Origins and Evolution of The Western Diet: Health Implications for the 21st Century

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As many as **22 hominin species** may have existed since the evolutionary split between hominins and pongids (5-7 MYA).

**No universal diet** existed, but rather varied by ecologic niche, season, geographic locale, availability of **edible** foods.

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Plio-Pleistocene Hominin Diet: 
The Known – An Omnivorous Diet

Minimally Processed, Wild Plants and Animals

!Kung Woman displays fruits of her gathering: tamma melons, grewia berries, tortoise, roots
The Diet of Our Closest Living Relatives

*Pan troglodytes, Pan paniscus*

- Primarily frugivorous
- Diet varies by habitat & season
- ~3-5% animal foods (small vertebrates & insects)
- During the dry season meat intake may reach ~ 65 g/day in adults

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**Plio-Pleistocene Hominin Diet: An Omnivorous Diet – The Evidence**

**The Diet of Our Closest Living Relatives**

*Pan troglodytes, Pan paniscus*

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- Diet varies by habitat & season
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Plio-Pleistocene Hominin Diet: An Omnivorous Diet – The Evidence

Stable Isotopes

“It now seems inescapable that all hominid species inhabiting the S. African landscape from the late Pliocene to the early Pleistocene exploited foods of C₄ grass origin and were very likely all omnivorous.”


Sponheimer M et al. Science 1999;283:368-70

δ¹³C %

more C₃

grass, sedges

more C₄

grass

-12 -10 -8 -6 -4 -2 0 2

Browsers

Grazers

Suuds

Procavia sp. - Hyrax

Papio sp. - Baboon

Theropithecus - Baboon

Homo

Paranthropus robustus

Australopithecus africanus

P. Pardus - leopard

Meganteron - sabertooth

Crocuta-spotted hyena

Hyena brunea

Chasmoporthetes (Pliocene hyena)

A. africanus
Beginning at least 2.5 MYA, a number of lines of evidence indicate increasing reliance upon animal foods by some species of hominins.
Plio-Pleistocene Hominin Diet:
Increasing Animal Food – The Evidence

Oldowan Lithic Technology
First Appears 2.5-2.6 MYA

Semaw S. et al. 2.5-million-year-old stone tools from Gona, Ethiopia. Nature 1997;385:333-6
Plio-Pleistocene Hominin Diet: Increasing Animal Food – The Evidence
Earliest Meat & Marrow Extraction (2.5 MYA)

Scanning electron microscopy of a stone cut mark on the medial surface of an Alcelaphine bovid (wildebeest/Hartebeest) mandible made during tongue removal

Hammerstone pits on Bovid right tibial midshaft made during marrow extraction

Plio-Pleistocene Hominin Diet:
Increasing Animal Food – The Evidence
The Expensive Tissue Hypothesis

Observed (65 kg Human)  Expected (Similar Sized Primate)

Organ Weight (gm)

Brain
Gut
Liver
Kidney
Heart

Brain
Gut
Liver
Kidney
Heart

Plio-Pleistocene Hominin Diet: Increasing Animal Food – The Evidence
The Expensive Tissue Hypothesis

INTERPRETATION:

- Relaxation of selective pressure formerly requiring a large gut caused by:
  - Increase in dietary quality
  - Increase in energy density
  - Decrease in fibrous, high roughage plant foods
  - Increase in animal foods

Plio-Pleistocene Hominin Diet: Increasing Animal Food – The Evidence
Northern Latitude Colonization
### Plio-Pleistocene Hominin Diet: Increasing Animal Food – The Evidence

Evolutionary Biochemical Adaptations Similar to Carnivores

<table>
<thead>
<tr>
<th></th>
<th>Cats</th>
<th>Humans</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Synthesis of Taurine Lacking</td>
<td>Inefficient (Semi-conditional)</td>
</tr>
<tr>
<td>2</td>
<td>Synthesis of vitamin A from beta carotene Lacking</td>
<td>Inefficient</td>
</tr>
<tr>
<td>3</td>
<td>Desaturase enzymes Extremely low</td>
<td>Low</td>
</tr>
<tr>
<td>4</td>
<td>Dietary B12 requirement Essential</td>
<td>Essential</td>
</tr>
</tbody>
</table>

Cordain L et al. The paradoxical nature of hunter-gatherer diets: meat based, yet non-atherogenic. Eur J Clin Nutr 2002;56 (suppl 1): s42-s52
- Clearly, plant:animal subsistence would have varied by season, geographic locale and food availability
- Were there general trends?
Plio-Pleistocene Hominin Diet: 
The Uncertain – How Much Plant Food? How Much Animal Food?

