BIOTECH 101

Session 1: the basics

Dr. Neil Lamb, Vice President for Educational Outreach

HUDSONALPHA INSTITUTE FOR BIOTECHNOLOGY

BIOTECH 101

- The Basics
- Agriculture
- Cancer
- COVID19

HUDSONALPHA INSTITUTE FOR BIOTECHNOLOGY

Thank you to our sponsors

TWICKENHAM ADVISORS

A HIGHTOWER COMPANY

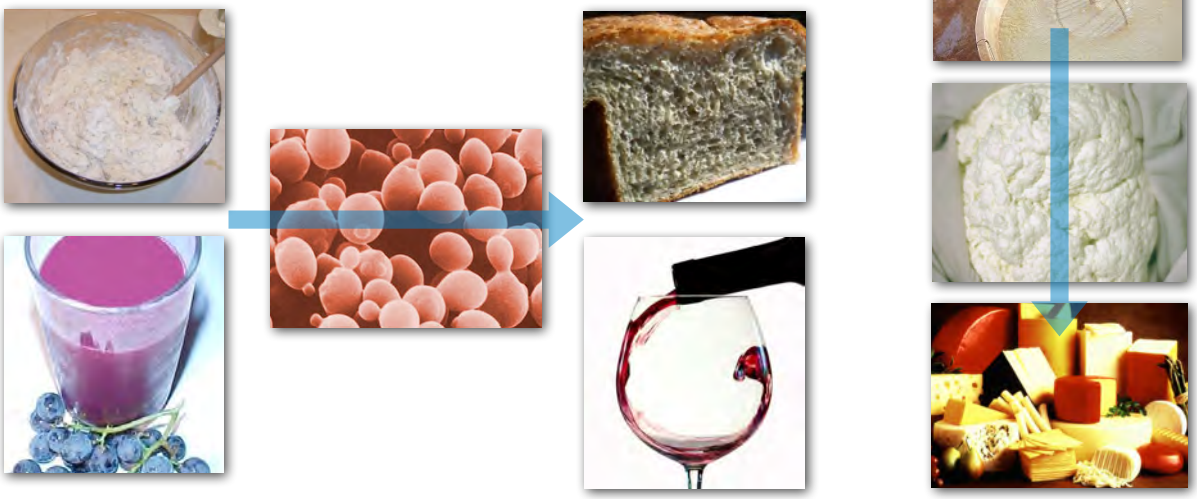
Jackson Center

HudsonAlpha Institute for Biotechnology Alumni Association



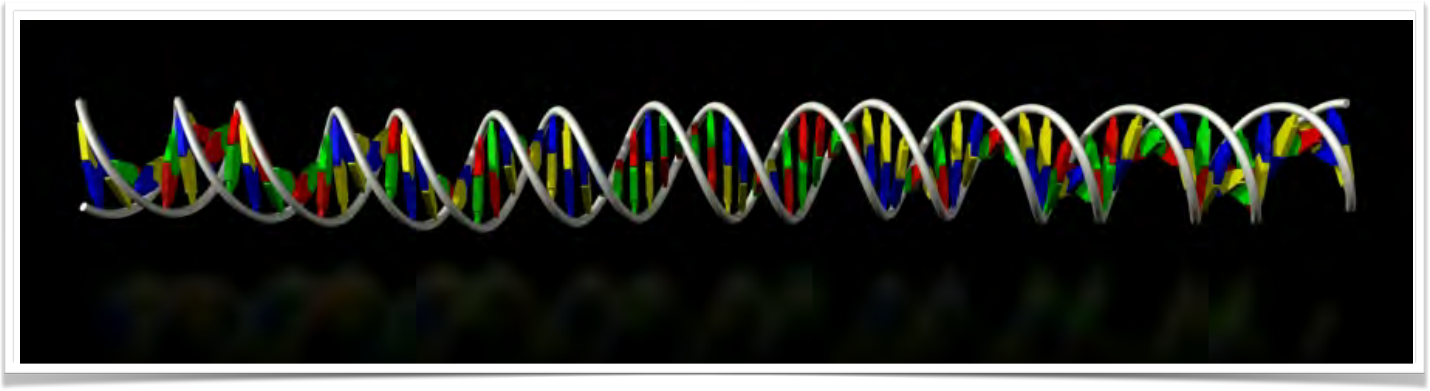
What is Biotechnology?

Using biological systems, organisms or processes to create products that improve our environment and quality of life

