

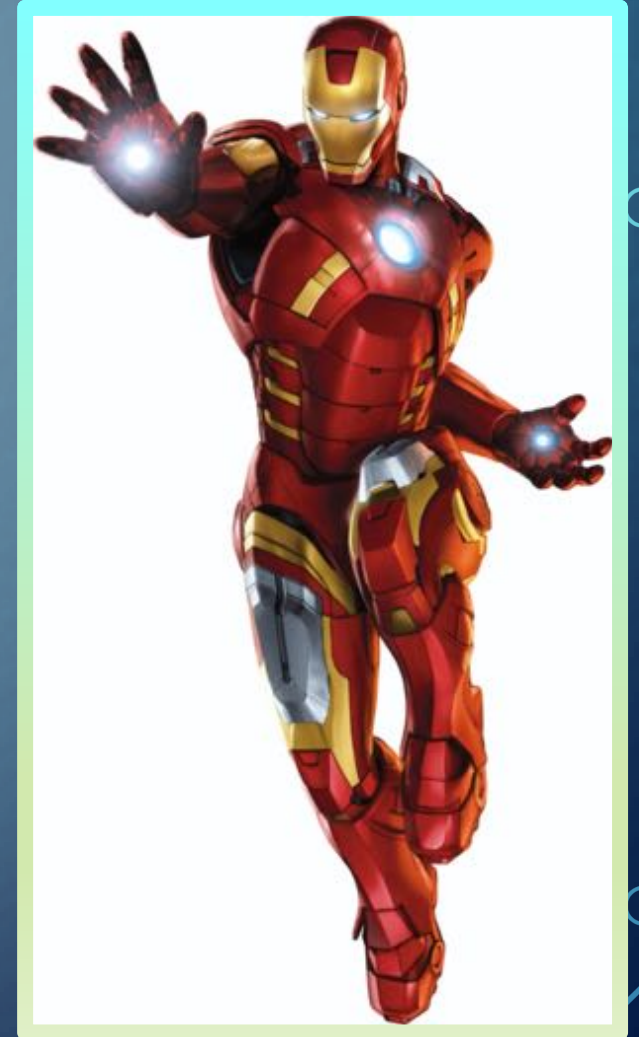
TRANSHUMANISM I: BIOENGINEERED SUPERHUMANS

TECHNOLOGY...(ETHICS, RELIGION)

NELS HOFFMAN

LOS ALAMOS FAITH AND SCIENCE FORUM

SUMMER 2020

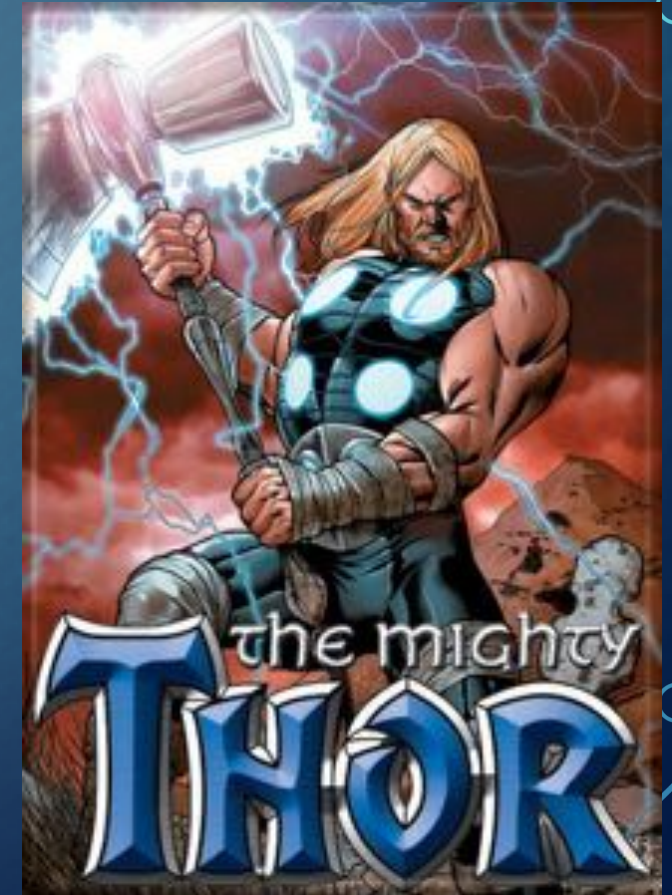


HUMANS HAVE ALWAYS IMAGINED SUPERHUMAN BEINGS



They fly, they're powerful, they're beautiful, they're immortal

HUMANS HAVE ALWAYS IMAGINED SUPERHUMAN BEINGS (CONT'D.)