Clues From Historically Studied Hunter Gatherers:

- The ethnographic data
- Analysis included 229 World Wide Hunter Gatherer Societies

!Kung Hunter-Gatherers
Butchering Giraffe

Frequency Distribution of Subsistence Dependence upon GATHERED PLANT FOODS in World Wide Hunter Gatherer Societies (n = 229)

Mode = (26-35%)
Median = (26-35%)

Only 13.5% of all societies have > 56% subsistence upon gathered plant foods

Frequency Distribution of Subsistence Dependence upon TOTAL (FISHED + HUNTED) ANIMAL FOODS in World Wide Hunter Gatherer Societies (n = 229)

Mode = (56-65%)
Median = (56-65%)

58 % of all societies have ≥ 56% subsistence dependence upon animal foods

Shortcomings of Ethnographic Data

- The majority of ethnographic data is subjective & not quantitative
- However, a few quantitative studies of hunter-gatherer diet do exist

Bannock Indians (circa 1870)
### The 13 Quantitative Studies of Hunter Gatherer Animal: Plant Subsistence

<table>
<thead>
<tr>
<th>Population</th>
<th>Location</th>
<th>Latitude</th>
<th>% animal</th>
<th>% plant</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aborigines</td>
<td>Australia</td>
<td>12S</td>
<td>80</td>
<td>20</td>
<td>McArthur, 1960</td>
</tr>
<tr>
<td>(Arhem Land)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ache</td>
<td>Paraguay</td>
<td>25S</td>
<td>90</td>
<td>10</td>
<td>Hill <em>et al</em>, 1984</td>
</tr>
<tr>
<td>Anbarra</td>
<td>Australia</td>
<td>12S</td>
<td>87</td>
<td>13</td>
<td>Meehan, 1982</td>
</tr>
<tr>
<td>Efe</td>
<td>Africa</td>
<td>2N</td>
<td>44</td>
<td>56</td>
<td>Dietz <em>et al</em>, 1989</td>
</tr>
<tr>
<td>Eskimo</td>
<td>Greenland</td>
<td>69N</td>
<td>96</td>
<td>4</td>
<td>Sinclair, 1953; Krogh &amp; Krogh, 1914</td>
</tr>
<tr>
<td>Gwi</td>
<td>Africa</td>
<td>23S</td>
<td>24</td>
<td>76</td>
<td>Silberbauer, 1981; Tanaka, 1980</td>
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<tr>
<td>Hadza</td>
<td>Africa</td>
<td>3S</td>
<td>54</td>
<td>46</td>
<td>Blurton Jones <em>et al</em>, 1997; Hawkes <em>et al</em>, 1989</td>
</tr>
<tr>
<td>Hiwi</td>
<td>Venezuela</td>
<td>6N</td>
<td>78</td>
<td>22</td>
<td>Hurtado &amp; Hill, 1986; Hurtado &amp; Hill, 1990</td>
</tr>
<tr>
<td>!Kung1</td>
<td>Africa</td>
<td>20S</td>
<td>33</td>
<td>67</td>
<td>Lee, 1968</td>
</tr>
<tr>
<td>!Kung2</td>
<td>Africa</td>
<td>20S</td>
<td>68</td>
<td>32</td>
<td>Yellen, 1977</td>
</tr>
<tr>
<td>Nukak</td>
<td>Columbia</td>
<td>2N</td>
<td>61</td>
<td>39</td>
<td>Politis G, 1996</td>
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<tr>
<td>Nunamiut</td>
<td>Alaska</td>
<td>68N</td>
<td>99</td>
<td>1</td>
<td>Binford, 1978</td>
</tr>
<tr>
<td>Onge</td>
<td>Andaman</td>
<td>12N</td>
<td>81</td>
<td>19</td>
<td>Rao <em>et al</em>, 1989; Bose, 1964</td>
</tr>
<tr>
<td></td>
<td>Islands</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td></td>
<td></td>
<td><strong>69</strong></td>
<td><strong>31</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Without Eskimo, Nunamiut</strong></td>
<td></td>
<td></td>
<td><strong>64</strong></td>
<td><strong>36</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Cordain L et al. Eur J Clin Nutr 2002;56 (suppl 1): s42-s52*
Plio-Pleistocene Hominin Diet:
The Uncertain – How Much Plant Food? How Much Animal Food?

