L6.1: Synthetic Life

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In this lecture …

• What is synthetic life?

• What is the potential?

• What are the limits?
BioNanotechnology

Artificial Intelligence

Synthetic Biology

Tissue Engineering

Neuro Engineering

SYNTHETIC

NATURAL
What Defines These Boundaries?

What is Life?
What is Human?
What is Synthetic?

Is it important to know when we’ve crossed?
Does Synthetic = Unnatural?
The Role of Liberal Arts

“People, especially early twenty-first century people, live in a world where strangeness lurks just beyond our frame of vision — but we can't see it by looking straight at it.”

Literature, Movies and the Arts Provide

Neural Implants

Science Fiction

Science

Wireless neural implant
Records, Stimulates
Up to 8 in one patient

Pedro Irazoqui, Purdue University Center for Implantable Devices

http://discovermagazine.com/2013/march/1-matrix-learning
NeuroEngineering → Neural Implants

Why?

Because ....

~1% of the world has epilepsy

&

30% - 40% of patients have drug resistant seizures

http://www.cureepilepsy.org/
NeuroEngineering → the Brain Computer Interface

Science Fiction
AMPed war exoskeleton
James Cameron movie, Avatar

Science
Mind-controlled exoskeleton
http://www.cbsnews.com
NeuroEngineering → the Brain Computer Interface

Why?

To restore the ability to experience and engage with the outside world to those who have lost that ability.

http://michaelchorost.com/books/
Tissue Engineering → Organs in the Lab

Science Fiction

Science

Real Human Brain

Engineered Human Brain

Gritsenko et al 2012

Rickus Lab

Watching tumor cells from a human patient migrate along a pseudo blood vessel in an engineered brain.
Tissue Engineering $\rightarrow$ Organs in the Lab

Why?

Because ...

the median survival after diagnosis with glioblastoma is 15 – 18 months

current cell and animal models do not predict therapy outcomes in humans

http://www.neurooncology.ucla.edu/Performance/GlioblastomaMultiforme.aspx
Synthetic Biology → Writing Genomes

Science Fiction

Science

2010 – the first genome transplant of a chemically synthesized genome

https://thehungergames2012.wordpress.com

Gibson et al. Science 329, 52 (2010)
Synthetic Biology → Writing Genomes

Why?

Because ...

Human global extraction of earth’s raw materials is 70 billion metric tons / year

The Materials Footprint of Nations. PNAS. Wiedmann et al 2013

http://earthobservatory.nasa.gov
What Defines These Boundaries?

What is Life?

What is Human?

What is Synthetic?

Is it important to know when we’ve crossed?

Does Synthetic = Unnatural?
A Working Definition of Life?

- **Function**
  - Metabolize, Evolve, Replicate

- **Thermodynamics**
  - Decreases the entropy of its own system

- **Control**
  - Respond to surroundings
  - Strive for conservation

- **Cognitive**
  - Goal-oriented
  - Self-aware

- **Beyond Current Understanding**
  - Human intellect cannot fathom
  - Evaluated on case by case basis
  - Life can come in many forms
What makes us human?

**hardware:** Is humanity in the biological substrate?

**software:** Is humanity in the input output functions and interaction with the outside world and other people?

When are we modified to a point that we are **synthetic**?

Synthetic manipulation of higher function?

Memory Emotion Attention

What then about

Identity Free Will Responsibility
Coming up …

- Technology & Society
- Ethics
- Risks / Safety