

Evolution, Genes and Human Nature

IDH 1002
January 13, 2009

Darwin and Natural Selection

- Those individuals with traits that favor the competition for limited resources will be more likely to survive and reproduce.
- These traits will therefore exist to a greater degree in subsequent generations.
- Darwin stressed that natural selection applies only to inheritable traits, not learned behaviors

Mendel's Conclusions

- inheritance of each trait is determined by a factor that is passed on to descendants unchanged (factors are now called genes)
- an individual inherits one such factor from each parent for each trait
- one trait may dominate another
- a trait that does not appear in an individual can still be passed to the next generation.

FLORIDA HEADLINES

Thursday, January 3, 2008

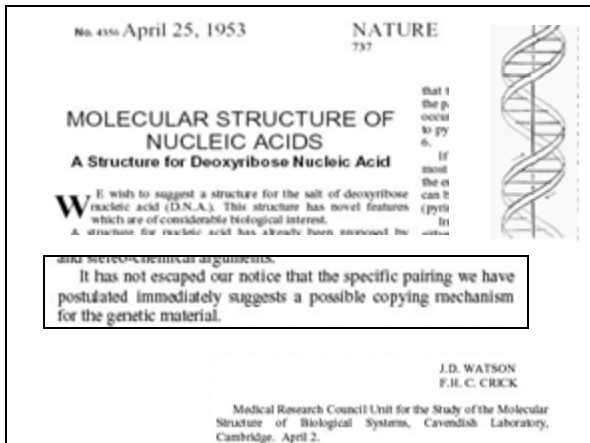
Public debates evolution, intelligent design

By **RON WORD**
Associated Press Writer

JACKSONVILLE, Fla. - The pros and cons of evolution and intelligent designed were hotly debated for several hours Thursday as the state school board is considering revisions in science standards that would substitute the word evolution for "biological changes over time."

Molecular Basis of Evolution

- DNA Structure
- Watson and Crick
- 1953
- “The greatest, simplest, and most surprising secret in the universe”
- Ladder with 4 types of rungs = Double Helix

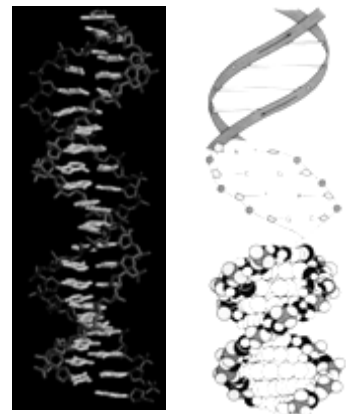


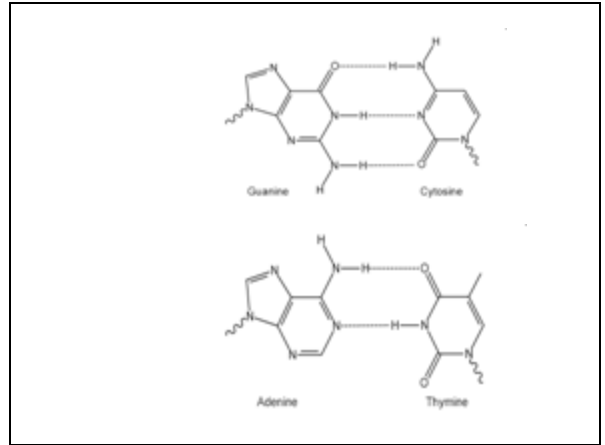
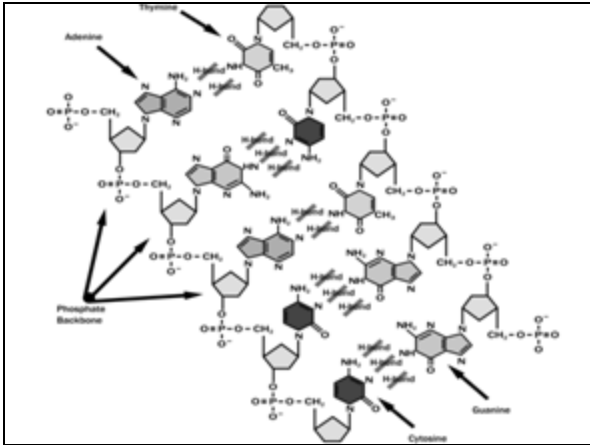
Models were used by Watson and Crick to solve structure

