“Anthropogeny”— Explaining the Origin of Humans

Where did we humans come from?
How did we get here?

Anthropogeny: Investigation of the Origin of Humans
(1839 HOOPER Med. Dict., the study of the generation of man).
Pursuing Anthropogeny Involves Most Academic Disciplines

Engineering & Computing Sciences

Social Sciences

Arts and Humanities

Biomedical Sciences

Biological Sciences

Physical & Chemical Sciences

ANTHROPOGENY

UCSD/Salk Center for Academic Research and Training in Anthropogeny (CARTA)

“To explore and explain the origins of the human phenomenon”

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http://carta.anthropogeny.org

CARTA
Center for Academic Research & Training in Anthropogeny
"To explore and explain the origins of the human phenomenon"

Home

The Center for Academic Research and Training in Anthropogeny™ (CARTA) was established in a collaboration between faculty at UC San Diego and at the Salk Institute for Biological Studies, along with interested scientists at other institutions. CARTA became a UC San Diego organized Research Unit (ORU) in January 2009.

As the word anthropogeny implies, the primary goal of CARTA is to "explore and explain the origins of the human phenomenon." In other words, finding the answers to the two age-old questions regarding humans:

- Where did we come from?
- How did we get here?

CARTA is a virtual organization formed in order to promote transdisciplinary research into human origins, drawing on methods from a number of traditional disciplines spanning the humanities, social, biomedical, biological, computational & engineering and physical & chemical sciences.


CARTA Public Symposia

Symposia Archive

Search for past symposia events and talks by title keywords, speaker name, or year. To narrow your search, include any combination of those three properties in your search keywords (e.g. *“*events 2011*“*).

Search for:

Show:
- Only Events
- Events and Talks

1 2 next last

Date Title
Fri May 10, 2013 Behaviorally Modern Humans: The Origin of Us
Fri Nov 15, 2013 Is the Human Mind Unique?
Fri Dec 07, 2012 The Evolution of Human Nutrition
Fri Apr 13, 2012 Culture-Gene Interactions in Human Origins
Fri Dec 16, 2011 The Upright Ape: Bipedalism and Human Origins
Fri Oct 07, 2011 Uniquely Human Features of the Brain
Fri Apr 08, 2011 The Genetics of Humanness
Fri Dec 10, 2010 The Evolution of Human Altruism
Fri Oct 01, 2010 Early Hominids
Fri Mar 12, 2010 The Evolution of Human Biodiversity
Fri Oct 02, 2009 Human and Non-Human Cultures
Upcoming CARTA Public Symposia

Below is a list of upcoming CARTA symposia. If you have an interest in an event, visit the event's detail page for more information. If the event requires registration, the link to the registration page will be provided at the bottom of the event page. All event times below are in Pacific time.

<table>
<thead>
<tr>
<th>Date</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fri October 18, 2013 @ 1:00pm</td>
<td>Mind Reading: Human Origins and Theory of Mind</td>
</tr>
<tr>
<td>Fri February 21, 2014 @ 1:00pm</td>
<td>Birth to Grandmotherhood: Childrearing in Human Evolution</td>
</tr>
<tr>
<td>Fri May 16, 2014 @ 1:00pm</td>
<td>Male Aggression and Violence in Human Evolution</td>
</tr>
<tr>
<td>Fri October 10, 2014 @ 1:00pm</td>
<td>Domestication and Human Evolution</td>
</tr>
</tbody>
</table>
Limited Intermating With Other Hominins
But We Eventually Replaced All Of Them....

H. erectus and extinct descendant lineages

H. floresiensis

H. neanderthalensis

Anatomically Modern H. sapiens

Behaviorally Modern H. sapiens

Denisovan hominins

Thousands of Years Before Present (Dates Approximate)

Anthropogeny: A Transdisciplinary Approach.

*GREAT APES*

HUMANS


Environment

Physical

Biological

Cultural

Comparisons

Interactions

Ontogeny

Phylogeny

Archeological Data

Fossil Data

LAST COMMON ANCESTOR
KEY QUESTION

How Different Are Humans and Chimpanzees?