Clues From Stable Isotopes:

“The isotope evidence overwhelmingly points to the Neanderthals behaving as top-level carnivores”

Plio-Pleistocene Hominin Diet:
The Uncertain – How Much Plant Food? How Much Animal Food?

Clues From Stable Isotopes:

“We were testing the hypothesis that these humans had a mainly hunting economy, and therefore a diet high in animal protein. We found this to be the case...”

Plio-Pleistocene Hominin Diet: The Known – Foods That Couldn’t Have Been Eaten

Minimally Processed, Wild Plants

Minimally Processed, Wild Animals

Highly Processed, Refined Foods

What are the Health Implications?
These foods comprise (>70% energy) in typical Western Diets. But were virtually unknown in Ancestral Human Diets.

- Breads, Cereals, Rice and Pasta
- Dairy Products
- Added Salt
- Refined Vegetable Oils
- Refined Sugars (except honey)
- Processed Meats
- Alcohol

Refined sugars, grains, vegetable oils and dairy = 70.9% of energy in the U.S. food supply

- Refined sugars, grains, vegetable oils and dairy represent Neolithic & Industrial era foods that were not present in traditional ancestral human diets
- By default, their inclusion displaces minimally processed, wild plant and animal foods.

## Evolution of the Western Diet: Neolithic (10,000 to 5,500 yrs ago) Food Introductions

<table>
<thead>
<tr>
<th>Years ago</th>
<th>Human Generations (30 yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,000</td>
<td>333</td>
</tr>
<tr>
<td>9,000</td>
<td>300</td>
</tr>
<tr>
<td>8,000</td>
<td>267</td>
</tr>
<tr>
<td>7,000</td>
<td>233</td>
</tr>
<tr>
<td>6,000</td>
<td>200</td>
</tr>
<tr>
<td>5,000</td>
<td>167</td>
</tr>
<tr>
<td>4,000</td>
<td>133</td>
</tr>
<tr>
<td>3,000</td>
<td>100</td>
</tr>
<tr>
<td>2,000</td>
<td>66</td>
</tr>
<tr>
<td>1,000</td>
<td>33</td>
</tr>
<tr>
<td>Present</td>
<td>0</td>
</tr>
</tbody>
</table>

- **WHEAT & BARLEY DOMESTICATED ~10,000 YRS AGO**
- **FIRST DAIRYING EVIDENCE**
- **WINE AND BEER**
- **FIRST SALT MINES**
- **SUCROSE**

Human generations are calculated assuming 30 years per generation.
Evolution of the Western Diet:
Industrial Revolution (~200 yrs ago)

Year:
- 1798
- 1828
- 1858
- 1888
- 1918
- 1948
- 1978
- 2008

Human Generations (30 yrs):
- 7
- 6
- 5
- 4
- 3
- 2
- 1
- 0

Ingredients:
- SUCROSE
- Refined Grains
- Refined Vegetable Oils
- Hydrogenated Oils
- HFCS
- Feedlot Produced Meats
Evolution of the Western Diet: Industrial Revolution
Processed Foods – The 20th Century

1900: HERSHEY’S CHOCOLATE BAR
1902: PEPSI
1906: KELLOGS CORN FLAKES
1911: CRISCO
1913: OREO COOKIE
1921: WONDERBREAD
1928: RICE KRISPIES
1932: CORN CHIPS
1941: M&M’s
1952: SUGAR FROSTED FLAKES
1969: PRINGLES CHIPS

Year

Human Generations (30 yrs)
4 3 2 1 0
Neolithic and Industrial Era Foods: Nutritional Implications

As Neolithic & Industrial Era foods displace minimally processed, wild plant and animal foods, they adversely affect the following nutritional factors:

1. The Glycemic Load
2. The Fatty Acid Balance
3. The Macronutrient Balance
4. The Trace Nutrient Density
5. The Acid/Base Balance
6. The Sodium/potassium Balance
7. The Fiber Content

Disruption of these 7 nutritional components fundamentally underlies much of the chronic diseases in the Western World.
Plio-Pleistocene Hominin Diet:

**The Known – Foods That Couldn’t Have Been Eaten**

(Cereals)

Contribution of Cereals To Total Energy in the U.S. Diet

<table>
<thead>
<tr>
<th>Item</th>
<th>% total energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole grains</td>
<td>3.5</td>
</tr>
<tr>
<td>Refined grains</td>
<td>20.4</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td><strong>23.9</strong></td>
</tr>
</tbody>
</table>

- 85% of all grains are consumed as refined grains

Cereal grains which are the seeds of grasses (Poaceae) in their wild state are:

1. Small
2. Difficult to harvest
3. Minimally digestible without (a) grinding to break down cell walls (b) cooking to gelatinize starch granules

Cordain L. Cereal grains: humanity’s double edged sword. World Review of Nutrition and Dietetics 1999;84:19-73
Thus, the appearance of crude grindstones and mortars in the Middle East (Natufians) and elsewhere (10-15,000 years ago) heralds the beginnings of humanity’s use of cereal grains as a staple food.
How Cereals Were Milled until about 1880

- Water or Draft Animal Powered Stone Mill
  - 100% extraction, unless flour sieved of bran

- Human Mortar & Grindstone
  - 100% of flour (endosperm, germ, bran) used – hence 100% extraction
Evolution of the Western Diet: Industrial Food Introductions (Refined Cereals)

- Steel rollers **squeeze** endosperm out of coating to leave germ & bran to be sieved off
- **Whereas**, Stone mills **pulverize** & mix germ along with endosperm; bran remains unless sieved; flour particle size is mixed
- Multiple breaks with steel rollers = **uniformly small particle size**

How Steel Roller Milling of Flour Influences Fiber Content, Particle Size & Glycemic Index

<table>
<thead>
<tr>
<th>Description</th>
<th>Fiber Content</th>
<th>Particle Size</th>
<th>Glycemic Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Wheat Kernel</td>
<td>100%</td>
<td>Fully intact</td>
<td>41</td>
</tr>
<tr>
<td>Crackled Wheat Kernel (bulgur bread)</td>
<td>Full cracked</td>
<td></td>
<td>52</td>
</tr>
<tr>
<td>Whole Meal Flour</td>
<td>Steel milled</td>
<td></td>
<td>69</td>
</tr>
<tr>
<td>White Bread</td>
<td>Steel milled</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>Fancy Patent Flours</td>
<td>Steel milled</td>
<td>40-65% extraction</td>
<td>70-80</td>
</tr>
</tbody>
</table>
### High Glycemic Foods

- **Almost all refined grains have high glycemic indices**
  - Rice Chex Cereal: 89
  - Corn flakes: 84
  - Pretzels: 83
  - Rice Krispie Cereal: 82
  - Rice Cakes: 82
  - Rye bread: 76
  - Waffles: 76
  - Total Cereal: 76
  - Graham crackers: 74
  - Cheerios: 74
  - Bagels: 72
  - Short grain white rice: 72
  - Corn chips: 72
  - White bread: 70
  - Whole Wheat bread: 69

**Classification of Glycemic Index (G.I.):**

- **HIGH G.I. FOODS** (> 70)
- **MEDIUM G.I. FOODS** (55-70)
- **LOW G.I. FOODS** (< 55)

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Foster-Powell K et al. Am J Clin Nutr 2002;76:5-56
High Glycemic Load Carbohydrates Promote Diseases of Insulin Resistance

- Type 2 Diabetes
- Hypertension
- Coronary Heart Disease (CHD)
- Dyslipidemia (Reduced serum HDL cholesterol, elevated triglycerides, elevated VLDL, elevated small dense LDL cholesterol)
- Obesity
- Gout