Only 4 nucleotides (bases) A, T, G, C

Each base of one strand matches a complementary base of the other

A=T
G=C





Major functions of DNA

- The mechanism for reproduction = separate to single strands and then make copies
- The sequence directs the organism on assembly of proteins

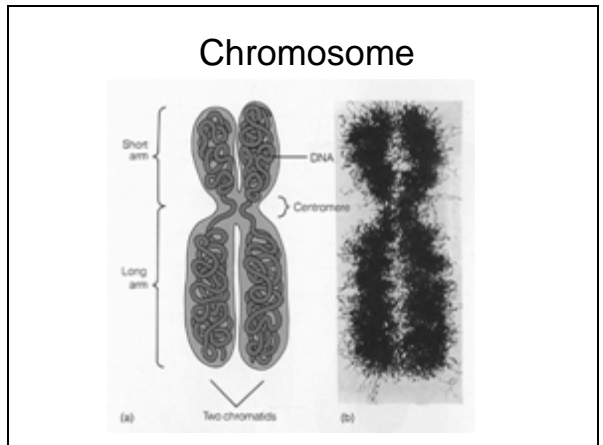
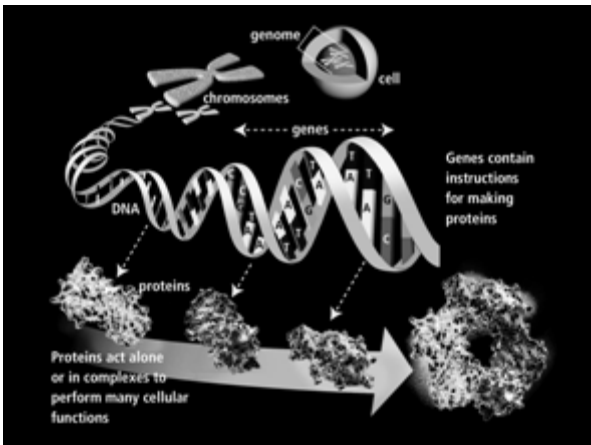
Solving the Genetic Code

- DNA contains the recipe for synthesis of proteins
- All organisms use same code
- Each code directs the incorporation of a specific amino acid to build a protein
- 20 amino acids – what is minimum code?
- Need at least 3 letters
- DNA transfers info via messenger RNA
- RNA uses U instead of T, and a different sugar molecule as part of its backbone
- Solved by Nirenberg, 1961

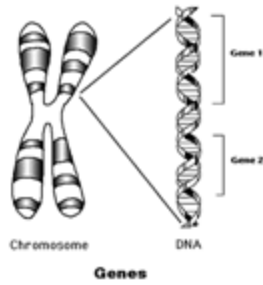
		Second letter				
		U	C	A	G	
First letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA } Stop UAG } Stop	UGU } Cys UGC } UGA } Stop UGG } Trp	U C A G
	C	CUU } CUC } Leu CUA } CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } Arg CGA } CGG }	U C A G
	A	AUU } AUC } Ile AUA } AUG } Met	ACU } ACC } Thr ACA } ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G
	G	GUU } GUC } Val GUA } GUG }	GCU } GCC } Ala GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } Gly GGA } GGG }	U C A G

Human Genome: the genetic information in your body

- 50 -100 Trillion cells
- Each cell nucleus has about 2 meters of DNA and 2 Sets of the genome (3 B bases)
- One set from mother, one from father
- Sex cells (one set) and red blood cells (none)
- Contain in 46 units called chromosomes
- Current estimate is 25,000 genes



Each Chromosome is a single long strand of DNA holding hundreds of genes



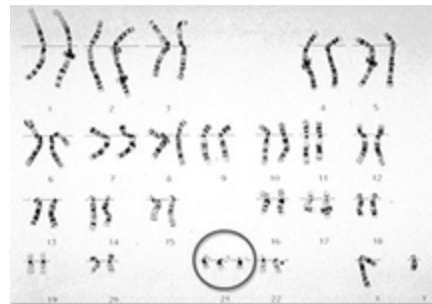
Number of chromosomes

Organism	Number of chromosomes
pea plant	14
sun flower	34
cat	38
puffer fish	42
human	46
dog	78