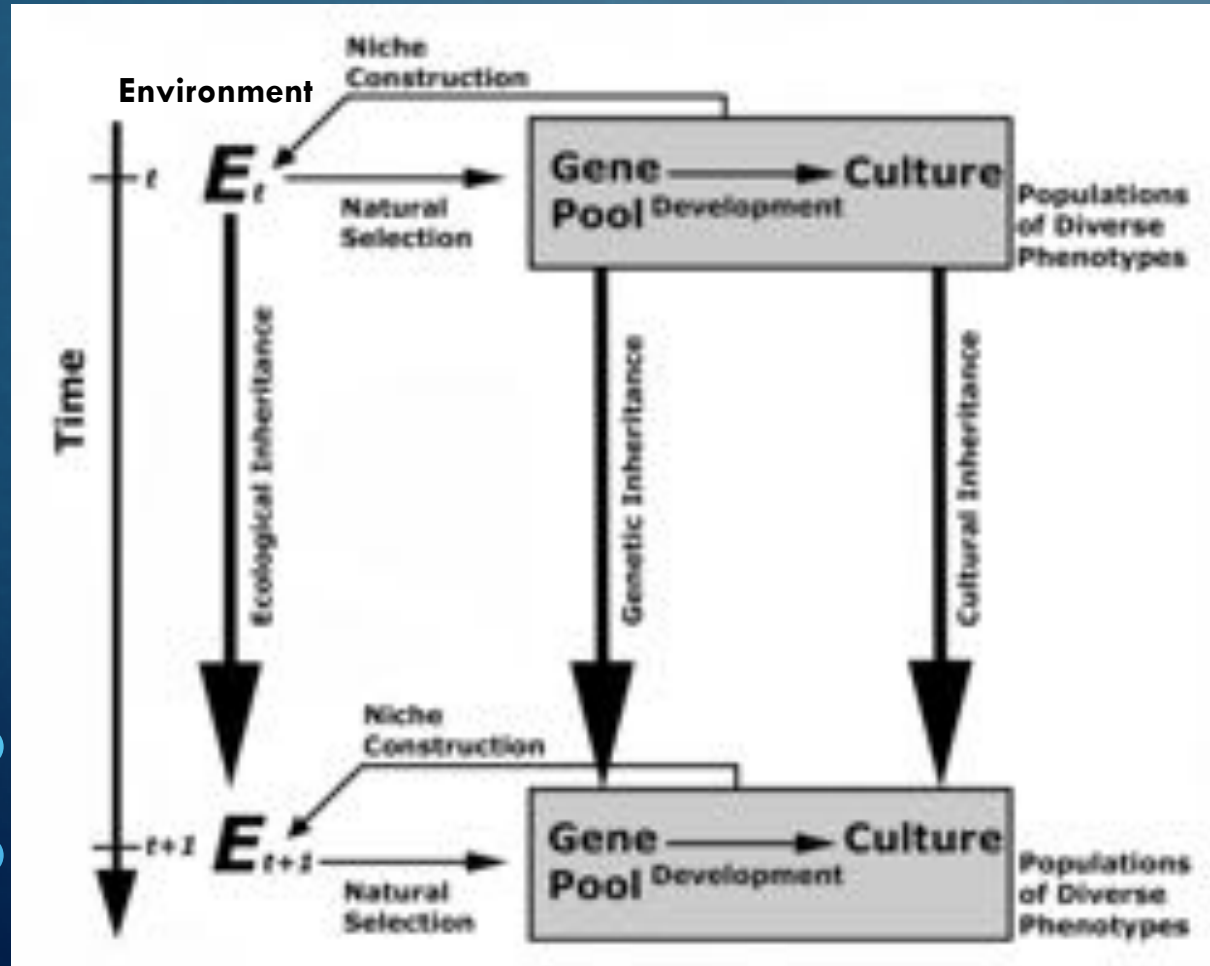


They fly, they're powerful, they're beautiful, they're immortal

WE HAVE ALREADY BECOME “SUPERHUMAN” THROUGH OUR TOOLS

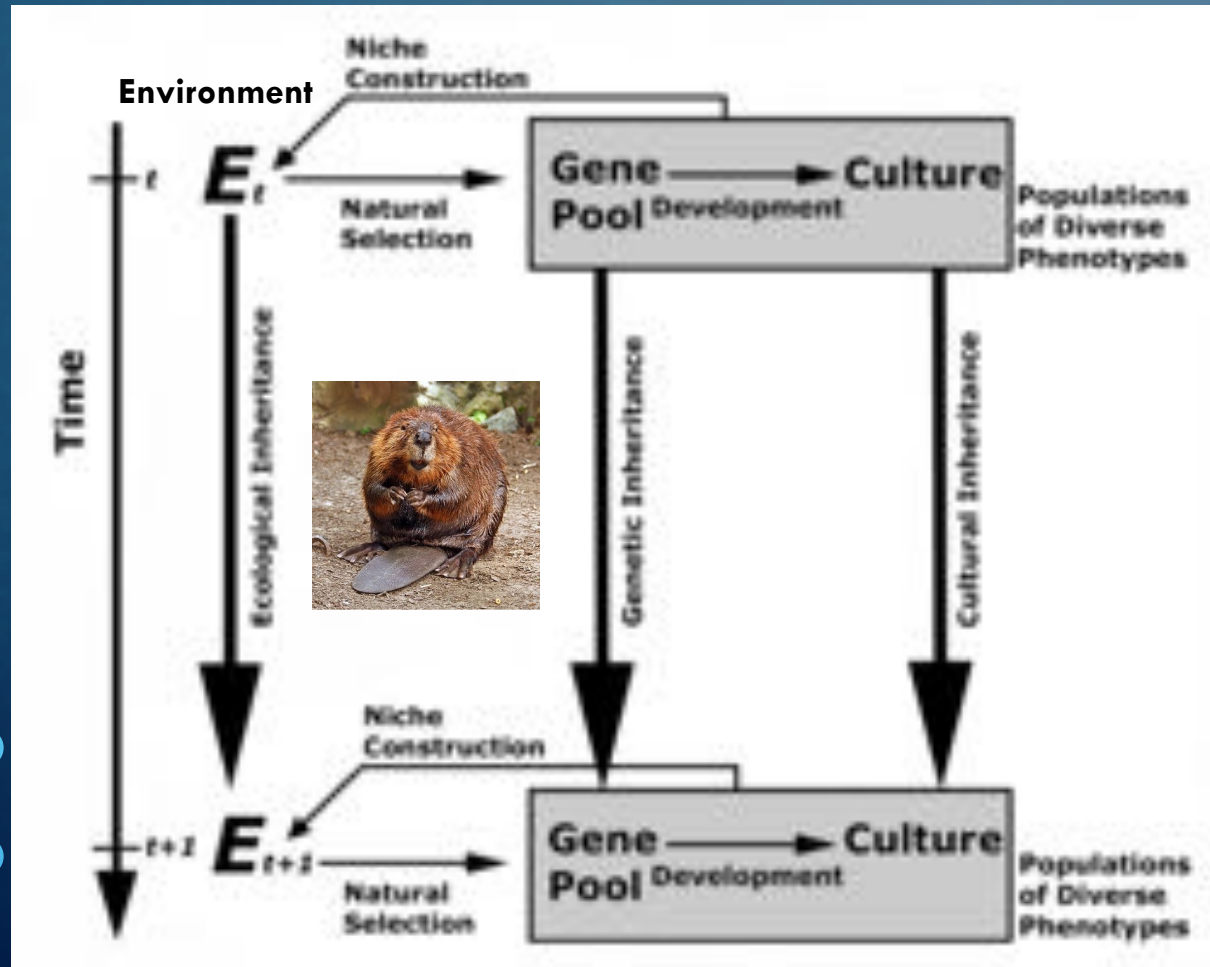


OUR TOOLS CHANGE US, AS WE USE AND DEVELOP THEM



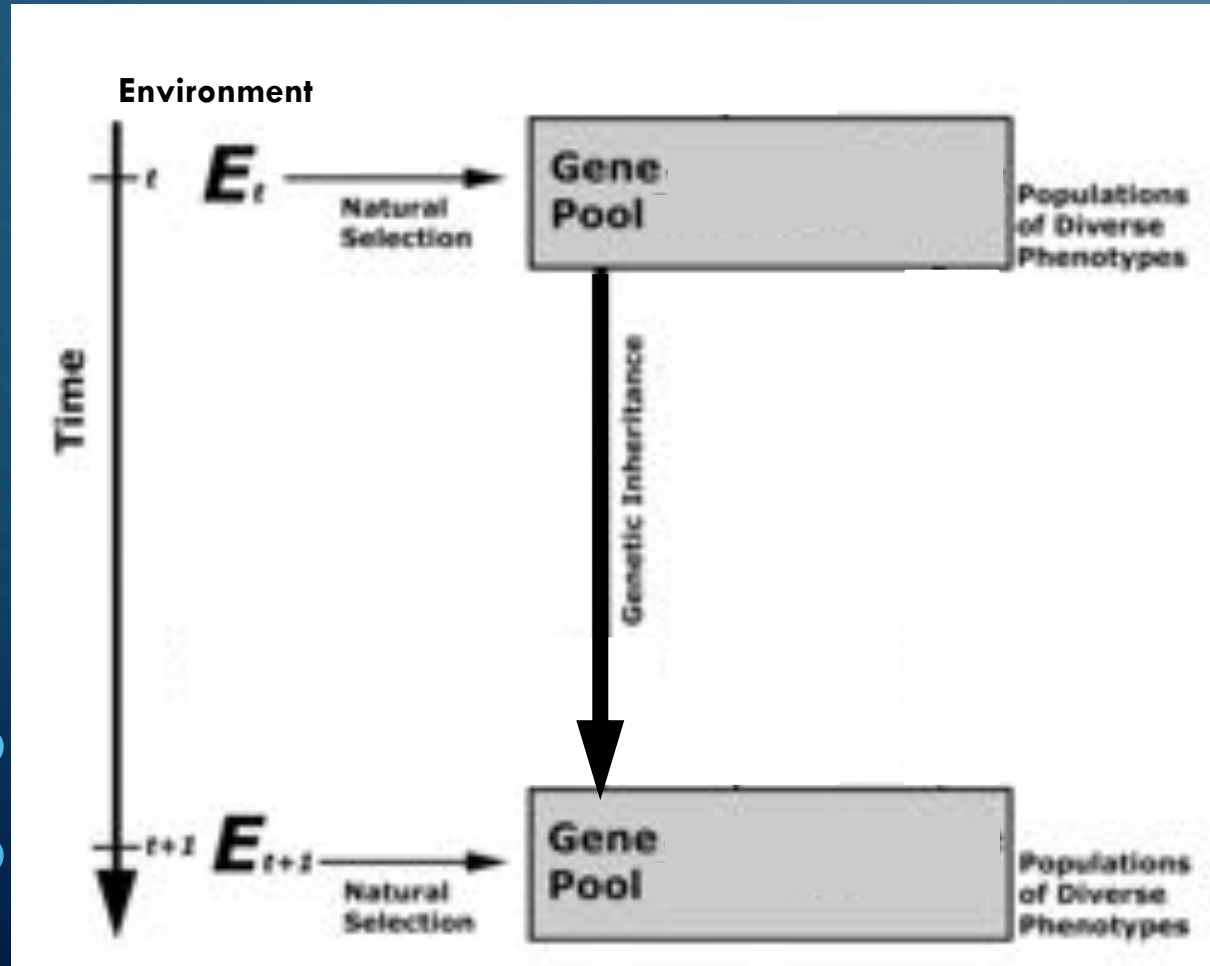
- Organisms
 - Change their environment
 - Learn, change, transmit their culture
- Environment
 - Changes the organisms

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THIS VIEW CONTRASTS WITH NEO-DARWINISM



- Naïve Neo-Darwinian picture is simple
- Organisms are passive
- Evolution proceeds only by
 - Natural selection
 - Genetic drift
 - Gene flow
 - Recombination

PERHAPS OUR TOOLS HAVE BEEN CHANGING US FOR MILLIONS OF YEARS *UNINTENTIONALLY*

- Hominin brains began dramatic expansion 2-3 million years ago
- Feedback between tools and brain might explain how hominin brains got so big so fast