Chimpanzees are Remarkably Similar to Humans!
Humans are Remarkably Different from Chimpanzees!

Answer:

Both Statements are Correct!
The Need for a Hominid “Phenome” Project


Matrix of Comparative Anthropogeny
“Nothing in biology makes sense, except in the light of evolution” (Theodosius Dobzhansky)

Corollary:

Nothing in the biological aspects of medicine should make sense, except in the light of evolution?

Based on an Annual Lecture to UCSD Medical Students

DOI 10.1007/s00139-012-0900-5

Nothing in medicine makes sense, except in the light of evolution

Ajit Varliki
**Theory**
Major diseases of a given species are likely to be related to (mal)adaptations during the recent evolutionary past of that species

**Corollary**
Comparisons of Disease Incidence and Susceptibility between Humans and our closest evolutionary relatives should be useful

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**Striding Bipedal Gait - A Uniquely Human Condition With Biomedical Consequences**

Striding bipedal Gait (upright walking and running) apparently originated soon after divergence of the chimpanzee and human lineages, >6 million years ago. Sustained running ability likely originated later, ~2 million years ago. While there were (and still are) advantages, humans are continuing to suffer negative medical consequences, such as:

- Low Back Pains, Strains and Injuries
- Spine Deformity Problems
- Herniated Inter-vertebral Discs (“slipped discs”)
- Varicose Veins
- Hernias
- Hemorrhoids
- Knee Joint Osteoarthritis
- Obstetric Difficulties (Narrow Pelvis)
**Hominin Brain Size Increase Over 6 million Years**

- *Homo sapiens*
- *Homo heidelbergensis*
- *Homo erectus*
- *Homo habilis*
- *Australopithecus boisei*
- *Australopithecus africanus*
- *Australopithecus afarensis*
- *Ardipithecus ramidus*
- *Pan troglodytes*


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**“Cephalo-Pelvic Disproportion” in Human Birth**

- *6-7 million years ago*
- *3 million years ago*
- *Today*

Pregnancy & Parturition: Human versus "Great Ape" Differences

<table>
<thead>
<tr>
<th>Feature</th>
<th>Human</th>
<th>Chimpanzee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variation in Gestation period (days)</td>
<td>~35</td>
<td>~10</td>
</tr>
<tr>
<td>Duration of Labor (hours)</td>
<td>&gt; 10 HOURS</td>
<td>1 HOUR</td>
</tr>
<tr>
<td>Indication of pain (vocalization, wincing, etc.)</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Time of day for delivery</td>
<td>Unpredictable</td>
<td>Night</td>
</tr>
</tbody>
</table>


Apparent Differences Between Humans and Non-Human Hominids ("Great Apes") in the Incidence and Severity of Biomedical Conditions

<table>
<thead>
<tr>
<th>Medical condition</th>
<th>Human</th>
<th>Non-Humans</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DEFINITE DIFFERENCES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coronary Thrombosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Falciparum Malaria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacterial STDs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIDS, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PROBABLE DIFFERENCES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hepatitis Complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alzheimer's Pathology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcinomas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-eclampsia</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>POSSIBLE DIFFERENCES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bronchial Asthma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early Fetal Loss</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rheumatoid Arthritis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

“Nothing in biology makes sense, except in the light of evolution” (Theodosius Dobzhansky)

HOWEVER:

"Although no biological explanation makes sense except in the light of evolution, it does not follow that all evolutionary explanations make sense.” (John M. Coffin)
Six Reasons Why Diseases Exist (From R. Nesse/G.C.Williams)

Natural selection is slow:
(1) Mismatch: Our bodies are in a novel environment, different from the one it was selected for.
(2) As slowly replicating organisms, we are always behind in competing with faster evolving pathogens (The “Red Queen” Effect).

Selection is constrained:
(3) Every selected trait is a trade-off, and none can be perfect for all aspects.
(4) Natural selection must work with existing situation and possibilities, and cannot recover something that has been lost.