Schematic of human chromosomes



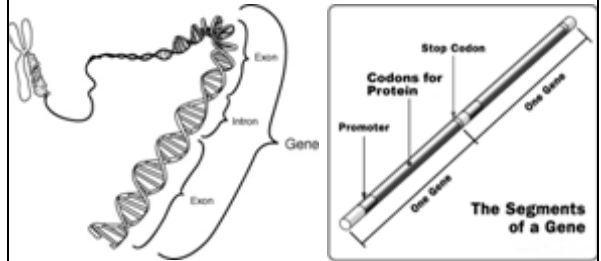
Down Syndrome – an extra chromosome 21



Genome as a book

- 23 chapters (*chromosomes*)
- Each chapter hundreds of stories (*genes*)
- Each story has several paragraphs (*exons*), interrupted by ads and junk (*introns*)
- Each paragraph has words (*codons*)
- Each word written in three letters (*bases*)
- Alphabet is only four letters (A, G, C, T or U)
- One billion words in the book
- Linear one-dimensional information

Schematic of a gene



Message buried in introns

Igvrldlnquthequickababcmfxbrownfoxjuirvemped
 Overthelazyyyzplfdogjjiurttiythedoglayhhbeldquietly
 dreaminghwwiqldnsodinnerplwosiuwnd

Message buried in introns

Igvrldlnquthequickababcmfxbrownfoxjuirvemped
 Overthelazyyyzplfdogjjiurttiythedoglayhhbeldquietly
 dreaminghwwiqldnsodinnerplwosiuwnd

Igvrldlnquthequickababcmfxbrownfoxjuirvemped
Overthelazyyyzplfdogjjiurttiythedoglayhhbeldquietly
dreaminghwwiqldnsodinnerplwosiuwnd

Human Genome Project

- Draft of gene sequences announced June 2003
- Human Genome Project, methodical project involving many scientists, headed by NIH
- Independent “shotgun approach” by Celera with massive computer crosschecking
- Both facilitated by the PCR reaction, which enables a duplication of DNA from a single sample

Mechanism for natural selection

- DNA strand breaks about once every 10 seconds = constant need for repairs
- Error rate = ~ 1 per billion replications
- DNA fragments get modified or exchanged
- Most changes cause no effect (introns)
- Changes may be passed to offspring
- Errors in repair – linked to aging, cancer,

Mutations in chromosome duplication



deletion

duplication

inversion

Genes and Evolution

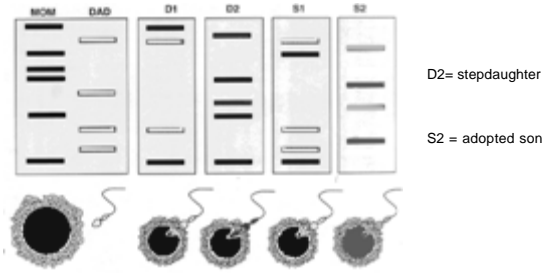
- Other genomes are being characterized
- Linkages between organisms came be based on genetic makeup, much more accurately than on morphology
- Learning from other organisms – 2/3 of the genes that cause cancer in fruit flies are also found in human genome

DNA and ancestry

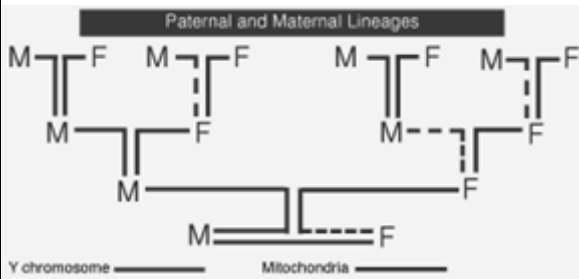
1. DNA fingerprinting – CSI
2. Mitochondrial DNA
3. y-chromosomes

DNA fingerprints

DNA is chopped into fragments and compared with standards



Applications to Human Ancestry



DNA Maternal Ancestry Lines

- Mitochondrial DNA - a small loop of DNA not from cell nucleus - about 16,000 base pairs
- Therefore not divided in new generations and usually passed on unchanged
- Useful to determine common ancestry on maternal side
- Limitation – if you and I have a common maternal ancestor, can't tell if linkage is recent or ancient