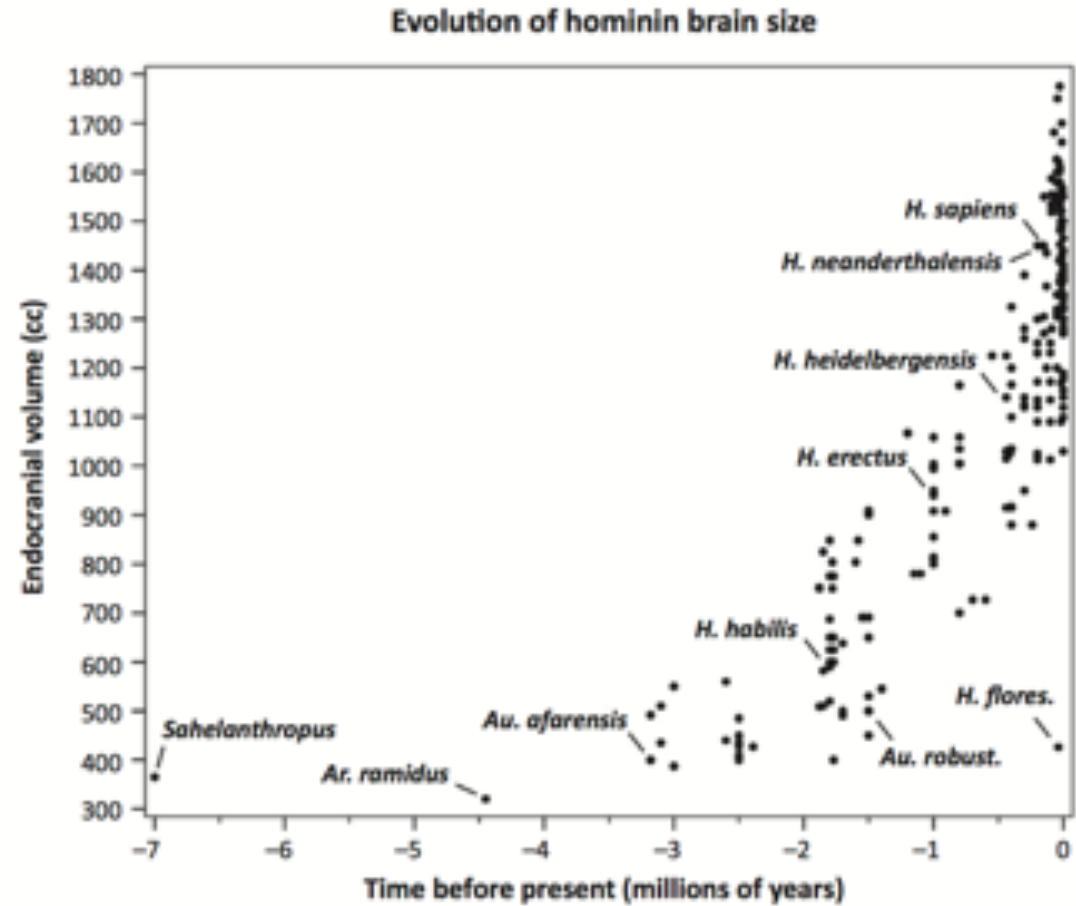


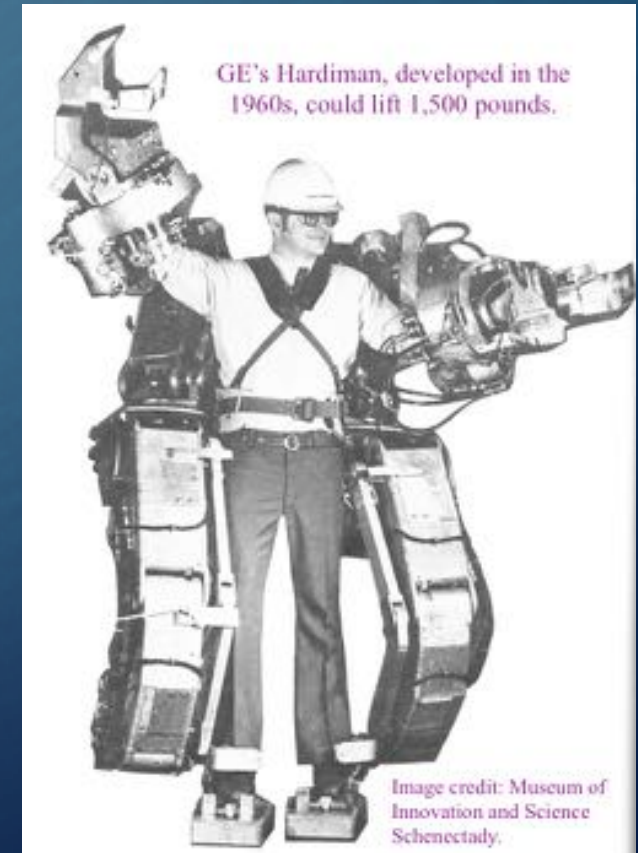
Figure 1. Hominin brain evolution estimated from fossil endocrasts.

WE ARE NOW DEVELOPING THE MEANS TO ENHANCE THE HUMAN BODY *INTENTIONALLY*

Many kinds of research are being pursued

We'll discuss three fields of research:

- Genetic editing
- Brain-computer interfaces
- Anti-aging research

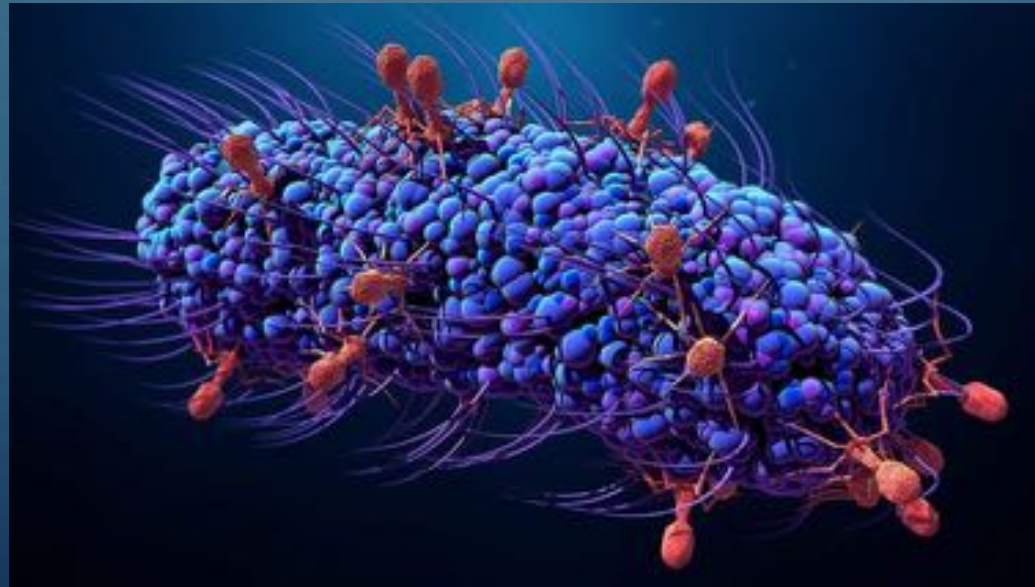


THESE RESEARCH FIELDS HAVE VALUE AS *THERAPIES*, BUT PERHAPS ALSO AS *ENHANCEMENTS*

- Genetic editing
 - Cure genetic diseases
 - Modify genes to enhance desired attributes
- Brain-computer interfaces
 - Restore mobility or sensory input
 - Connect humans directly with machines/cyberspace
- Anti-aging research
 - Mitigate diseases of accelerated aging
 - Extend human lifespan