# Cereal Grains Are Net Acid Producers

## Potential Renal Acid Loads of Foods (100 g portion)

<table>
<thead>
<tr>
<th>Foods</th>
<th>+ values = acid</th>
<th>-values = alkaline</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grains:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown rice</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>Rolled oats</td>
<td>10.7</td>
<td></td>
</tr>
<tr>
<td>Whole wheat bread</td>
<td>8.2</td>
<td></td>
</tr>
<tr>
<td>Spaghetti</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>Cornflakes</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>White Rice</td>
<td>4.6</td>
<td></td>
</tr>
<tr>
<td><strong>Meats, Fish, Eggs:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trout</td>
<td>10.8</td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td>9.9</td>
<td></td>
</tr>
<tr>
<td>Chicken</td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td>Eggs</td>
<td>8.2</td>
<td></td>
</tr>
<tr>
<td>Beef</td>
<td>7.8</td>
<td></td>
</tr>
<tr>
<td>Cod</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td><strong>Dairy:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parmesan cheese</td>
<td>34.2</td>
<td></td>
</tr>
<tr>
<td>Processed cheese</td>
<td>28.7</td>
<td></td>
</tr>
<tr>
<td>Hard cheese</td>
<td>19.2</td>
<td></td>
</tr>
<tr>
<td>Cottage Cheese</td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td>Whole milk</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td><strong>Fruits:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raisins</td>
<td>-21.0</td>
<td></td>
</tr>
<tr>
<td>Black currants</td>
<td>-6.5</td>
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</tr>
<tr>
<td>Bananas</td>
<td>-5.5</td>
<td></td>
</tr>
<tr>
<td>Apricots</td>
<td>-4.8</td>
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<tr>
<td><strong>Legumes:</strong></td>
<td></td>
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</tr>
<tr>
<td>Peanuts</td>
<td>8.3</td>
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</tr>
<tr>
<td>lentils</td>
<td>3.5</td>
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</tr>
<tr>
<td>Peas</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Spinach</td>
<td>-14.0</td>
<td></td>
</tr>
<tr>
<td>Celery</td>
<td>-5.2</td>
<td></td>
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<tr>
<td>Carrots</td>
<td>-4.9</td>
<td></td>
</tr>
<tr>
<td>Lettuce</td>
<td>-2.5</td>
<td></td>
</tr>
</tbody>
</table>

Cereal Grains: Acid/Base Balance

- The average western diet produces a slight chronic metabolic acidosis

**Net Acid Yielding:**
- 1. Cereal Grains = 23.9 % energy
- 2. Meats, fish = 15.7 % energy
- 3. Dairy = 10.6 % energy
- 4. Nuts, legumes = 3.1 % energy
- 5. Eggs = 1.4 % energy
- 6. Salt (NaCl) = 9.6 g/day

**Net Alkaline Yielding:**
- 1. Vegetables = 4.8 % energy
- 2. Fruits = 3.3 % energy
- Neutral (but displace alkaline foods):
  - 1. Refined sugars = 18.6 % energy
  - 2. Refined Oils = 17.9 % energy

Cereal Grains: Acid/Base Balance

- The displacement of fruits and vegetables by cereal grains shifted hominin diets to net acid yielding
- Diseases promoted by a net metabolic acidosis:
  - 1. Osteoporosis
  - 2. Hypertension
  - 3. Kidney stones
  - 4. Stroke

Refined Grains Reduce the Trace Nutrient Density of the Western Diet

Vitamin Depletion from Flour Milling

- Biotin
- Vit E
- Vit B3
- Vit B2
- Vit B1
- Panto Acid
- Vit K

Whole wheat
White flour

Percentage

Hyperhomocysteinemia: low B6, folate = Increased risk for CHD

Only since 1998 (not the same as folate!)
Enriched following WWII

Enriched
Refined Grains Reduce the Trace Nutrient Density of the Western Diet

Mineral Depletion from Flour Milling

Diseases: iron deficiency anemia (Fe), osteoporosis (Ca), hypogonadal dwarfism (Zn)
Both Whole and Refined Cereals Reduce Fiber Content

**Diseases:** Constipation, appendicitis, hemorrhoids, deep vein Thrombosis, varicose veins, diverticulitis, hiatal hernia, gastro-esophageal reflux
Ancestral Human Diet:
Foods That Couldn’t Have Been Eaten
(Dairy)