DNA Ancestry via Male Lines

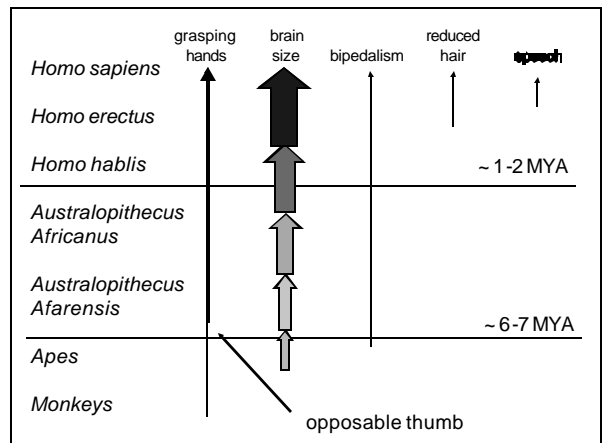
- Y-test (Y-clan) uses Y- chromosome and is restricted to males
- Cleaves DNA in Y-chromosome with specific agents and compares patterns
- Using multiple cleavage agents
- Relatives have similar patterns, but can't tell degree of relationship
- Useful to determine tribal roots
- \$199 for 44 markers

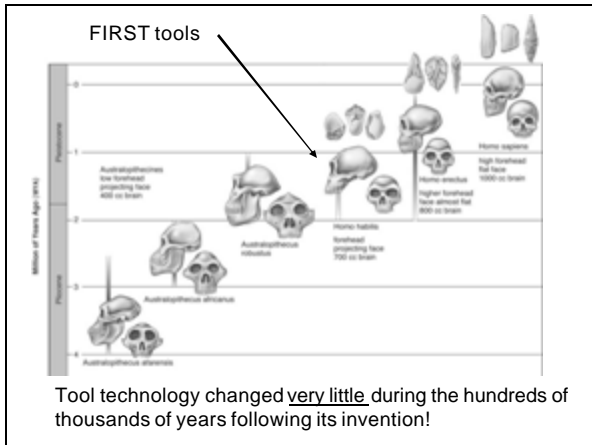
Early human evidence

- Assume aborigines migrated to Australia about 30,000 years ago, assume a common ancestor at that time
- Can measure the number of mutations since then – about 1 per 1000 years
- Assuming constant mutation rate, can date the oldest human remains at 200,000 year

Early human evidence – cont.

- Ancient European mt-DNA no closer to neanderthal mt-DNA than aborigines = no cross-breeding
- Confirms that earliest homo sapiens (most divergent) came from Africa
- Can date migrations out of Africa, but dates vary from 50,000 – 200,000 years
- 95% of women in Europe from 7 ancestors of 45,000 years ago
- Rapidly changing field of research





Why was human “progress” so slow and then so suddenly dramatic in last few thousand years?

- Speech and Language?

Question

- Would you rather be the recipient or the donor in a heart transplant?
- Would you rather be the recipient or the donor in a brain transplant?
- If knowledge goes with the brain, is it the donor who lives on?
- Does brain serve the body or does the body serve the brain?

The Selfish Gene - Dawkins

- Individuals are born and die
- Genes seek to reproduce themselves
- Those genes whose host successfully promotes their own propagation will be favorably selected in detriment to their competitors
- “A chicken is just an egg’s way of making more eggs.”
- The selfish gene may be altruistic toward its own kin, if this will increase the probability of the gene being reproduced

What is the unit of evolution?

- The individual gene?
- The assembly of genes?
- The species?
- The cultural community (tribe)?
- “On earth this is nothing great, but man; in man there is nothing great but mind”
– Sir William Hamilton

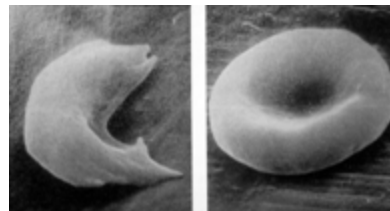
- Nov. 13, 2006
- “Spirited Debate”
- Richard Dawkins –
atheist biologist
- Francis Collins –
geneticist
(Director Human
Genome Project)



Implications of Knowing Genome

- Genetic screening for propensity to various diseases
- Create replacement parts, eg, spinal nerve cells
- Extinction of natural organisms as replaced by “better” ones, designed by humans?