BACTERIA SUFFER VIRAL INFECTIONS

- Bacteria are vulnerable to attack by viruses called bacteriophages
- Bacteriophages attach to outside of bacterium and inject genetic material

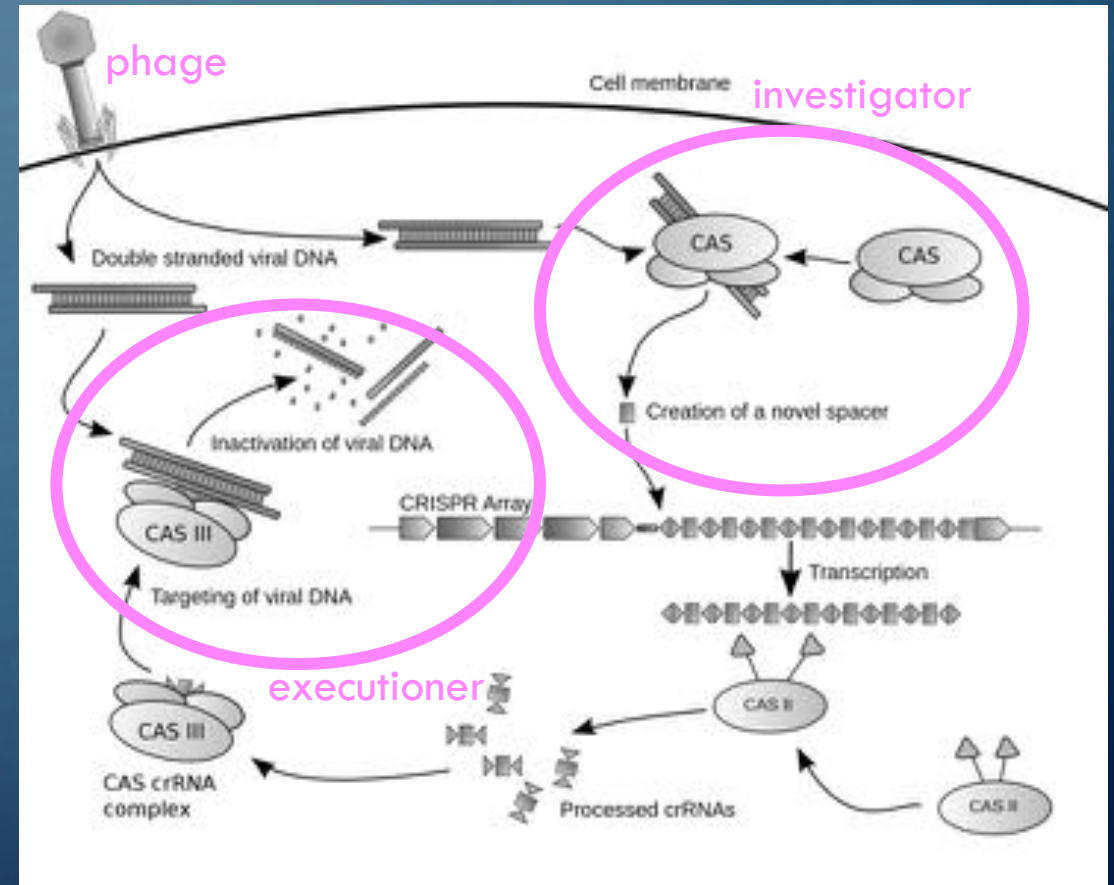


Cholera bacterium attacked by bacteriophages

Credit: Shutterstock

BACTERIA HAVE EVOLVED THEIR OWN IMMUNE SYSTEMS TO COUNTER VIRAL INFECTIONS

- CRISPR Cas system
 - “CRISPR array” is library of past infections
 - Records harmful viral genetic material
 - Cas enzymes are “investigator” and “judge, jury, executioner”
 - Add new genetic data to library
 - Family of enzymes Cas1, Cas2, ...
 - Chops up viral material

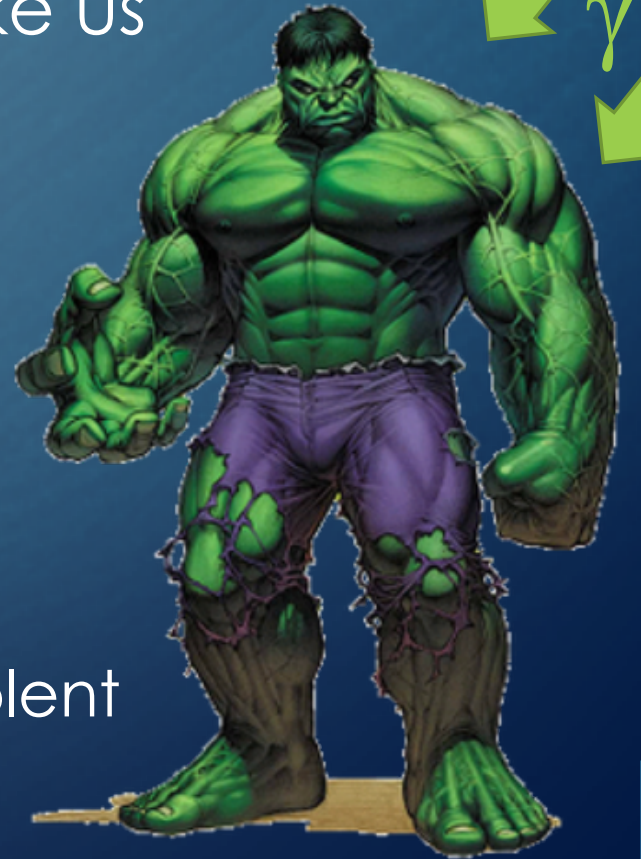


SCIENTISTS HAVE DISCOVERED HOW TO USE CRISPR-CAS9 TO ALTER ANY DNA SEQUENCE ARBITRARILY

- Cheap, easy way to engineer any DNA
- Researchers hope to use it to cure a wide array of genetically based diseases
- Discovery was made only 7 years ago – very new!
- By late 2019, more than a dozen studies are in progress to test CRISPR-Cas9 against:
 - Cancer
 - HIV
 - Blood disorders
- Still too early to know whether technique will be safe and effective
- Obstacles include:
 - Off-target editing
 - Cas9 doesn't know when to stop
 - Viral vectors cause immune reaction

IF CRISPR-CAS9 CAN BE USED FOR *THERAPY*, CAN IT ALSO BE USED FOR *ENHANCEMENT*?

