technologies, such as whole genome sequencing and synthetic biology, which allow humans to understand more about symbiotic bacteria and to find possible ways to drive our own evolution at a cellular level.

The dress is stained with normal environmental bacteria from a Winogradsky Column (an in vitro bacterial ecosystem), *Mycobacterium vaccae*: a soil bacterium that enhances cognitive function by increasing serotonin levels, MRSA: a drug-resistant bacterium that can interface with the human nervous system and affect how we feel pain, and *Bacillus Calmette Guerin* (BCG): a form of attenuated Bovine Tuberculosis, a bacterium strongly linked to creativity throughout history. The video mapping of the dress is created from a film of the artist’s own blood fighting an infection with BCG which, although used as a vaccine for Tuberculosis, can also be a human pathogen in its own right in some cases. Dumitriu safely infected her own white blood cells in vitro in the lab with this bovine tuberculosis. Playing with the notional link between TB and creativity that has reappeared throughout history. She has also used the sterilised infected blood as an artistic medium.

PASTORIANUM

Credit: Anna Dumitriu, in collaboration with Kevin Cole and Professor John Paul, Modernising Medical Microbiology, and Dr Jane Freeman and Dr Caroline Chilton, The Healthcare Associated Infection Group at the University of Leeds.

Materials: Flax, vintage hair wreaths, resin, glass, metal, calico, killed bacteria

Year: 2018

"Pastorianum" responds to the mythology around linen and explores bacteria responsible for the retting (rotting) of flax, a key part of the manufacturing process of linen. The work takes the form of a necklace woven together from unspun natural flax, antique human hair wreaths, glass beads containing *Clostridium pasteurianum* bacteria, beads made from resin and linseed, Irish linen lace and embroidered cloth impregnated with *Clostridiodes difficile* bacteria and mud from a captive bacterial ecosystem known as a Winogradsky Column.

The pioneering Russian microbiologist Sergei Winogradsky was obsessed with microbial ecosystems. In the 1890s he published papers on the bacteria involved in the retting of flax, which includes Clostridia species and also on a novel nitrogen-fixing bacterium *Clostridium pastorianum* which translates to “spindle from the field” but the name was later changed to *Clostridium pasteurianum* in honour of his colleague Louis Pasteur. It is part of the species known as Clostridia which also includes the disease-causing ‘superbug’ *Clostridiodes difficile*.
**SPINDEL**

**Credit:** Anna Dumitriu, in collaboration with Dr Jane Freeman and Dr Caroline Chilton, The Healthcare Associated Infection Group at the University of Leeds.

**Materials:** Vintage linen, linen thread killed bacterial biofilms

**Year:** 2018

In “Spindle”, three-dimensional solid sculptural appendages, which resemble drop spindles, have been created using the interaction between crocheted linen lace and biofilm, producing bacteria from the human gut, including spindle-shaped *Clostridioides difficile*. These are threaded into an antique linen lace collar. When flax is retted (rotted), bacteria, including bacteria from the genus known as Clostridia swarm over the plant stems and help to separate the fibres often creating bacterial biofilms which help the microbes cling together. In disease-causing *Clostridioides difficile* bacteria, these biofilms formed in the human gut make the bacteria harder to treat. Clostridia can also form spores that are resistant to antibiotics. Clostridium is derived from the Greek word for the spindle.

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**THE ART AND SCIENCE OF LINEN**

**Credit:** Anna Dumitriu and Alex May, in collaboration with Dr John Paul, sound by Martin A. Smith, with thanks to Robert Martin, The Irish Linen Centre and Lisburn Museum and McConville’s Flax Mill & Museum

**Materials:** Video

**Year:** 2011

This video art piece explores the role of bacteria in the production of linen textiles. It looks at the whole ecology of linen production from the bacteria used to break down the stems of flax plants in retting (rotting) tanks to the industrial production of linen and its cultural importance in the creative arts. It was inspired by pioneering microbiologist Sergei Winogradsky who isolated the beneficial bacterium *Clostridioides pasteurianum* involved in the retting of flax in 1893-95. In his day Winogradsky was considered a maverick as he believed bacteria could not be properly studied in isolation from their complex ecosystems but has since been proved correct.
MAKE DO AND MEND

Credit: Anna Dumitriu in collaboration with Dr Sarah Goldberg and Der Roee Amit at Technion, and an additional collaboration with Dr Nicola Fawcett. Funded via the FEAT Project. FEAT is funded by the EU- backed programme FET (Future and Emerging Technologies) Open. It has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 686527 (H2020–FETOPEN–2015–CSA)

Materials: Vintage CC41 women’s suit patched with silk grown with E. coli bacteria which has been genetically modified using a technique called CRISPR (sterilised and dead), vintage sewing machine and embroidery silk, textiles, vintage leaflets, glass bottles with CRISPR plasmids and antibiotic discs