Ever tried to approach a wild animal? How about milking it?
## Contribution of Dairy Products To Total Energy in the U.S. Diet

<table>
<thead>
<tr>
<th>Item</th>
<th>% total energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole milk</td>
<td>1.6</td>
</tr>
<tr>
<td>Low fat milks</td>
<td>2.1</td>
</tr>
<tr>
<td>Cheese</td>
<td>3.2</td>
</tr>
<tr>
<td>Butter</td>
<td>1.1</td>
</tr>
<tr>
<td>Other</td>
<td>2.6</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td><strong>10.6</strong></td>
</tr>
</tbody>
</table>


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**Plio-Pleistocene Hominin Diet:**

*The Known – Foods That Couldn’t Have Been Eaten (Dairy)*
Plio-Pleistocene Hominin Diet: 
The Known – Foods That Couldn’t Have Been Eaten (Dairy)


FIRST DAIRYING EVIDENCE

SHEEP, GOATS, COWS DOMESTICATED

Years ago
10,000  9,000  8,000  7,000  6,000  5,000  4,000  3,000  2,000  1,000
333  300  267  233  200  167  133  100  66  33

Human Generations (30 yrs)

### Dairy Foods: Glycemic Index/Insulin Metabolism

**MILK, SKIM MILK, FERMENTED MILK AND YOGURTS HAVE LOW GLYCEMIC INDICES**

<table>
<thead>
<tr>
<th>Food</th>
<th>Glycemic Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skim Milk</td>
<td>32</td>
</tr>
<tr>
<td>Whole Milk</td>
<td>27</td>
</tr>
<tr>
<td>Reduced Fat Yogurt</td>
<td>27</td>
</tr>
<tr>
<td>Non Fat Yogurt</td>
<td>24</td>
</tr>
<tr>
<td>Fermented Milk (3% fat)</td>
<td>11</td>
</tr>
</tbody>
</table>

**BUT PARADOXICALLY HAVE INSULIN INDICES SIMILAR TO:**

<table>
<thead>
<tr>
<th>Food</th>
<th>Glycemic Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Bread</td>
<td>100</td>
</tr>
<tr>
<td>Yogurt</td>
<td>115</td>
</tr>
<tr>
<td>Fermented Milk</td>
<td>98</td>
</tr>
<tr>
<td>Whole Milk</td>
<td>90</td>
</tr>
<tr>
<td>Skim Milk</td>
<td>90</td>
</tr>
</tbody>
</table>

**HIGH G.I. FOODS > 70**

**MEDIUM G.I. FOODS 55-70**

**LOW G.I. FOODS < 55**

---

Foster-Powell K et al. Am J Clin Nutr 2002;76:5-56
Dairy Foods: Glycemic Index/Insulin Metabolism

Health Effects: Dietary Interventions

- CRONIC EFFECTS (Animals)

- CHRONIC EFFECTS (Humans)
  - 24 8-yr boys consumed 53 g protein as milk or meat daily for 7-d. “Our results indicate that a short-term high milk, but not meat, intake increased insulin secretion and resistance” Hoppe C et al. Eur J Clin Nutr 2005;59:393-98.
Nutritional Differences among Wild, Grass Fed, Grain Fed and Processed Meats
Plio-Pleistocene Hominin Diet: 
**The Known** – Foods That Were Rarely Eaten 
(Processed, Grain Produced **Muscle** Meats)

- Prior to Agriculture, all animal foods consumed by humans were: **Wild Animals**
- The entire edible carcass (all organs) was usually consumed
- In Western countries rarely are meats other than grain produced muscle/processed consumed
Grain Produced & Processed Meats: Year Round Staples in Western Diets

- **Salami**
  - 74% Fat, 22% Protein

- **Bacon**
  - 77% Fat, 21% Protein

- **Ground Beef**
  - 64% Fat, 33% Protein

- **Hot Dogs**
  - 82% Fat, 14% Protein

- **Pork Ribs**
  - 72% Fat, 26% Protein

- **T-bone Steak**
  - 68% Fat, 30% Protein
Wild vs. Domestic Animals

- Body fat in wild animals waxes and wanes seasonally.
- With the advent of animal husbandry 10,000 years ago, it became possible to attenuate or prevent the seasonal decline in body fat % by provisioning captive animals with plant food.
- It also became feasible to consistently slaughter the animal at peak body fat %.
Seasonal Change in Wild Mammal Body Fat % (by Weight)