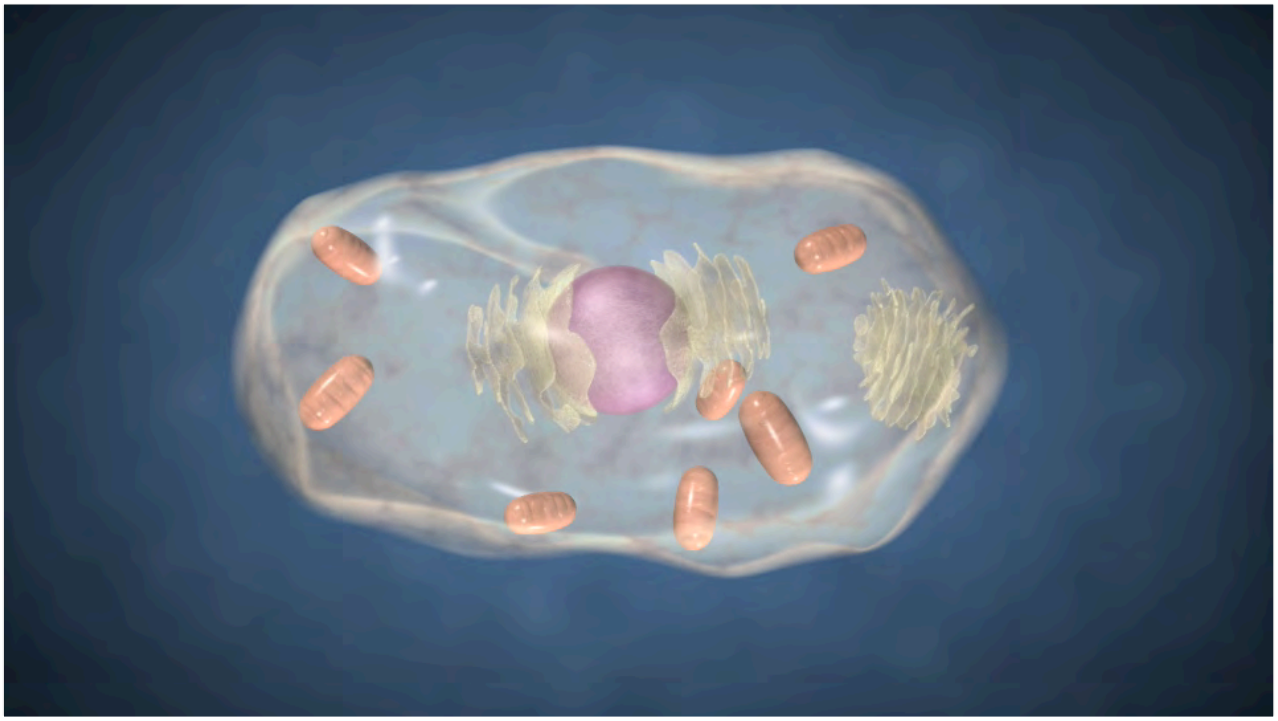


What is Biotechnology?

Using biological systems, organisms or processes to create products that improve our environment and quality of life



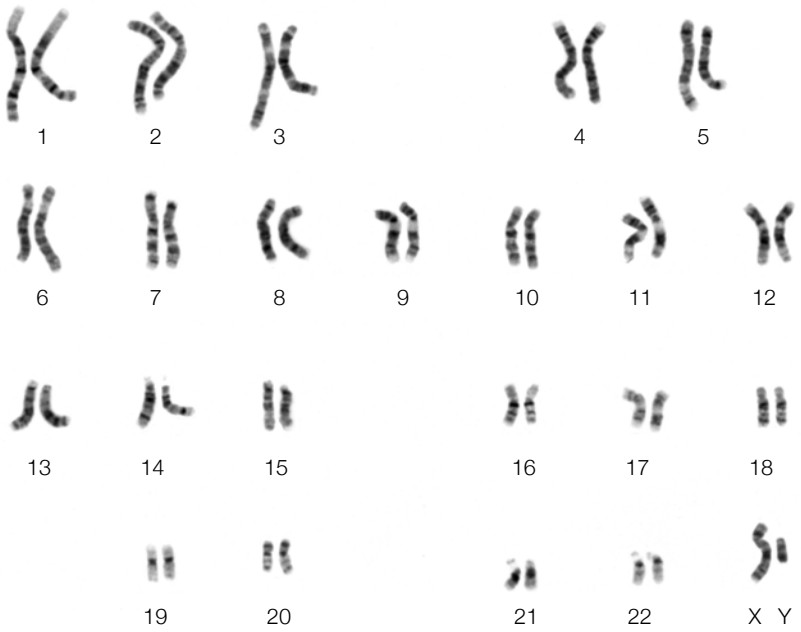
HudsonAlpha
INSTITUTE FOR BIOTECHNOLOGY



Chromosomes

humans have 46 -
organized in pairs





Understanding Size



Imagine that we scale up a DNA helix from 80-billionths of an inch wide to 1/4-inch wide, the same diameter as a pencil.

At that scale, we get the following relative sizes:

carbon atom	size of a small grain of rice
red blood cell	size of a one-story house
thickness of a hair	length of a football stadium
height of a human	distance from New York to Los Angeles!



