Self Reproducing Systems: Digitizing Life

John Glass
The J. Craig Venter Institute,
Rockville, MD & San Diego, CA
Conversion of the Analog Genetic Code into Digital Code

- Genetic Code
  ACGTTAGGCATAGTCAGT

- Computer Binary Code
  01000001 01010100 01000111
  01000010 10001001 00101010
  11100101 01100010 10001100
  01001001 00001100 11110001
  01001010 00011011 00010001
A computer analogy -- the genome of a cell is the operating system & the cytoplasm is the hardware

The cytoplasm is the hardware that runs the operating system.

The chromosome is the operating system.

The genome contains all information necessary to produce the cytoplasm and cell envelope and to replicate itself. Each is valueless without the other.
1) Self-replicate to make new cells

Synthetic Organism Designer 1.0

Design
- Organism:
  - Archaea
  - Bacteria
  - Single Cell Euk
  - Virus
  - Multicellular Euk
- Cell Membrane:
  - Gram +
  - Gram -
  - Archaeal
  - Euk
- Division Type:
  - Meiosis
  - Mitosis
  - Cellular Septation
- Form of Metabolism:
  - Photosynthesis
  - Methanogenesis
  - Glycolysis
  - Calvin Cycle
  - Pentose Phosphate

Codon Opt.
- Structural Genes:
  - Rubisco (30,000)
  - Ferredoxin (82,000)
  - Plastocyanin (9,000)
  - ATP Synthase (100,000)

Oligo Synthesis
- Control & Safety:
  - Auxotrophic Marker
  - Suicide Gene

Diagram:
- Organism structure with labels:
  - Cytoplasm
  - Nucleoid
  - Capsule
  - Cell Wall
  - Cytoplasmic Membrane
  - Ribosomes
  - Pilus
  - Flagella
Approach used to synthesize bacterial cell

Assemble overlapping synthetic DNA oligonucleotides (~60 mers)

Assemble cassettes by homologous recombination

Synthetic DNA Cassettes (5-7 kb)

Completely assembled synthetic genome

Recipient cell

Synthetic cell

Genome Transplantation

Clone genome in yeast

Genome Synthesis
Genome Scale Engineering Approaches

Moving life into the digital world and back

Our capacity to build organisms capable of solving human problems is limited only by our imagination