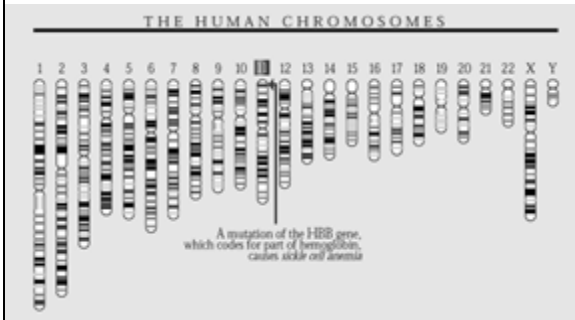
Sickle Cell Anemia



sickle cell

normal cell

Sickle Cell Anemia



Change of one base in DNA



Changes an amino acid at position 6 of 272 amino acids in protein chain of hemoglobin

Why Sickle Cell Gene Survives

- Normal blood cells = likely death to malaria
- Sickle cell gene from both parents = likely death from sickle cell anemia
- Sickle cell trait is passed on, with limited susceptibility to either disease



Propensity for many afflictions can now or soon will be diagnosable

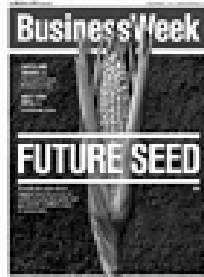
- Do you want to know?
- Should employer, government or insurance companies know?

Genetic "Opportunities"

- Modify and clone bacteria to produce medications such as insulin (1987)
- Modify bacteria to produce an organism that eats up oil in oil spills (1992)
- Modify plants to produce crops more resistant to pests, food with longer shelf life, better color, etc. (1990's)
- Cloning animals – get exact copies

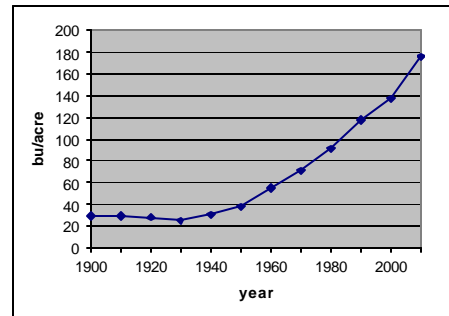
FEATURES		MIGHTY BUGS - OIL EATER	
Non-Flammable		Microbial Cleaner for Surfaces	
No VOC		MIGHTY BUGS is a general purpose microbial cleaner which can be used to almost any cleaning situation. This product is a concentrate and can be diluted with up to 10 parts water, depending upon the application. MIGHTY BUGS is non-hazardous. It can be used any where oil contamination is a problem. Typical applications include, but are not limited to:	
Non-toxic		Ship Floors	Marine Yacht
Protects the Interior of Cleaners		Engines	Walls
No Storage Regulations		Machinery	Painted Surfaces
Cleaner Without Polluting		Parking Lots	Driveways
Transfers, and Treats Oil		Car/Truck Washes	Carpets
Will Not Burn Hands or Skin		Petroleum Tanks	Oil Pits
For Industrial Surfaces		Cutting Coasters	Oil Spills
Applies Oil to a Problem		Textile Cleaning	Rainy Streets
		MIGHTY BUGS is a liquid concentrate. The general industries and the marine use applications:	
		1. Mix the liquid solution with the volume of water at the rate of one part per gallon of water. This will reduce the volume and weight from that amount water. Use the volume amount at least one tablespoon in a washing period of 24 hours or more.	
		2. The product may be applied with either a spray or brush. The amount used may not be allowed to rise above 100 ft in its complete dryness. Some may be present at all times, depending on the amount of usage for the situation.	
		3. The solution may not be allowed to rise above 100 ft in its complete dryness. Some may be present at all times, depending on the amount of usage for the situation.	
		4. In general, the amount used may be 1/2 to 1 gallon per 100 sq. ft. During this time, the surface will have been cleaned and the solution will have oxidized to the hydrocarbon. The complete oxidation process will continue for several days.	
		5. In some applications, the solution can be diluted and used in the general areas. The solution can be stored in an open container. It is non-hazardous. For specific cleaning applications, please refer to the application manual or contact your sales representative.	
		BROWN MARINE SERVICE, INC. 1-800-234-3473 or 850-453-3473 PENSACOLA, FL	
The 21st Century Cleaner			