unwound DNA from the chromosome

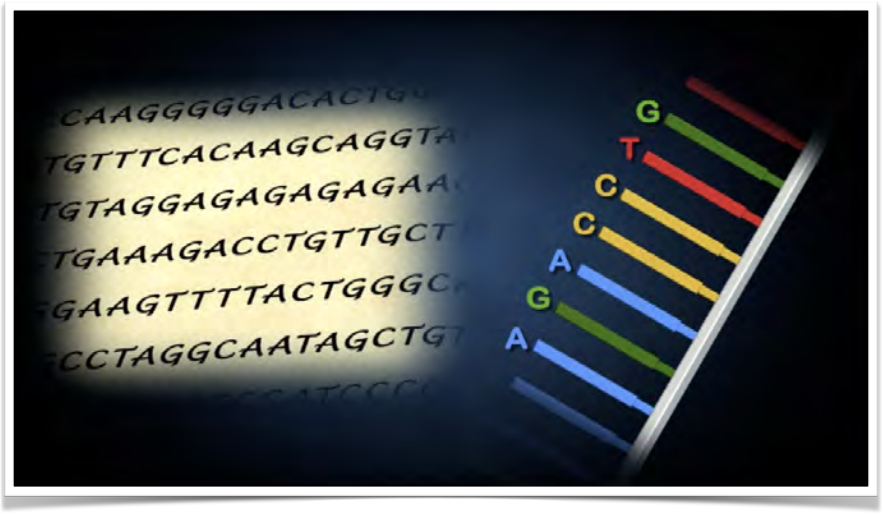


A closer look

The order of the rungs has meaning

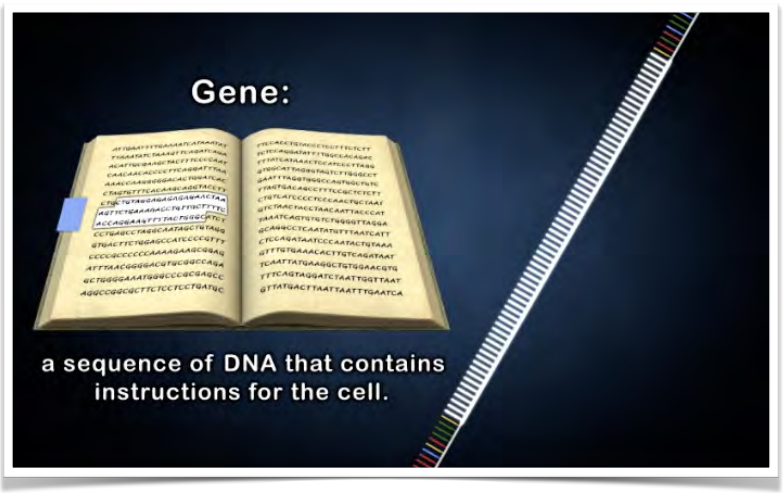
the sequence provides the instruction

MEAT TAME TEAM META AMTE

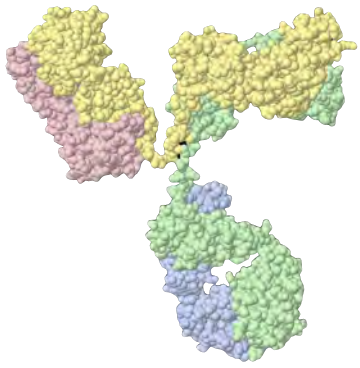


Gene: A set of DNA instructions

for making proteins or regulatory molecules



protein - made of amino acids

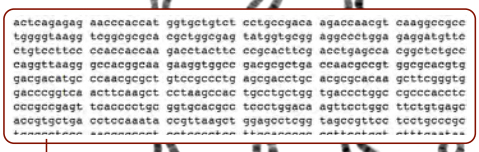


~20,000 genes in human DNA

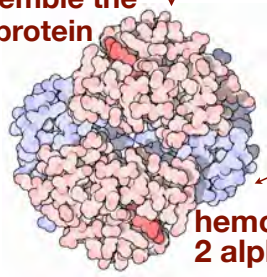
the whole picture

the 46 human chromosomes, paired by size

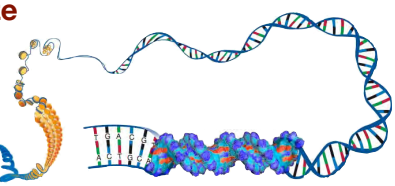
part of the HBB gene's DNA sequence



the gene sequence tells the cell how to assemble the protein



hemoglobin
2 alpha (blue) & 2 beta (red) protein chains



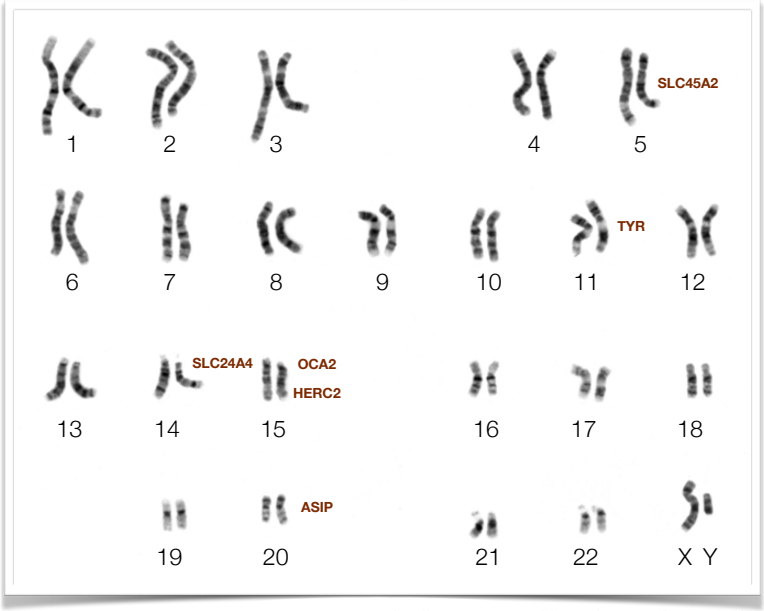
chromosomes contain DNA tightly wound around proteins

gene: a specific segment of the DNA that encodes instructions for making protein

Image credits: www.genome.gov; https://pdb101.rcsb.org/motm/41; Darryl Leja, NHGRI