- Can human genes be engineered to make us
 - Smarter
 - More creative
 - Stronger, faster
 - Bigger or smaller
 - Better looking
 - More hip and fashionable
 - Kinder, gentler, more compassionate, more peaceful
 - Crueler, harsher, more remorseless, more violent
 - ...?
- Environment plays a role as well



GENETIC EDITING TO ENHANCE HUMANS MAY NOT BE EASY

- Researchers don't really understand the relationship between genotype and phenotype
 - Genotype – what your genome contains
 - Phenotype – your physical traits and behaviors
- Attributes like intelligence and even height depend on many genes, as well as environment
- Still, some genes are known to affect specific traits
 - Deletion of gene for myostatin protein
 - greater muscle mass in dogs
 - faster race horses?
 - Non-coding DNA near GDF5 gene
 - height variations in humans
 - bone length variations in mice



*Liz Parrish, CEO of BioViva
Injected with gene to inhibit
myostatin, to avert aging-
related muscle loss*

BRAIN-COMPUTER INTERFACES ARE A PROMISING THERAPY FOR PARALYZED PEOPLE

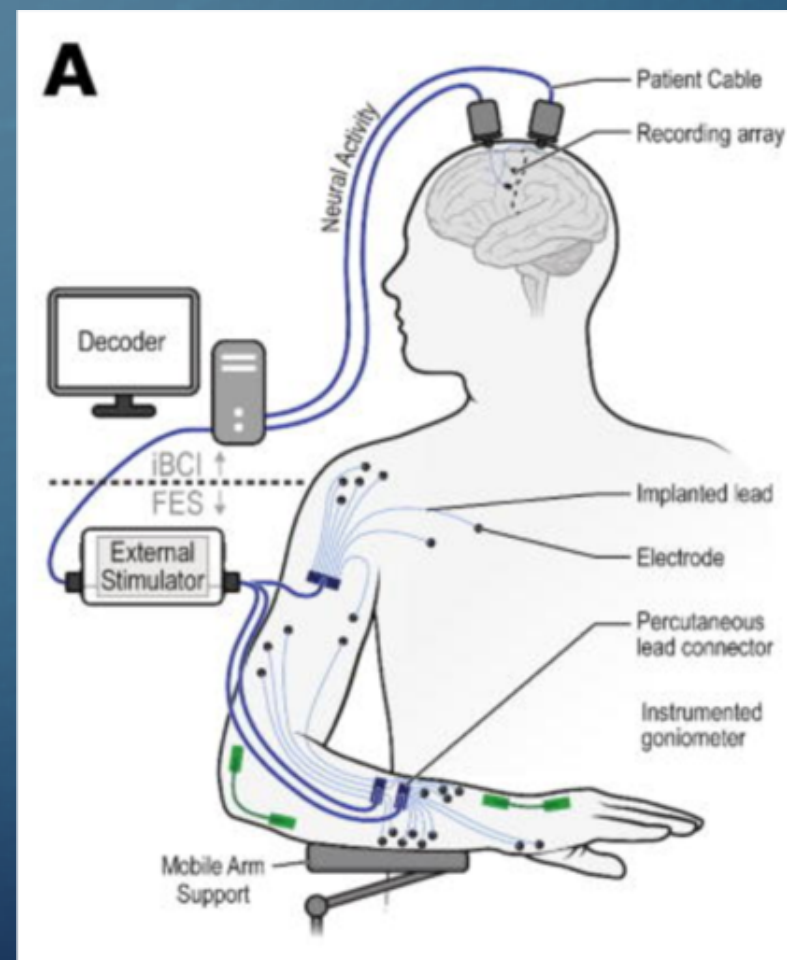
- Brain-computer interfaces (BCIs)
 - acquire and analyze brain signals
 - translate brain signals into commands that are relayed to output devices to carry out desired actions
- Main goal of BCI: replace or restore useful function to people disabled by neuromuscular disorders:
 - amyotrophic lateral sclerosis (ALS)
 - cerebral palsy
 - stroke
 - spinal cord injury



BCIs will allow people to control devices *with their thoughts*

A PARALYSED MAN HAS BEEN ABLE TO MOVE HIS ARM USING POWER OF THOUGHT

- Researchers at Case Western
 - Put electrical implants in the motor cortex of subject's brain
 - Put sensors in subject's forearm
 - Then arm and hand muscles could be stimulated in response to signals from subject's brain, decoded by computer