Genetically Modified Corn



- From teosinte to corn in 5,000 years

Corn Yields per acre in US



Genetically Modified Organisms

- Not new, done by breeders for centuries
- With genetic engineering, can make novel structures, such as blue corn
- Over 90% of soybeans, 70% of corn
- Bt-corn – 1990 – resistance to worms
- Current 3 gene corn
 - Resistance to two major pests
 - Inert to glyphos herbicides (Roundup)

Genetic bacteria can produce biofuels from many plants or even directly from CO₂



Gene Therapy

- Insert a new gene to replace a missing or defective one
- None yet approved for human use
- Successfully cured deafness in guinea pigs
- Leber's congenital amaurosis, a type of inherited childhood blindness caused by a single abnormal gene, cured in dogs

Human Behavior in Light of Evolution

- B. F. Skinner – behaviorism
- Noam Chomsky – language and cognition
- Nico Tinbergen – ethology
- E. O. Wilson – Sociobiology
- Cosmides and Tooby – Integrated Causal Model

B. F. Skinner



- Harvard Psychologist (1906-1990)
- Trained lab animals – “the Skinner box”

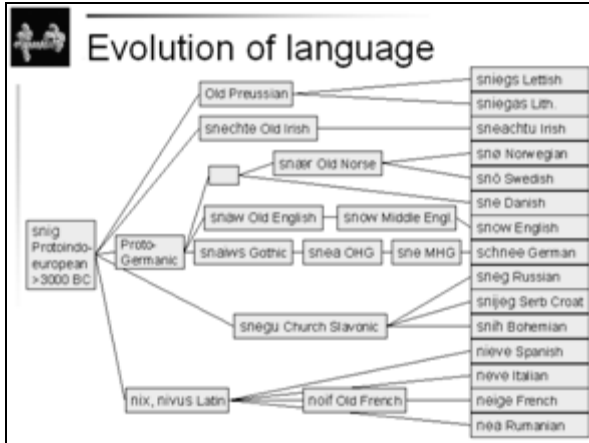
B. F. Skinner

- Behaviorism and operant conditioning
- Reinforced actions are “learned”: repeated even if reinforcement is intermittent
- Interpreted human behavior as mostly generated by our environment
- Walden 2 – “utopia” based on social engineering based on operant conditioning

Noam Chomsky

Noam Chomsky

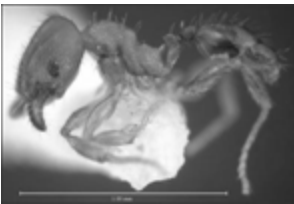
- Focused on language development as the unique feature of homo sapiens
- Innate capacity for processing language
- Developmental component – learn by hearing at early age, learn by written language later
- Language origin studies now blended with DNA ancestry to trace human migrations



Timbergen's four "Whys?" for a particular animal behavior

1. Immediate cause – muscle contractions, hormone secretions, nerve impulses
2. What stimulus led to behavior?
3. What is the function of the behavior?
4. Evolutionary history of the behavior?

E.O. Wilson



- Current Harvard scientist world renowned for studies on social insects
- Identified 426 species of ants in Caribbean Islands

E. O. Wilson

- Extrapolates far beyond his area of science to propose and popularize a philosophy of human nature
- Sociobiology (1975), On Human Nature (1978) The Creation (2006)
- Views all human knowledge as specialized branches of our biology
- Behavior is largely determined by genes
- Sociobiology, Evolutionary Psychology

Wilson's first dilemma

- “the human brain is a device for survival and reproduction, and **reason** is just one of its various techniques”
- Human Species lacks any goal external to its own biological nature
- Dilemma = to what transcendent goals can societies organize their energies?