many traits are influenced by multiple genes

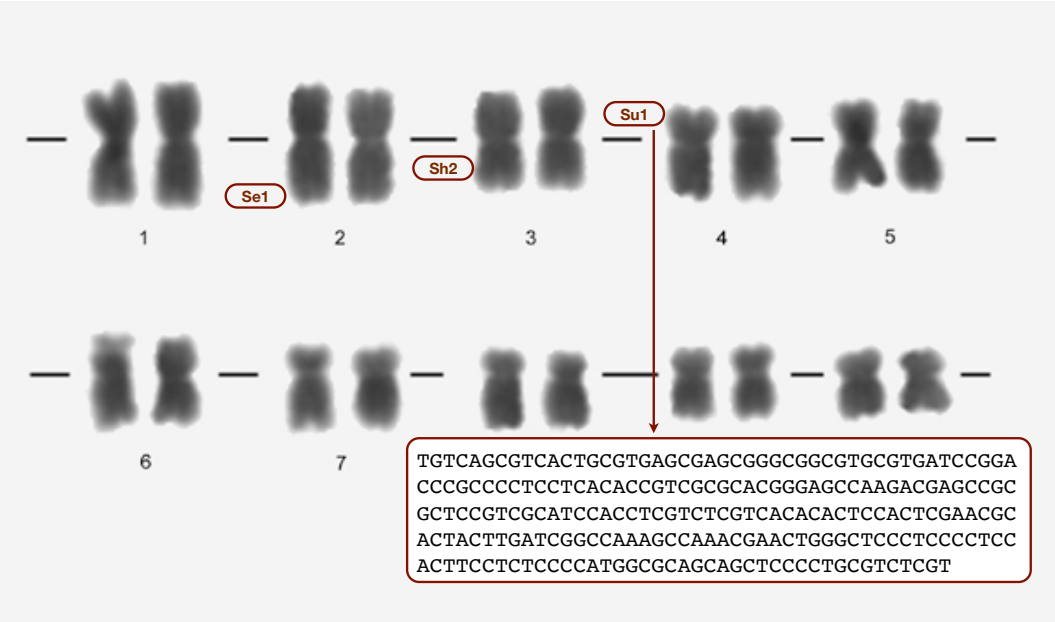
Genes that influence eye color



http://www.genome.gov/glossary/resources/karyotype.pdf

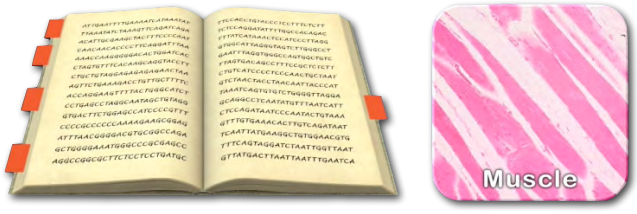
many traits are influenced by multiple genes

Genes involved in sugar content of corn kernels



Different cells activate different genes

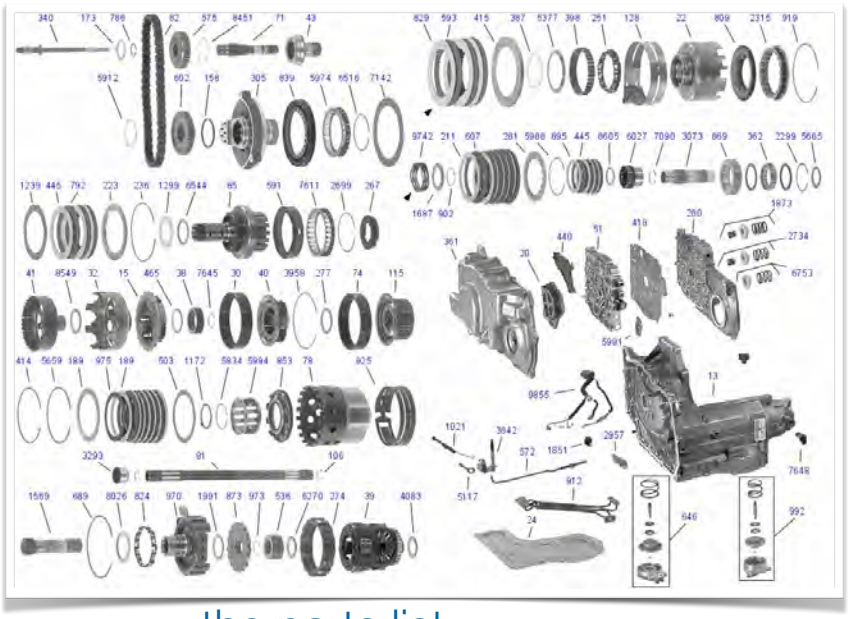
cell-specific gene activity (expression)



muscle

skin





the parts list

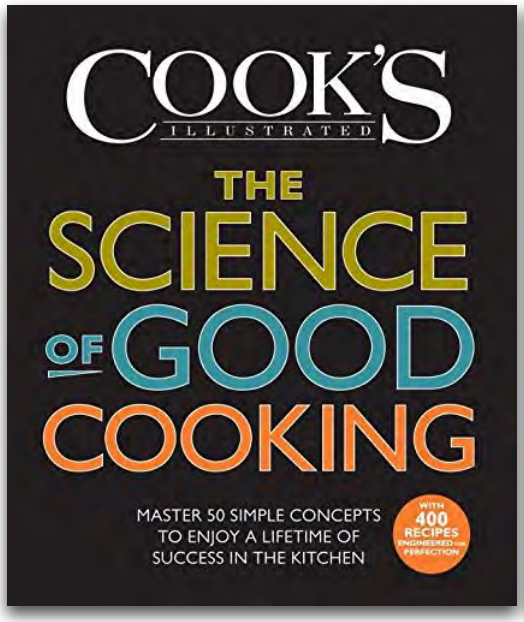
What does DNA tell us?



Genome findings

genome - the collection of DNA found inside a cell

- in Humans, about 1-2% is actually the genes
- most of the remainder is regulatory
- the genomes of any two humans differ by less than 1%
- some of these differences are in a single base ("rung"); others are thousands of bases long







Genome Gene Product

HudsonAlpha
INSTITUTE FOR BIOTECHNOLOGY

What happens when a cooking recipe changes?

Chocolate Cake

Ingredients:

2 cups sugar

3/4 cup cocoa powder
1-1/2 teaspoons baking powder
1-1/2 teaspoons baking soda
1 teaspoon salt
2 eggs
1 cup milk
1/2 cup vegetable oil
2 teaspoons vanilla extract
1 cup boiling water
2 cups strawberry frosting

Directions:



HudsonAlpha
INSTITUTE FOR BIOTECHNOLOGY

What happens when the DNA recipe changes?



