Gorillas Eat Termites

(and what that might tell us about humans)

Sandpoint Vegetarians
11 September 2011
Confusing Nutrient Soup

- Protein
- Carbs
- Saturated fat
- Iron
- Calcium
- Phosphorus
- Cholesterol
- Vitamin B12
- Glycogen
- Omega-6
- Lysine
- Valine
- Histidine
- Niacin
- Phenylalanine
- Threonine
- Antioxidants
- Vitamin C
- Vitamin K
- Vitamin D
- Phytic acid
- Thiamine
- Potassium
- Zinc
- Water
- Fiber
- Isoleucine
- Polyunsaturated fat
- Lectins
- Tryptophan
A Gastroenterologist In Glacier…

…and a bear eating huckleberries

“where does she get her protein?”
Metabolism 101

• Protein
  – Never a primary source of energy
  – Used for building cells/tissue – the body’s infrastructure
  – Cannibalized as energy source when in starvation mode (4 kcal/gram)

• Carbohydrates
  – Primary energy source (4 kcal/gram)
  – Stored as glycogen for release whenever needed
    • Glycogen → Glucose → Pyruvate → Acetyl CoA for the Krebs Cycle
  – Excess intake is converted to fat

• Fat
  – Regulatory role, vitamin transport, healthy skin/hair, disease buffer
  – Held in reserve metabolism during periods of inadequate carbohydrate intake (9 kcal/gram)
    • Triacylglycerol → Glycerol → Pyruvate → Acetyl CoA for the Krebs Cycle
    • or Triacylglycerol → Free Fatty Acids → (lypolysis) → Acetyl CoA for the Krebs Cycle
If your body was a car then a crude comparison might be:

- **Protein** = the chassis
- **Fat** = lubrication, transmission fluids, battery
- **Carbohydrates** = gasoline
Digestive Systems

• **Herbivores**
  - Foregut fermentation (deer, sheep, bovines, camels, peccaries, hippos, kangaroos, colobine monkeys, langurs, some rodents, leaf-eating sloths)
  - Hindgut fermentation (elephant, horse, guinea pig, rat, porcupine, beaver, rabbit, and some birds, including grouse)

• **Omnivores** - primates, raccoons, bear, pigs, most canines, opossum

• **Carnivores** - cat family, some aquatic mammals, fish, and some birds

*Question: Do herbivores ever eat meat?*
### Digestive Systems

#### Nonruminant Herbivore
- Simple stomach, large cecum

#### Ruminant Herbivore
- Four-chambered stomach with large rumen; long small and large intestine

#### Insectivore
- Short intestine, no cecum

#### Carnivore
- Short intestine and colon, small cecum

![Nonruminant Herbivore Diagram](image1)

![Ruminant Herbivore Diagram](image2)

![Insectivore Diagram](image3)

![Carnivore Diagram](image4)
What Kind of Animal Are We?

- Herbivore?
  - Folivore?
  - Frugivore?
- Omnivore?
- Insectivore?
- Carnivore?
Homo sapiens sapiens are Primates

• Humans are hominoids and belong to the order *Primates*
• Primates are classified as omnivores

Comparing Great Apes:

<table>
<thead>
<tr>
<th>Species</th>
<th>Genetic Difference</th>
<th>% Vegetarian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonobo (peaceful chimp)</td>
<td>1.0%</td>
<td>97-98%</td>
</tr>
<tr>
<td>Chimpanzee</td>
<td>1.1%</td>
<td>95%</td>
</tr>
<tr>
<td>Gorilla</td>
<td>1.5%</td>
<td>99%</td>
</tr>
<tr>
<td>Orangutan</td>
<td>3.0%</td>
<td>97% (frugivore)</td>
</tr>
</tbody>
</table>

Bonobos and Chimpanzees are so close to us that they can accept blood transfusions from humans or even a kidney transplant.
Gorilla & Human Digestive Systems are almost identical

Gorilla Digestive System

- Cecum
- Colon

Human Digestive System

- Small Intestine
- Transverse colon
- Ascending colon
- Cecum
- Taeniae coli
- Descending colon

Colon

40% of Digestive System

20% of Digestive System
What do Gorillas Eat

• Very high-fiber diet – 35-100% is fermentable (true for humans too)
  – Highland gorillas: leaves, stems, bark, roots, flowers
  – Lowland gorillas: leaves, stems, vines, fruit
• They spend a majority of their time eating – 40-75 lbs per day
• Gorillas’ colons are more efficient than human colons in fermenting high-fiber food to produce Short Chain Fatty Acids (SCFAs).
• In a 100 gram sample (dry weight) of the average Western Lowland Gorilla food:
  – Without colonic fermentation the metabolizable energy value would be 83 kCal:
    • fat 6%, protein 57%, carbohydrate 37%
  – With colonic fermentation the resulting energy value would be 194 kCal:
    • fat 3%, protein 24%, carbohydrate 16% and SCFA 57%
• SCFAs produced in the colon are thought to prevent colorectal cancer, reduce obesity, and prevent IBS
• When gorillas in zoos were fed human food (including meat) they suffered from premature cardiovascular disease and ulcerative colitis (and who knows what else)
## TABLE 1