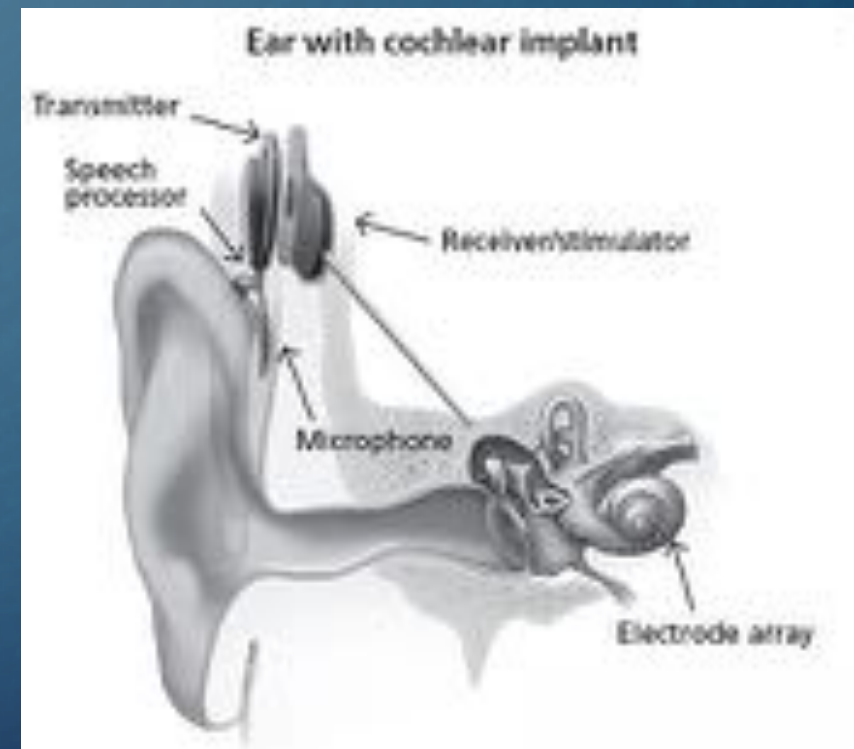


Bolu Ajiyoye et al., "Restoration of Reaching and Grasping Movements Through Brain-Controlled Muscle Stimulation in a Person With Tetraplegia: A Proof-Of-Concept Demonstration", *Lancet*, 2017 May 6;389(10081):1821-1830

<https://www.theguardian.com/science/2017/mar/28/neuroprosthetic-tetraplegic-man-control-hand-with-thought-bill-kochevar>

NEUROPROSTHETICS CONNECT THE BRAIN TO DEVICES THAT COMPENSATE FOR LOST MOTOR OR SENSORY FUNCTION

- Cochlear implant is very different from a hearing aid
- Hearing aids
 - amplify sounds so they may be detected by damaged ears
- Cochlear implants
 - bypass damaged portions of the ear
 - directly stimulate the auditory nerve

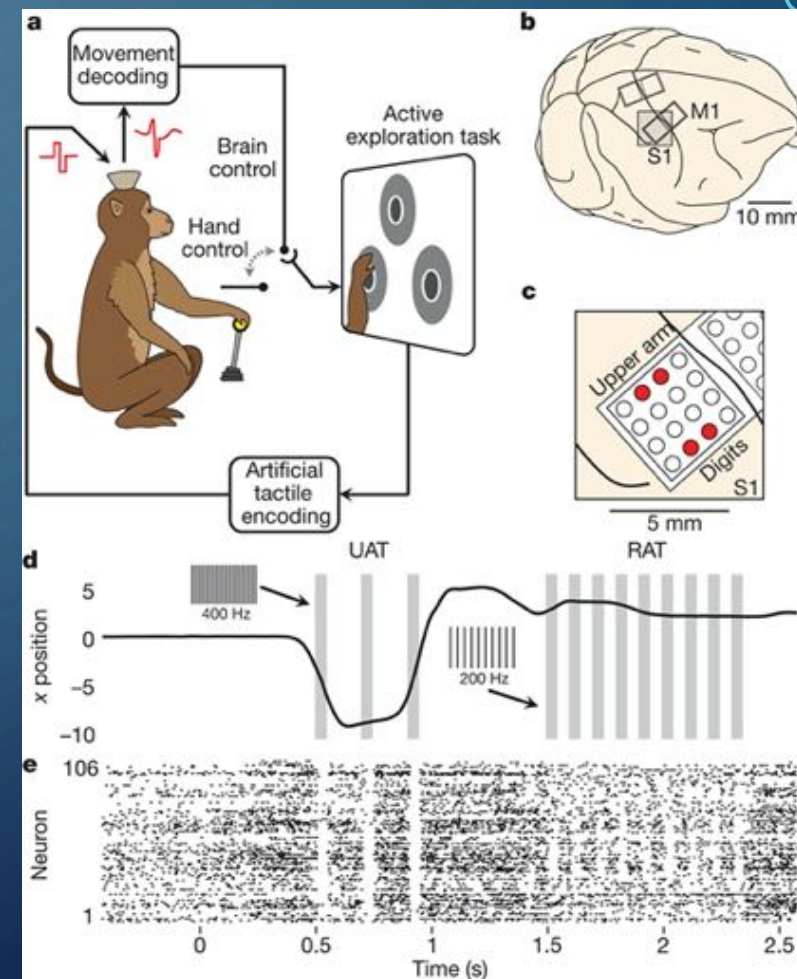


As of December 2012, approximately 324,200 registered cochlear implant devices had been implanted worldwide

MONKEYS HAVE BEEN TRAINED TO 'MOVE AND FEEL' VIRTUAL OBJECTS USING ONLY THEIR BRAINS

BMBI: brain-machine-brain interface experiments at Duke

- Virtual “cyberspace” hand is controlled directly by monkey’s brain activity
- Virtual hand generates tactile feedback, transmitted electrically to another part of monkey’s brain
- Invasive surgery required
- May allow severely paralyzed patients to regain mobility and sense of touch