- Mature Bull Caribou
- Young Bull Caribou
- Mature Female Caribou

Seasonal Change in Wild Mammal Body Fat % (by Weight)

For 7 months out of the year, the group mean body fat % is 3.6
For the entire year, the mean body fat % is 6.4

Wild vs. Domestic Animals: Body Fat Differences

- Whereas, wild caribou body fat ranges from (3.1 to 6.8 %)
- Feed lot produced cattle are typically slaughtered at (25 to 30 % fat)
Industrial Era Food Introductions:
Feed Lot Produced Beef

- As feed lot produced beef replaced traditional grass, pasture and free range beef ~150 years ago the following nutritional factors were adversely affected:
  - 1. The Fatty Acid Balance (increased $\omega_6$ fatty acids; reduced $\omega_3$ fatty acids)
  - 2. The Macronutrient Balance (More Fat/Less Protein)
  - 3. The Trace Nutrient Density (Fat contains fewer vitamins & minerals than muscle or organs per calorie)

Disruption of these 3 nutritional components may contribute to many chronic diseases in the U.S. and elsewhere
Literature Summary (n=7 studies) of $\omega$-3 and $\omega$-6 Fatty Acid Differences between Grass and Grain Produced Beef

Long Chain (LC) n-3 polyunsaturated fatty acids (PUFA) = 20:5n3 (EPA), 22:5n3 (DPA), 22:6n3 (DHA)

Cordain L. Grass fed beef in the human diet: Applications to clinical disease, 2007
Replacing Fatty Grain Produced Beef with Lean Grass Fed Beef: Potential Health Effects:

(Omega 3 Fatty Acids: EPA, DPA and DHA

Diseases linked to reduced ω-3 fatty acids: CHD, the metabolic syndrome, certain cancers, autoimmune diseases, many inflammatory (“itis”) diseases

100 g grass produced steak: 60.0 mg LC ω-3 fatty acids

100 g average grain produced steak: 28.5 mg LC ω-3 fatty acids
## Plio-Pleistocene Hominin Diet:
The Known – Foods That Were Rarely Consumed (Added Salt)

<table>
<thead>
<tr>
<th>Source</th>
<th>grams/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Added in processed foods</td>
<td>7.2</td>
</tr>
<tr>
<td>Table salt and cooking use</td>
<td>1.4</td>
</tr>
<tr>
<td>Naturally occurring in foods</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td><strong>9.6</strong></td>
</tr>
</tbody>
</table>

Plio-Pleistocene Hominin Diet: 
**The Known – Foods That Were Rarely Consumed**
(Added Salt)

The Mountain of Salt
(Cardona, Catalonia, Spain)

The first known salt mine in Europe
(6,200 - 5,600 years ago)

- Salt was known to be gathered on a dry lake bed in China ~ 8,000 years ago
- First inland salt mines appear in Europe ~ 6,000 years ago
- Hunter gatherers living near the ocean dipped food in seawater and used dried sea salt
- Inland hunter-gatherers rarely used salt on a regular basis

Diseases linked to salt consumption: Hypertension, stroke, osteoporosis, kidney stones, Menierre’s Syndrome, stomach cancer, insomnia, motion sickness, asthma, exercise induced asthma
## Contribution of Refined Sugars to Total Energy in the U.S. Diet

<table>
<thead>
<tr>
<th>Item</th>
<th>% total energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sucrose</td>
<td>8.0</td>
</tr>
<tr>
<td>High fructose</td>
<td>7.8</td>
</tr>
<tr>
<td>corn syrup</td>
<td>2.6</td>
</tr>
<tr>
<td>Glucose</td>
<td>0.1</td>
</tr>
<tr>
<td>Syrups</td>
<td>0.1</td>
</tr>
<tr>
<td>Other</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td><strong>18.6</strong></td>
</tr>
</tbody>
</table>


Plio-Pleistocene Hominin Diet: The Known – Foods That Were Not Consumed (Refined Sugars)

- Crystalline sugar was first produced from sugar cane in Northern India in ~ 500 BC
- Honey would have always been part of the human diet, but was only available seasonally.
- Thus, year round consumption of refined sugars would not have been possible

Evolution of the Western Diet: Industrial Era Food Introductions (Refined Sugars)

Per Capita Sugar (Sucrose) Consumption in the Netherlands (1745-1937)
Evolution of the Western Diet: Industrial Era Food Introductions (Refined Sugars)

Per Capita Sugar (Sucrose) Consumption in England (1815-1970)

Per capita consumption (lbs.)