Wilson's second dilemma

- Morality has evolved as an instinct
- Innate sensors and motivators in our brains and genes
- We have or soon will have the ability to choose which moralities to reinforce
- If so, how to choose

Three mythologies -Wilson

- **Marxism** – discredited, an inadequate form of non-biological materialism
- **Traditional Religion** – lacks explanatory power, but offers spiritual power to motivate people
- **Scientific Materialism** – intellectually superior formulation, but lacking in primal motivation

The Other Side

- ***“Love of Shopping” is not a Gene: Problems with Darwinian Psychology***

Anne Innis Dagg, 2005

Integrated Causal Model

- Cosmides and Tooby – 1990's
- Seamless matrix of causation
- Attempts to divide into dual nature are:
“a pre-modern version of biology, whose intellectual warrant has vanished”

Factors in Integrated Causal Model

1. Natural selection – over millennia
2. Historical development of variety of human cultures over centuries
3. Mixing of genes in sexual reproduction
4. Input of physical and social environment on each individual
5. Internal information processing in perception and speech, which join with motivation factors to produce an action

Integrated Causal Model

- “.. **everything**, from the most delicate nuance of Richard Strauss's last performance of Beethoven's Fifth Symphony to the presence of calcium in his bones at birth, is totally and to the same extent genetically and environmentally codetermined”

The Future – the **GRIN** technologies

- Genetics
- Robotics
- Information
- Nanotechnology

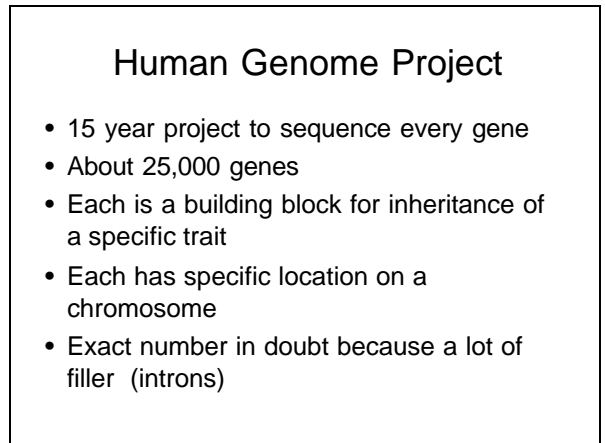
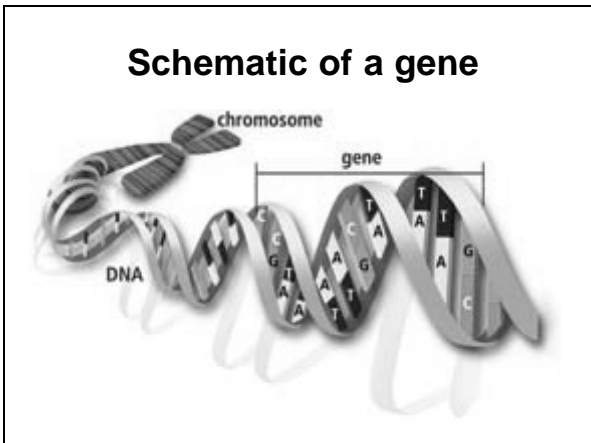
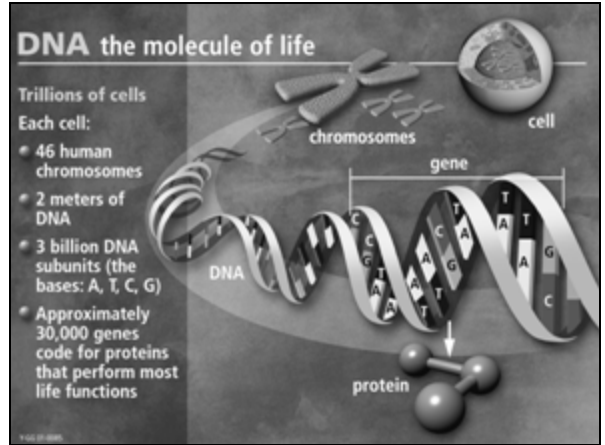
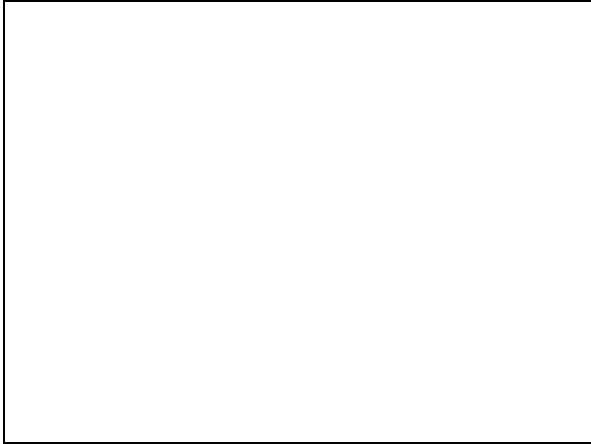
Can we reject technological “advances”?