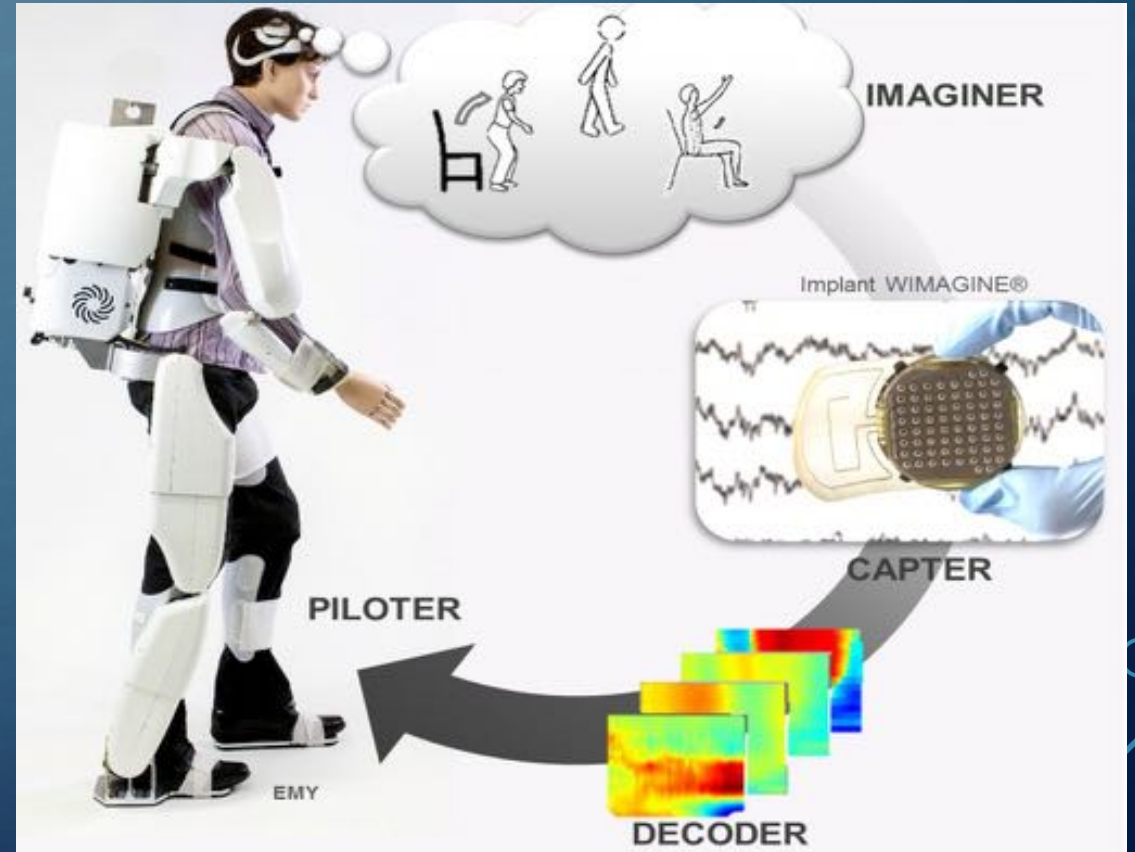


“Monkeys 'move and feel' virtual objects using only their brains”, <https://www.sciencedaily.com/releases/2011/10/111005131648.htm>

JE O'Doherty *et al. Nature* **479**, 228-231 (2011) doi:10.1038/nature10489

BRAIN-CONTROLLED EXOSKELETONS ARE BEING DEVELOPED

- When we imagine making a movement, we trigger *same electrical activity* in the motor cortex as when we actually perform that activity
- Researchers aim to
 - **record** these electrical signals
 - **decode** them
 - use them to **drive** complex objects
 - for example, move the limbs of an exoskeleton

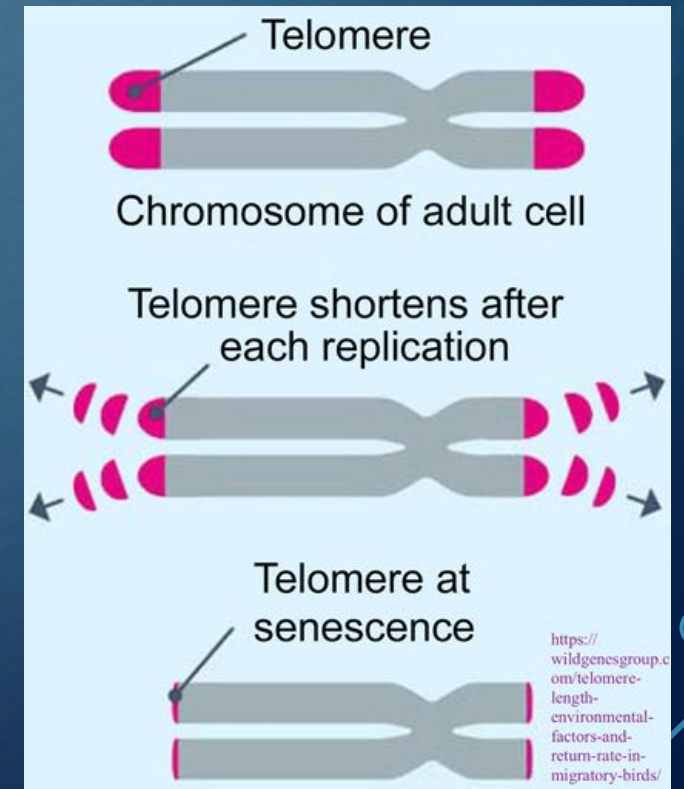


THERE IS NO SINGLE THEORY OF AGING

- Many aging mechanisms have been proposed
- Aging theories can be categorized in several ways
 - Stochastic vs systematic
 - Stochastic: aging is explained by random, chance events
 - Systematic: aging mechanisms involve cascade of interconnected events
 - *Intracellular vs intercellular*
 - Intracellular: breakdown in internal operations of cells
 - Intercellular: compromised interactions between cells
 - Etc.
- It would not be surprising if many mechanisms of various types all contribute

RESEARCHER AUBREY DE GREY PROPOSES SUITE OF TECHNIQUES TO COMBAT AGING-RELATED DAMAGE

- De Grey suggests addressing seven types of damage contributing to aging
 - Oxidative damage by free radicals
 - Atherosclerotic plaques from inflammatory enzymes
 - Beta-amyloid plaques in the brain
 - Glycation by sugars
 - Shortening of telomeres
 - Mutations to DNA
 - Cell loss from injury and disease



Aubrey de Grey with Michael Rae, *Ending Aging: The Rejuvenation Breakthroughs that Could Reverse Human Aging in Our Lifetime* (New York: St. Martin's Griffin, 2007)

F. Rana and K. Samples, *Humans 2.0: Scientific, Philosophical, and Theological Perspectives on Transhumanism* (2019, RTB Press, Covina CA)

ETHICAL AND RELIGIOUS QUESTIONS

- Who has access to this technology?
- Will our BCIs be hacked?
- Will our thoughts still be “private”?
- Should we experiment on human embryos?
- Does any of this relate to *mental health*?
 - Genetic editing
 - Brain-computer interfaces
 - Anti-aging research
- Is this how humanity is to be “saved”?

... Don't miss next week --

“Transhumanism II: Path Forward: Superhighway or Rocky Road?” by Dan Winske and Bob Reinovsky

SOME KIND OF GOD...



The background is a dark blue gradient. In the corners, there are decorative white circuit-like patterns consisting of lines and small circles, resembling a network or data flow diagram.

BACKUP SLIDES

THERE IS CONTINUAL FEEDBACK BETWEEN ORGANISM AND ENVIRONMENT, OVER GENERATIONS

organism



makes



environment

makes

"Niche construction"