Silent
no difference

Polymorphism
normal variation

Mutation
harmful

DNA variation - changes in the recipe

- frequently due to errors in DNA replication
- also caused by DNA damage that is not repaired
- if in an egg or sperm cell, the variation can be passed along from generation to generation
- if the change is in a body cell, it is not passed to children

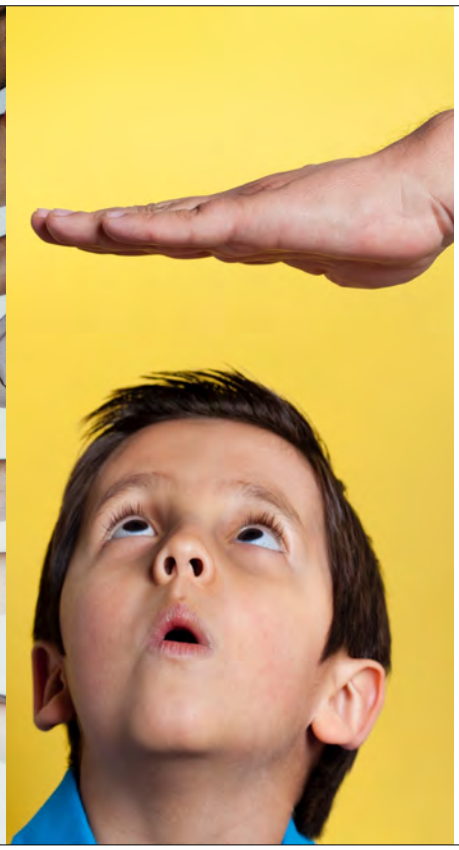
HudsonAlpha
INSTITUTE FOR BIOTECHNOLOGY



Wikimedia Commons: the wub



Strum, R.A., Human Molec Genetics (2009) 18:R9-R17



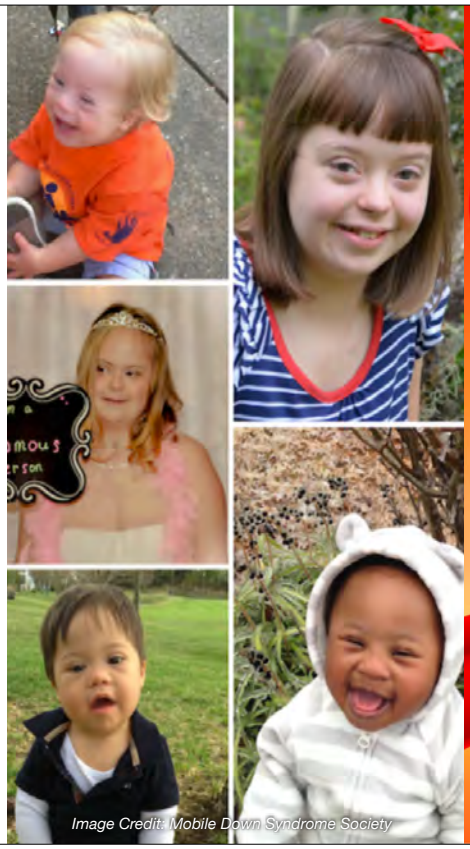
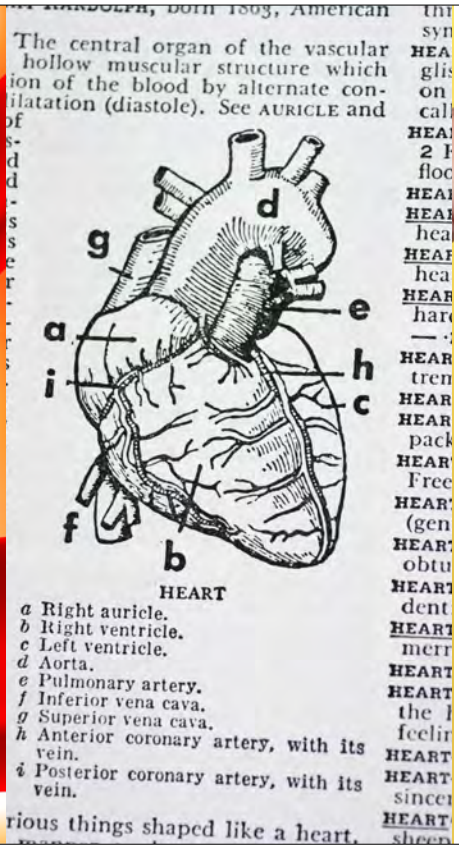


Image Credit: Mobile Down Syndrome Society





The central organ of the vascular hollow muscular structure which ion of the blood by alternate con- ilatation (diastole). See AURICLE and

HEART

a Right auricle.
b Right ventricle.
c Left ventricle.
d Aorta.
e Pulmonary artery.
f Inferior vena cava.
g Superior vena cava.
h Anterior coronary artery, with its vein.
i Posterior coronary artery, with its vein.

rious things shaped like a heart.

