Eduardo Kac
Genesis

A population of fluorescent bacterial clones contains a synthetic gene created by Eduardo Kac. This new gene encodes a sentence from the book of Genesis: "Let man have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moves upon the earth."
Electron micrograph: Stuart Knutton

Genesis (1998/99) is a transgenic artwork that explores the intricate relationship between biology, belief systems, information technology, dialogical interaction, ethics, and the Internet. *Genesis* has live DNA music synthesis by Peter Gena and genetic consultation by Dr. Charles Strom. The key element of the work is an "artist's gene", i.e. a synthetic gene that I invented and that does not exist in nature. This gene was created by translating a sentence from the biblical book of *Genesis* into Morse Code, and converting the Morse Code into DNA base pairs according to a conversion principle which I developed specifically for this work. The sentence reads: "Let man have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moves upon the earth." This sentence was chosen for its implications regarding the dubious notion of humanity's (divinely sanctioned) supremacy over nature. Morse Code was chosen because, as first employed in radiotelegraphy, it represents the dawn of the information age–the genesis of global communications.

The initial process in this work is the cloning of the synthetic gene into plasmids and their subsequent transformation into bacteria. A new protein molecule is thus produced by the gene. Two kinds of bacteria are employed in the work: bacteria that have incorporated a plasmid containing ECFP (Enhanced Cyan Fluorescent Protein) and bacteria that have incorporated a plasmid containing EYFP (Enhanced Yellow Fluorescent Protein). ECFP and EYFP are GFP (Green Fluorescent Protein) mutants with altered spectral properties. The ECFP bacteria contain the synthetic gene, while the EYFP bacteria do not. These fluorescent bacteria emit blue and yellow light when exposed to UV radiation. As they grow in number mutations will occur in the plasmids, and as they make contact with each other, we start to see color combinations and green bacteria arise. Ultimately, transgenic bacterial communication will evolve as a combination of three visible scenarios: 1–ECFP bacteria donate their plasmid to EYFP bacteria (and vice-versa), generating green bacteria; 2–No donation takes place (individual colors are preserved); 3–Bacteria lose their plasmid altogether (become pale, ochre colored).

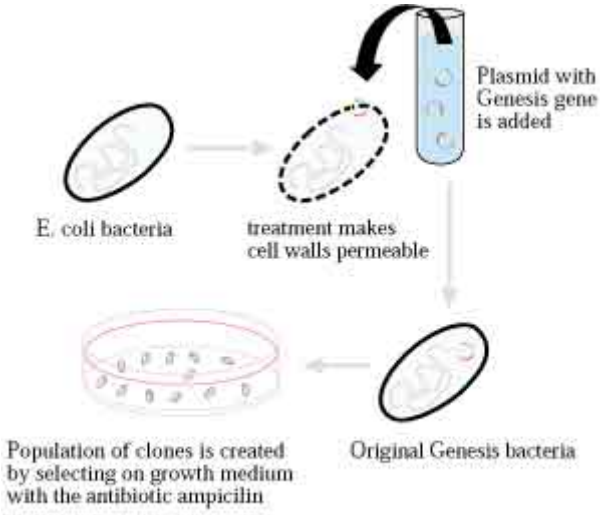
A gallery display enables local as well as remote (Web) participants to monitor the evolution of the work. This display consists of a microscope with a built-in UV source, a computer functioning as a Web server, and a larger-than-life video projection of the bacterial division and interaction seen in the microscope. Local and remote participants, in the gallery and on

the Web, interfere with the process by turning the UV light on and off. The fluorescent protein in the bacteria responds to the UV light by emitting visible light. The energy impact of the UV□light on the bacteria is such that it disrupts the DNA sequence in the plasmid, accelerating the mutation rate.

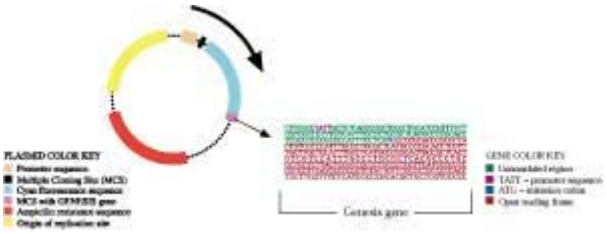
Genesis explores the notion that biological processes are now writable and programmable, as well as capable of storing and processing data in ways not unlike digital computers. At the end of the show, the altered biblical sentence present in the bacteria is decoded and read back in plain English, offering insights into the process of transgenic interbacterial communication. The boundaries between carbon-based life and digital data are becoming as fragile as a cell membrane.

The DANN music, generated live in the gallery, is synthesized by the use of a complex algorithm that transcribes the physiology of DNA into musical parameters. Changes in the sequences are dictated by the mutation rate of the bacteria. Acoustic variations indicate the presence of remote participants in the server.

DNA Consultation: Charles Strom, MD, PhD, Director of Medical Genetics, Illinois Masonic Medical Center, Chicago
Music: Peter Gena, Professor of Art and Technology and Sound, The School of the Art Institute of Chicago
Technical Support: Svetlana Rechitsky, Illinois Masonic Medical Center, Chicago
Programming and Electronics: Jon Fisher, SGI System Administrator, The School of the Art Institute of Chicago
Production: O.K Centrum für Gegenwartskunst, Linz
Project Coordination: Julia Friedman and Associates, Chicago



This diagram shows the transformation of E. coli into Genesis bacteria. Genetic transformation occurs when a cell incorporates and expresses a new piece of genetic material. In this case, the Genesis gene was inserted into E. coli bacteria. After division and selection in a growth medium containing ampicilin, a population of Genesis bacterial clones is created. The exhibition explores transgenic bacterial communication: the Genesis population shares a Petri dish and dialogues with another colony, which does not have the Genesis gene.



This diagram shows the plasmid (left) and the gene used in the transgenic artwork "Genesis". A plasmid is an extrachromosomal ring of DNA. The black circular arrow at the top of the plasmid indicates the direction of transcription (i.e., the process by which one strand of DNA is copied into a single strand of RNA). Shown in the illustration are:
1) Promoter sequence (sequence of DNA where RNA polymerase binds on to begin transcription);
2) Multiple Cloning Site (part of the plasmid that has been engineered to accept the insertion of other sequences);
3) Cyan fluorescence sequence (sequence of DNA that codes for cyan fluorescent protein);
4) MCS with GENESIS gene (site where the Genesis gene was inserted);
5) Ampicilin resistance sequence (gene that codes for resistance to the antibiotic Ampicilin);
6) Origin of replication site (site where the process of replication of DNA molecules originates, by one single strand being used as a template for the production of another single strand). The Genesis gene (above, right) has an initiation codon (ATG, in red). The initiation codon is the site where translation begins, i.e., where the protein starts to be built. Before the ATG initiation codon we see an untranslated region (in magenta) with a promoter sequence (TATT, in blue). After the ATG initiation codon we see an open reading frame (in orange), i.e., codons that do not code for termination. The Genesis gene is completely synthetic and does not exist in nature.