We misunderstand:
(5) Organisms are selected for reproductive success, and not for strength and health after the peak reproductive period
(6) Defenses such as pain, fever, nausea, and diarrhea can cause suffering, but may also represent beneficial responses and/or early warning signals of pathology, i.e., the “Smoke Detector Principle”

We Are Living in an Unusually Stable and Warm Period: The Holocene Epoch

http://www.amap.no/maps-gra/show.cfm?figureId=366
Consider Genetic/Behavioral Changes that Occurred After the Common Ancestors of Modern Humans Spread across the Planet

Prior to 10,000 years (~400 generations) ago, no evidence for Agriculture nor Establishment of Major Civilizations. Most humans very likely lived in small scattered groups or tribes of “Hunter-Gatherers”

Thus, the period prior to 10,000 years ago is sometimes considered the “Environment of Evolutionary Adaptation” (EAE) of Humans

But there was no single EAE!

Some Examples of Genetic Variation in Modern Humans

**Skin Color**
- Geographic Distribution: Relationship to latitude
- Genes Involved: Multiple genes affecting skin melanocytes, under study
- Number of Selection Events: Multiple independent events
- Likely Selection Mechanisms: Sunlight generates Vitamin D, destroys Folate
  - Sexual Selection by Mate Choice?

**Lactase Persistence**
- Geographic Distribution: Centers of cattle domestication and milk drinking
- Genes Involved: Lactase
- Number of Selection Events: Multiple independent events
- Likely Selection Mechanisms: Survival advantage to adult milk drinkers.
LACTASE HOTSPOTS
Only one-third of people produce the lactase enzyme during adulthood, which enables them to drink milk.


DAIRY DIASPOR
Dairying practices spread from the Middle East to Europe as part of the Neolithic transition from hunting and gathering to agriculture.

Some Examples of Genetic Variation in Modern Humans

Skin Color
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- Likely Selection Mechanisms: Survival advantage to adult milk drinkers.

Alcohol Intolerance
- Geographic Distribution: Far East
- Genes Involved: Alcohol Dehydrogenases
- Number of Selection Events: Multiple?
- Likely Selection Mechanisms: protection against liver parasites? Other??

Phylogeny of Human Adaptive Alleles Characterized to Date
### Examples of Changes in Modern Lifestyle/Biology in Relation to Disease

<table>
<thead>
<tr>
<th>Item</th>
<th>Change</th>
<th>Pro</th>
<th>Con</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk Drinking after infancy</td>
<td>Increased (Lactose Tolerance)</td>
<td>Source of many nutrients, e.g. calcium</td>
<td>Rich source of Saturated Fat</td>
</tr>
<tr>
<td>Mother-Infant Co-sleeping</td>
<td>Decreased</td>
<td>Father does more?</td>
<td>Increased SIDS and &quot;Colic&quot;?</td>
</tr>
<tr>
<td>Hygiene</td>
<td>Improved</td>
<td>Protection from Infections</td>
<td>Increase in Allergies?</td>
</tr>
<tr>
<td>Dietary Soluble Fibre</td>
<td>Reduced</td>
<td>Chewing Easier</td>
<td>Irritable Bowel, Colon Cancer</td>
</tr>
<tr>
<td>Toughness of Food</td>
<td>Reduced</td>
<td>Chewing Easier, Less Gingivitis</td>
<td>Dental Crowding, Impacted Molars</td>
</tr>
<tr>
<td>Consumption of Red Meat</td>
<td>Marked Increase</td>
<td>Nutritious Satisfying</td>
<td>Carcinomas, Atherosclerosis</td>
</tr>
<tr>
<td>Gut Bacteria/Worms</td>
<td>Reduction</td>
<td></td>
<td>Crohn’s Disease?</td>
</tr>
</tbody>
</table>