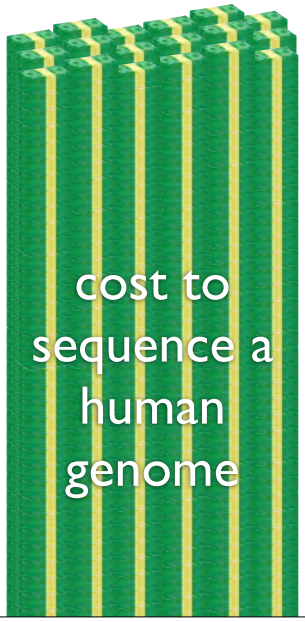


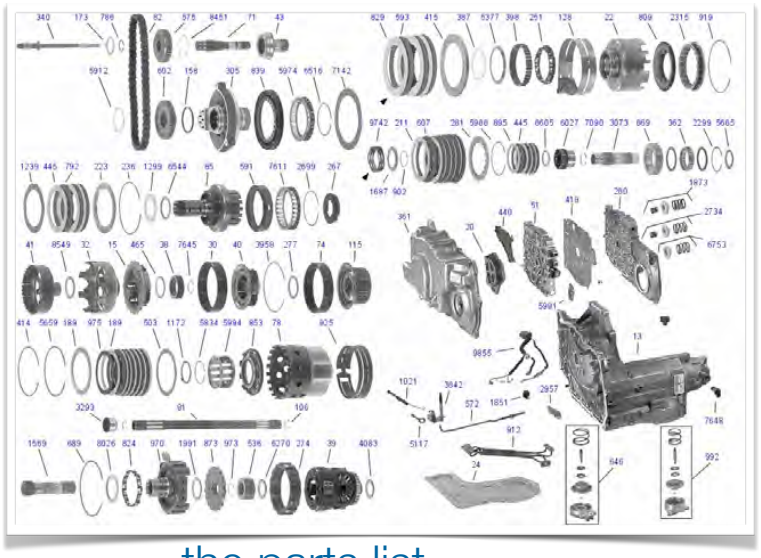


2021: < $1,000



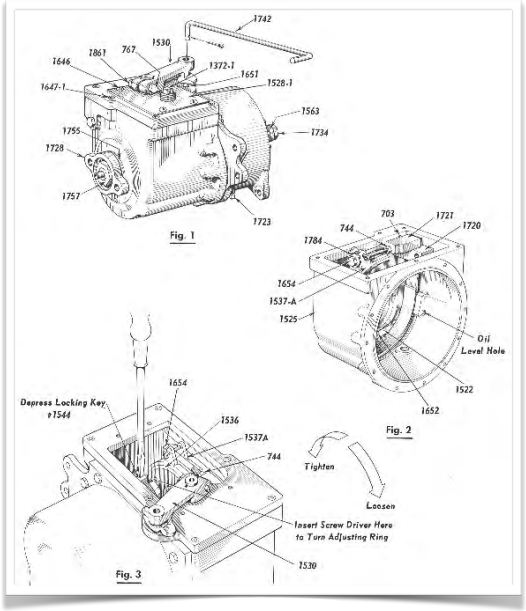
2000: $500,000,000





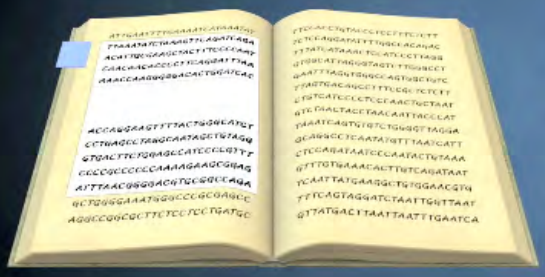
the parts list

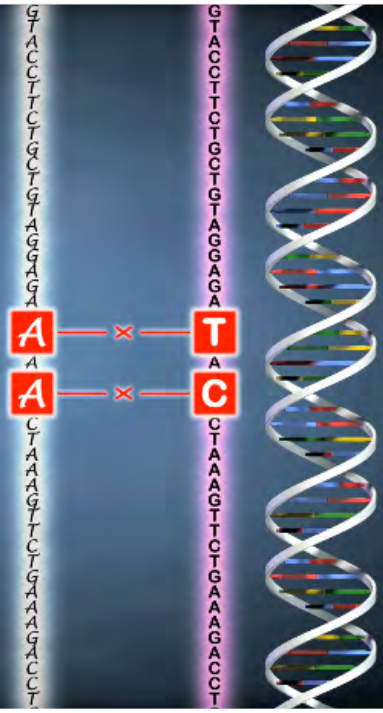
the instruction manual



What does DNA tell us?

combine the genetic risks with your lifestyle and environmental risks to determine overall susceptibility