- DDT
- SST
- Nuclear Weapons
- Biological and Chemical Warfare
- Nuclear Reactors
- New Hydroelectric dams

The Challenge

- “The problems of modern civilization rise from the disjunction between our ancient and glacially slow-evolving **genetic** heritage at one level of evolution and our ultrafast **cultural** evolution at the other level.”

E.O. Wilson, The Creation, 2006



The dispersal of modern humans out of Africa ca. 100,000 years ago led to:

Populations of human adapted to local conditions

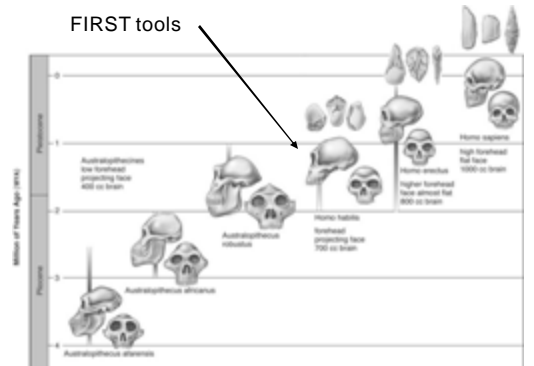
- differences in nose size.
- differences in body types
- differences in skin color



* Sexual selection is also thought to have played an important role in the evolution of different features among races.

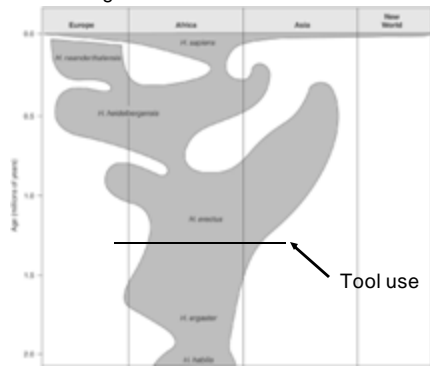
* The extinctions of many large mammals including all other homonids.

FIRST tools



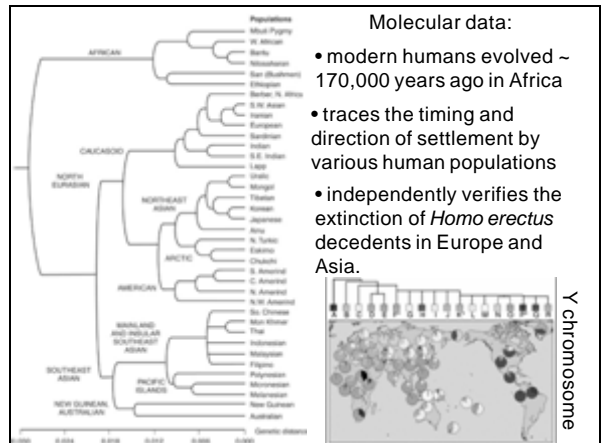
Tool technology changed very little during the hundreds of thousands of years following its invention!

Several migrations out of Africa are documented soon after the tool making evolved.



Molecular data:

- modern humans evolved ~ 170,000 years ago in Africa
- traces the timing and direction of settlement by various human populations
- independently verifies the extinction of *Homo erectus* decedents in Europe and Asia.



Spontaneous Generation

- Life appears spontaneously
- Worms from mud
- Flies from decaying flesh

Laboratory Creation of Life?

- Miller-Urey experiment, 1953, obtained amino acids from a “pre-biotic soup” (simulated early atmosphere of methane and ammonia) plus electric discharge

Miller-Urey Experiment