Year: 2016-17

“Make Do and Mend” references the 75th anniversary of the first use of penicillin in a human patient in 1941 and takes the form of an altered wartime women’s suit marked with the British Board of Trade’s utility logo CC41, which stands for ‘Controlled Commodity 1941’. The holes and stains in the suit have been patched with silk and linen lace stained with pink colonies of E. coli bacteria, grown on dye-containing agar. The genomes of these bacteria have been edited using a technique called CRISPR, to remove an ampicillin antibiotic resistance gene and scarlessly patch the break using homologous recombination with a fragment of DNA encoding the WWII slogan “Make Do and Mend". Ampicillin is part of the penicillin group of antibiotics so with this artistic genomic edit, Anna Dumitriu and her collaborator Sarah Goldberg have used today’s technology to return the organism to its pre-antibiotic era state, reflecting on how we might in the future control and protect such biotechnological advances. Here, linen can be seen as a metaphor for the way humans have learned to control and use biological media since ancient times.

PLAGUE DRESS

Credit: Anna Dumitriu in collaboration with the National Collection of Type Cultures at the UK Health Security Agency

Materials: Dyed contemporary silk dress with 17th Century embroidery, padded bumroll, net underskirt, lavender

Year: 2018

This 1665 style ‘Plague Dress’ is made from raw silk, hand-dyed with walnut husks in reference to the famous herbalist of the era Nicholas Culpeper who recommended walnuts as a treatment for the Plague. The dress is appliqued with original 17th-century embroideries which are impregnated with the DNA of Yesinia pestis bacteria (Plague), that the artist extracted from killed bacteria in the laboratory of the National Collection of Type Cultures (NCTC) at Public Health England where she is an artist in residence. The dress is stuffed and surrounded by bunches of lavender that were historically carried under people’s noses during the Great Plague of London to cover the stench of infection and prevent the disease, which was believed to be caused by ‘bad air’ or ‘miasmas’. The silk that the dress is made from references the Silk Road, a key vector for the spread of the Plague, but also the fact that the first and worst affected tradespeople to suffer in the Great Plague of London were the cloth workers who received the imported fine silks and linen.
PNEUMOTHORAX MACHINE

Credit: Anna Dumitriu

Materials: Altered antique medical device with engraving and carving

Year: 2014

This altered Pneumothorax Machine was originally used to collapse the lung of tuberculosis (TB) patients. The object is transformed through intricate carving and engraving. The carved case represents the texture of the lung tissue as the immune system attempts to ‘wall off’ the ‘foreign’ TB bacteria that it cannot eliminate. The engraving represents the TB bacteria under the microscope. The therapy was intended to give the lung “a proper rest” in the belief that this would give it a chance to repair itself, and also that it would cut off the oxygen supply to the TB bacteria and kill them. Around one-third of pulmonary (lung) TB patients underwent some form of so-called ‘collapse therapy’ between the 1930s and 1950s until antibiotic treatments replaced this unpleasant procedure. The rise of drug-resistant tuberculosis has seen new trials of artificial pneumothorax treatments.

TEETH MARKS SERIES: RELIC

Credit: Anna Dumitriu in collaboration with Dr Melissa Grant and Dr Sarah A. Kuehne

Materials: DNA, plastic vial, metal box, cotton thread and sealing wax

Year: 2019

The DNA of an organism contains the instruction book of how that organism is made. Today we are able to read and compare the DNA of bacteria to learn more about them, how they are transmitted and how they can be treated. Inside this sealed box is the DNA of Porphyromonas gingivalis, an important dental bacterium which can cause serious gum disease and has also recently been linked to Alzheimer’s disease. This DNA is a relic of the scientific research taking place at Birmingham Dental Hospital nowadays.
TEETH MARKS SERIES: TALISMAN

Credit: Anna Dumitriu in collaboration with Dr Melissa Grant and Alex May

Materials: 3D printed Sterling silver and a vintage silver charm bracelet with Birmingham Assay Mark

Year: 2019

A talisman was traditionally believed to protect its wearer from harm, and the idea of the charm bracelet evolved from it. The charm bracelet became a popular product for Birmingham Jewellery Quarter and this bracelet references both the historical relationship of dentistry and jewellery-making and the future directions of both fields: 3D scanning and 3D printing. The charms are based on photogrammetry scans of important pieces from the Birmingham Dental Hospital collection: a narwhal tusk (a symbol of dentistry), a dental key (for extracting teeth), a pelican (for extracting teeth), pliers (for extracting teeth), a device for opening locked jaws, an impressions plate, a dental bridge with human teeth, false teeth carved from animal bone, a device for gouging out teeth, and a tooth from an Anglo Saxon archaeological site which has been ground flat by a gritty diet. Some of these original artefacts surround the bracelet.