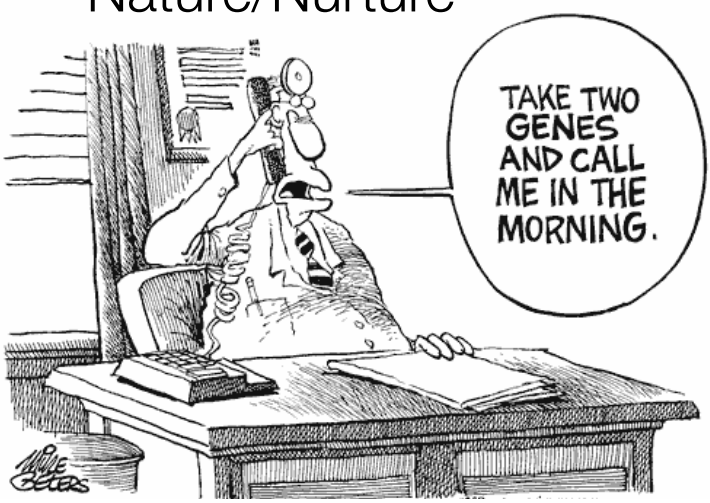
precision medicine

HUDSONALPHA
INSTITUTE FOR BIOTECHNOLOGY



HUDSONALPHA
INSTITUTE FOR BIOTECHNOLOGY

Nature/Nurture

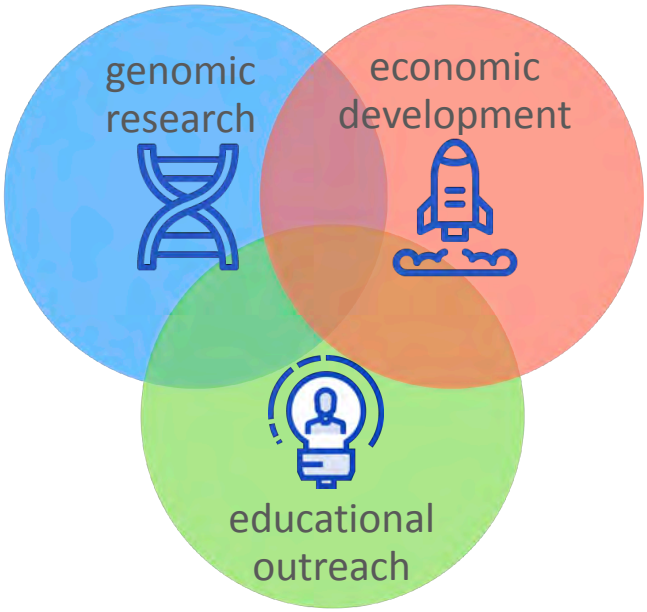




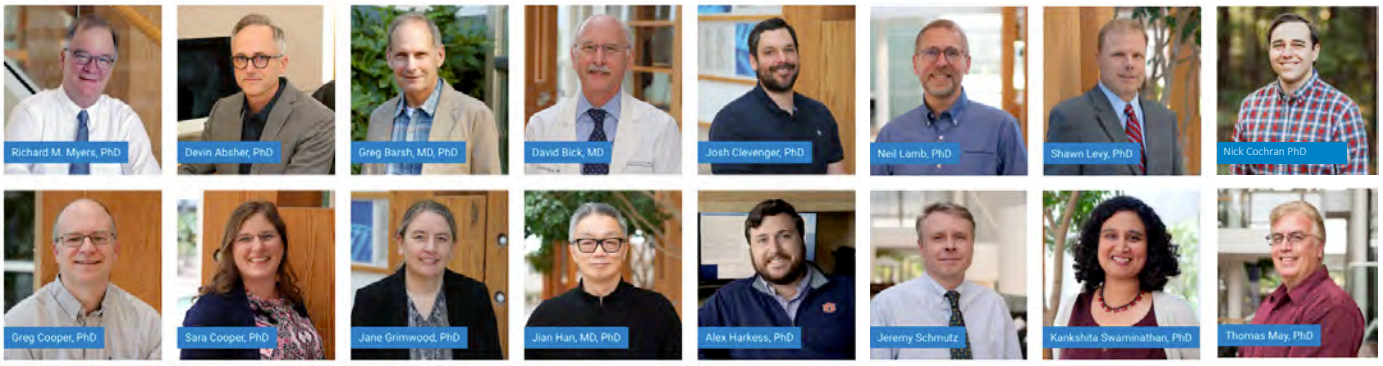
DNA is NOT the sole determinant of what we are

there is a strong environmental component for most traits and diseases

HudsonAlpha's mission is to use biotechnology to:



- improve life
- stimulate economic development
- and inspire Alabama's youth to seek careers in science



ophthalmologic disorders
childhood disorders
genomic health
autism
neurodegeneration
DNA Analysis
cancer
diabetes
agriculture
immune system
disease discovery
bioinformatics
hibernation
population studies
infectious disease
education
bioethics
pharmacogenomics
microbiome
pigment and colouration

HudsonAlpha
INSTITUTE FOR BIOTECHNOLOGY

HudsonAlpha's Associate Companies

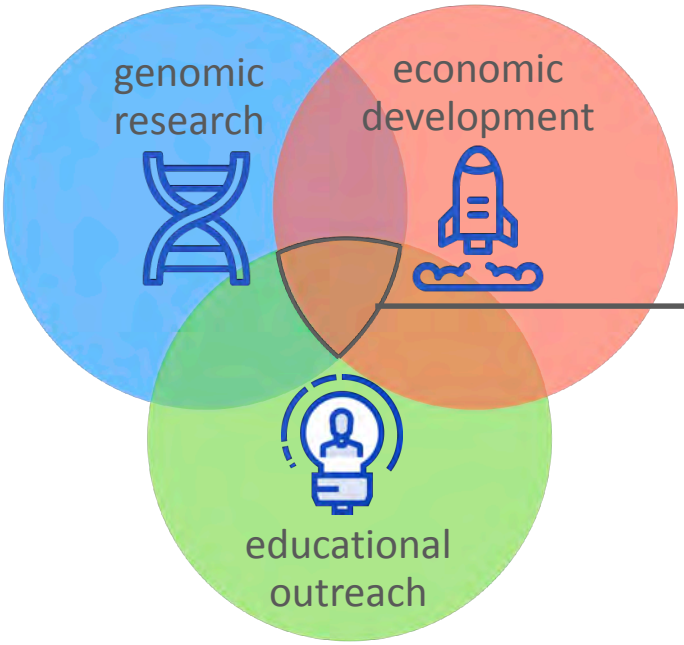
ACCLINATE
Advancing Sight Network
Alimetrix
BIO ALABAMA
BioDynami
Celsion Corporation
CFD RESEARCH
Gene Capture
eurofins | Diatherix
IMIDomics
DISCOVERY LIFE SCIENCES
Everbloom HEALTH
Gemini Genomics
HudsonAlpha HEALTH ALLIANCE
Foresight Biosciences
Foresight Chemistry
HUDSONALPHA DISCOVERY
icubate
ITSC Secure Solutions
iXpressGenes Inc.
Jackson Center
kailos
KEYSYS
Regenesis BioMed Technologies
SustainSpace
LEAVENDARY
MI Microarrays
m·v·w Nutritionals, LLC
InnoFocas
PTEN
PROZONE
SAVANTZ
SERINA THERAPEUTICS, INC.
NSS
Sulfilatec
SYNVIVO
TheraPlay Analytics
The Smith Family CLINIC for GENOMIC MEDICINE
The HudsonAlpha CLINICAL SERVICES LAB
Theos Health BE · EVERYWHERE
transOMIC technologies inc.
Trilinear
V|H LABS
the Written SCIENCE LLC
Translating science into medicine

HudsonAlpha
INSTITUTE FOR BIOTECHNOLOGY



Education is not the filling of a pail,
but the lighting of a fire.