Year


WWI  WWII
Annual Per Capita Consumption of Refined Sugars in the U.S. (1909-2009)

- 1909-19: 90 pounds
- 1910-19: 113 pounds
- 1920-29: 112 pounds
- 1930-39: 105 pounds
- 1940-49: 109 pounds
- 1950-59: 115 pounds
- 1960-69: 123 pounds
- 1970-79: 127 pounds
- 1980-89: 148 pounds
- 1990-99: 148 pounds
- 2000-09: 141 pounds

Over the century, the consumption of refined sugars has increased by 64%.
Changes in the Refined Sugar Composition in the U.S. Diet Since 1970

- In 1960, 90% of the refined sugar in the U.S. Food supply came from sucrose.
- With the advent of chromatographic enrichment technology.
- Beginning in the late 1970’s it became economically feasible to manufacture high fructose corn syrup in mass quantity from corn starch.

Annual Per Capita Consumption of Refined Sugars in the U.S.

HFCS has increased from 0.4 lb in 1970 to 64 lbs in 2000. Total fructose (from sucrose & HFCS) has increased from 51.5 lbs in 1970 to 64.9 lbs in 2000 (26 %)


Diseases linked to refined sugars:
- Metabolic Syndrome (Type 2 diabetes, CHD, dyslipidemia, obesity, gout, hypertension
- Dental caries
- Certain cancers

### Contribution of Refined Vegetable Oils to Total Energy in the U.S. Diet

<table>
<thead>
<tr>
<th>Item</th>
<th>% total energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salad, Cooking Oils</td>
<td>8.8</td>
</tr>
<tr>
<td>Shortening</td>
<td>6.6</td>
</tr>
<tr>
<td>Margarine</td>
<td>2.4</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td><strong>17.8</strong></td>
</tr>
</tbody>
</table>

Vegetable Oils are made via three processes:

1. Rendering & pressing (oldest)
2. Steel expeller pressing (recent)
3. Solvent extraction (recent)

Oils made from walnuts, almonds, olives, sesame seeds and flaxseed were first produced via rendering & pressing ~ 5-6,000 years ago.

However, except for olives most oils were used for non-food purposes (lubrication, illumination, medicine).

High pressure steel expeller technology developed in the industrial era + new purification processes allowed non traditional oilseeds to be exploited (i.e. cottonseed – Wesson oil -- 1899)

The hydrogenation process was first developed in 1897 which allowed vegetable oils to become solidified to produce shortening and margarine

Yielding novel trans fatty acids
Per Capita Change in Refined Vegetable Oils in the U.S. (1909-99)

Total vegetable oil consumption has increased 459 % since 1909
Salad, Cooking Oil consumption has increased 1340 % since 1909
Margarine consumption has increased 488 % since 1909
Shortening consumption has increased 237 % since 1909

Vegetable oils are high in ω-6 fatty acids (linoleic acid), but low in long chain ω-3 fatty acids (EPA, DPA, DHA).

Diseases linked to high ω-6 (linoleic acid)/low long chain ω-3 fatty acids:

- Metabolic Syndrome (Type 2 diabetes, CHD, dyslipidemia, obesity, gout, hypertension), cancers, autoimmune diseases, virtually all inflammatory (“itis”) diseases.
Humanity’s Evolutionary Food Plate

“My Plate” replaced the USDA Food Pyramid in June 2011

Recommendations for a Contemporary Diet Based Upon Paleolithic Food Groups

- Fresh Veggies
- Fresh Fruits
- Nuts/Seeds
- Healthful Oils
- Fish/Seafood
- Grass Produced Meats
Thank You!