### "Hygiene" Hypothesis for Autoimmune Diseases

- Prior to modern medicine and sanitation, humans were frequently exposed to viral, bacterial and parasitic pathogens.
- Modern "Westernized" societies prize "cleanliness", resulting in marked reductions in incidence of various infectious diseases.
- However, the immune system has been selected to battle pathogens.
- The human body has also been selected to constantly interact with numerous microbial commensals/symbionts.
- The frequency and severity of allergic disorders such as asthma has increased markedly in recent times.
- The highest incidence tends to be in "developed" societies with the highest level of hygiene.
- In animals and humans, chronic infection with parasitic worms decreases allergies.
- Frequent failure of drugs for allergic diseases has led to consideration of deliberate worm infections as an alternative therapy.
- Replenishment of normal commensals may also decrease allergies? (But some common "Probiotics" are not normal commensals.)
Human Diet has undergone major changes in the last 10,000 years. This can help explain the severity and frequency of some modern human diseases.
### Dietary Intake of Fruits and Mammalian Meat by Primates

<table>
<thead>
<tr>
<th>Species</th>
<th>Fruit as % of Diet</th>
<th>Red Meat in Diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humans</td>
<td>Low/Variable</td>
<td>Highly Variable</td>
</tr>
<tr>
<td>Chimpanzees</td>
<td>&gt;75%</td>
<td>Small mammals, variably</td>
</tr>
<tr>
<td>Bonobos</td>
<td>&gt;75%</td>
<td>Small mammals occasionally</td>
</tr>
<tr>
<td>Gorillas (lowland)</td>
<td>50-70%</td>
<td>None</td>
</tr>
<tr>
<td>Gorillas (mountain)</td>
<td>&lt;5%</td>
<td>None</td>
</tr>
<tr>
<td>Orangutans</td>
<td>&gt;70%</td>
<td>Small mammals occasionally</td>
</tr>
<tr>
<td>Old World Monkeys</td>
<td>Variable*, usually high</td>
<td>Rare or absent</td>
</tr>
<tr>
<td>New World Monkeys</td>
<td>Variable*, usually high</td>
<td>Cebus only</td>
</tr>
</tbody>
</table>

*Correlates positively with presence of Tri-color Stereoscopic Vision

### Post-Paleolithic Changes in Human Diet, Activity and Disease

<table>
<thead>
<tr>
<th>Food</th>
<th>Hunter-gatherer</th>
<th>Agrarian</th>
<th>&quot;Western&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruits</td>
<td>++++ (variable)</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Nuts</td>
<td>++++ (variable)</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Tubers</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Corn</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Rice</td>
<td>–</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Wheat</td>
<td>–</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Red meat (lean)</td>
<td>+</td>
<td>++ (fatty)</td>
<td>++++ (very fatty)</td>
</tr>
<tr>
<td>Milk and milk products</td>
<td>–</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Soluble fiber</td>
<td>++++</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>Physical activity</td>
<td>++++</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>Obesity/diabetes/heart disease</td>
<td>Rare</td>
<td>Variable</td>
<td>Common</td>
</tr>
</tbody>
</table>

Varki A.: Nothing in Medicine Makes Sense, Except in the Light of Evolution
"Thrifty Genes" Hypothesis (J.V. Neel, 1962)

- Prior to modern civilization, it was helpful to crave nutrients
- Especially: Salt, Sugar, and Saturated Fat (e.g., from Red Meat)
- It was useful to eat a lot of them when food was available
- Why? These are limiting for growth/physiology ---> Reproduction
- Alleles that encouraged craving/eating them were adaptive?
- We still crave salt, sugar, and saturated fat
- But these nutrients are superabundant in our environment
- Our genetic make-up is "tuned" to a different environment
- Results: Insulin Resistance, Obesity, Diabetes, Heart Disease etc.

Modified from Greg Wray, Duke University

Biodemography of human ageing
James W. Vaupel
Nature 464, 536-542. 2010

Human Longevity is Actually Not a Recent Novelty!
Female age structures modelled from life tables

Hawkes K PNAS 2010;107:8977-8984
Books on Evolution and Medicine


*Evolution of Infectious Disease.*


Web Sites

http://www.evolutionandmedicine.org/
http://www.evomedicine.org
And links therein

(Note: Beware of Many Other Web Sites with "Just-So" Stories!)

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