HudsonAlpha's mission areas

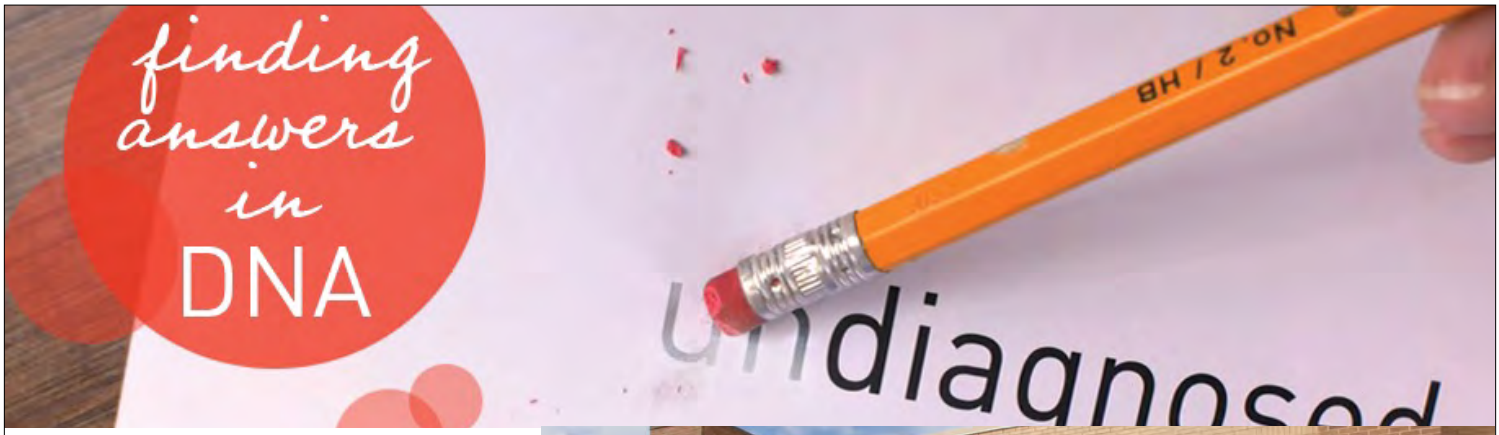


Mission-specific programs

Initiatives that draw from all three missions

- genomic health
- sustainable agriculture

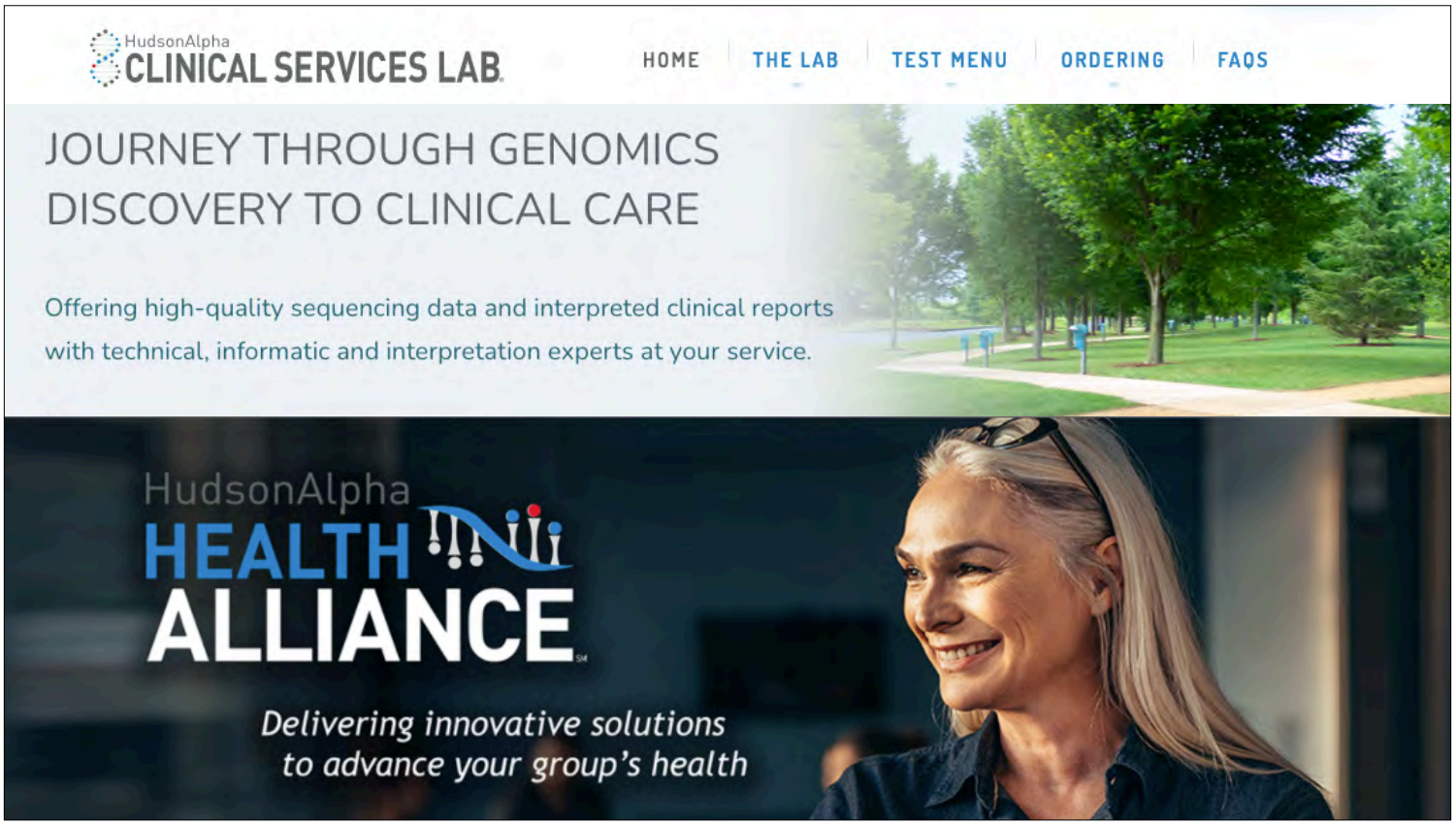
HUDSONALPHA
INSTITUTE FOR BIOTECHNOLOGY



The Smith Family CLINIC for GENOMIC MEDICINE

Powered by HudsonAlpha, Children's of Alabama and UAB Medicine





Genomics in Agriculture





HUDSONALPHA
INSTITUTE FOR BIOTECHNOLOGY

Let's Recap

- DNA is the "recipe of life" - a set of instructions
- DNA is stored in the nucleus of cells as tightly wound structures called chromosomes
- a gene is a specific instruction that tells cells how to make proteins
- different types of cells call on different sets of genes
- the genomes of all humans differ only slightly
- these differences may have no impact, be part of normal variation, or lead to clinical symptoms