TEETH MARKS SERIES: TEETH WORMS

Credit: Anna Dumitriu in collaboration with Dr Melissa Grant

Materials: Beeswax

Year: 2019

In ancient times people believed that tooth decay was due to tiny worms living in the teeth and eating away at them from within. This may have been because tooth pulp squeezing out of a broken tooth resembles a worm. Beeswax, the medium of “Teeth Worms” (2019) was sometimes used for fillings in broken teeth in early dentistry but of course, it was not very effective or strong.
**TEETH MARKS SERIES: TERRA INCOGNITA**

**Materials:** Satin devoir, vintage glass bottle, vintage metal anaesthetic mask

**Year:** 2019

Terra Incognito references the desire for painless dental surgery and the development of anaesthetics, as well as the surprising protests against these early discoveries by those who saw suffering as a virtue. Many of the pioneers of anaesthetics misused their own discoveries and, in some cases, became addicted to them through the process of self-experimentation, leading to shocking outcomes. We can see parallels between our modern desire for a pain-free existence and the resulting opioid crisis in some parts of the world that has resulted from the over-promotion of addictive prescription medications and a subsequent black market. The goal of removing pain is a complex ethical area and an ongoing field of research. Pioneers in the stranger-than-fiction history of dentistry helped to define the field of modern surgery, and dental researchers today continue to develop innovations we will see in the future. This exhibition draws threads across time and asks us to consider where the potential benefits, and risks, might occur.

**TEETH MARKS SERIES: THE MOST PROFOUND MYSTERY**

**Credit:** Anna Dumitriu in collaboration with Dr Melissa Grant and Dr Sarah A. Kuehne

**Materials:** Altered antique bone fan, silk impregnated with *Prevotella intermedia* and *Porphyromonas gingivalis* and gold-plated wire

**Year:** 2019

In his 1845 essay ‘On Artificial Teeth’ WHMortimer described false teeth as “the most profound mystery” because they were never discussed. Instead, people would hide their bad teeth and foul breath using fans. This altered antique fan is made from animal bone and has been mended with gold-plated wire. The silk of the fan and ribbon has been grown and patterned with two species of oral pathogens *Prevotella intermedia* and *Porphyromonas gingivalis* (the cloth having been embedded in the bacteria on agar plates and in liquid media and then sterilised). These bacteria cause gum disease and bad breath, and the latter has also recently been linked to Alzheimer’s disease.
THE MUTABILITY OF MEMORIES AND FATES SERIES: THE CELLULAR REPROGRAMMING NECKLACE

Credit: Anna Dumitriu, with thanks to Maria-Elena Torres Padilla and Adam Burton for their scientific support and Alex May for 3D modelling support

Materials: 3D printing, jewellery wire, ribbon, copper sulphate

Year: 2021

This sculptural necklace physically represents the chromatin structure of the OCT-4 gene. This gene is important for inducing an embryonic stem cell-like state, in effect wiping the memory of the cell (at least to a degree) and giving it the potential to become a different kind of cell. In eukaryotic cells (cells with nuclei) DNA is wrapped around histones and the tightness of this binding either prevents or allows the expression of genes. The necklace is embedded with extracted heterochromatin and euchromatin from the OCT-4 gene.

COMMUNICATING BACTERIA DRESS

Credit: Anna Dumitriu, with thanks to Dr John Paul, and Alex May for video projection mapping support. Funded by the Wellcome Trust.

Year: 2011

Materials: Edwardian dress, whitework embroidery, killed bacteria, video projection mapping

The Communicating Bacteria Dress combines bioart, historical textile techniques, such as whitework embroidery, and 3D-mapped video projections. The work was created by staining textiles using pigmented bacteria, which change colour when they send and receive communication signals. Bacteria have intricate communication capabilities, for example, quorum sensing (voting on issues affecting the colony and signalling their presence to other bacteria); chemotactic signalling (detecting harmful or favourable substances in the environment); and plasmid exchange (e.g. for transfer of antibiotic resistance genes). This is being investigated as a form of social intelligence and these so-called ‘simplest’ of life forms can work collectively, obtain information about their environment (and other cells) and use that information in a ‘meaningful’ way. Using signalling chemicals such as Homoserine Lactone, the bacteria pass on messages to nearby cells, which can be either part of their colony or other living cells (including eukaryotic and plant cells).

The dress was stained using a genetically modified strain of the bacterium Chromobacterium violaceum called CV026. Chromobacterium violaceum is normally white but turns purple when it receives a communication signal, since bacteria grow in colonies and individual bacteria are continually sending and receiving signals it always appears purple. But the CV026 strain is effectively mute. It can receive a chemical communication signal but cannot send one, so it only turns purple in the presence of communication from another bacterium. When exposed to unmodified Chromobacterium violaceum it slowly turns purple as the chemical signal spreads. The bacteria were then killed via heating as they were in the process of communicating. A time-lapse film was made of the process and video mapped onto the dress in order to bring the dress back to life.