<table>
<thead>
<tr>
<th>Common name</th>
<th>Species name</th>
<th>Ash</th>
<th>Protein</th>
<th>Fat</th>
<th>Available carbohydrates</th>
<th>Total dietary fiber</th>
<th>Neutral detergent fiber</th>
<th>Acid detergent fiber</th>
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<td>11.8</td>
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<td>74.0</td>
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<td>53.3</td>
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<td><strong>Overall energy,</strong></td>
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<td>203.3</td>
<td>128.2</td>
<td>464.5</td>
<td>197.0 (471)</td>
<td>203.3 (492)</td>
<td>128.2 (360)</td>
</tr>
</tbody>
</table>
What does eating leaves get you?

• Males
  – 5-6 feet tall
  – 300-500 lbs
• Females
  – 4-5 feet tall
  – 150-300 lbs
• Upper body strength 6x human

(Blood type B, Individual fingerprints)
Guess the Fierce Creatures
Guess the Fierce Creatures

Fruit Bat

Tiger

Hippo

Water Deer
Our Dangerous Canines and Incisors!

- Chimpanzee
- Orangutan
- Gorilla
- Human
# Are Humans Naturally Meat Eaters?

Compare the diet of our closest non-human relatives: great apes are 95-99% vegetarian

<table>
<thead>
<tr>
<th>Feature</th>
<th>Humans</th>
<th>Carnivores &amp; True Omnivores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Claws and Fangs</td>
<td>Absence of killing claws and fangs</td>
<td>True killing claws and/or fangs</td>
</tr>
<tr>
<td>Dentition</td>
<td>Teeth adapted for fruit and nuts, for grinding and jaw moves side-to-side. “Canine” teeth are miniscule</td>
<td>Teeth adapted for ripping and shredding. Jaws cannot move side-to-side.</td>
</tr>
<tr>
<td>Saliva &amp; Salivation</td>
<td>Saliva is alkaline and contains enzymes (alpha-amylase) to pre-digest leaves, fruits, nuts and grains. We do not salivate on seeing raw meat or an animal on the hoof. We do salivate on seeing ripe fruit.</td>
<td>Small salivary glands, very limited enzymes and is acidic. True carnivores salivate on seeing raw meat or an animal on the hoof.</td>
</tr>
<tr>
<td>Intestinal Tract</td>
<td>10-11 times body length, long and bumpy with sacculations, need fiber.</td>
<td>3-6 times body length, short and smooth, no need for fiber.</td>
</tr>
<tr>
<td>Stomach Acidity</td>
<td>pH of 4-5</td>
<td>pH &lt; 1</td>
</tr>
<tr>
<td>Cholesterol &amp; Acid</td>
<td>Cope poorly with high cholesterol and high uric acid found in meat. Increased acid leads to both reflux as well as drawing of calcium from bones.</td>
<td>Cope perfectly well with very high levels of cholesterol and uric acid.</td>
</tr>
<tr>
<td>Vitamins</td>
<td>Require vitamin C, synthesize vitamin A</td>
<td>Synthesize vitamin C, require vitamin A</td>
</tr>
<tr>
<td>Protein in Mother’s Milk</td>
<td>Average of 1.6%, baby doubles birth weight in 180 days</td>
<td>Average of 7-9%, cats double birth weight in 7 days</td>
</tr>
<tr>
<td>Performance</td>
<td>Endurance measured in days (!Kung San, Tarahumara)</td>
<td>Endurance measured in minutes</td>
</tr>
<tr>
<td>Lifespan</td>
<td>Similar to herbivores in having the longest lifespans</td>
<td>Lifespans are 3-6 times less than humans</td>
</tr>
</tbody>
</table>

The most common cause of choking deaths is eating meat!
A Vindication of A Natural Diet
Percy Bysshe Shelley (1813)

“Comparative anatomy teaches us that man resembles frugivorous animals in everything, and carnivorous in nothing; he had neither claws wherewith to seize his prey, nor distinct and pointed teeth to tear the living fibre….

After every subterfuge of gluttony, the bull must be degraded into the ox, and the ram into the wether, by an unnatural and inhuman operation, that the flaccid fibre may offer a fainter resistance to rebellious nature. It is only by softening and disguising dead flesh by culinary preparation, that it is rendered susceptible of mastication of digestion; and that the sight of its bloody juices and raw horror does not excite intolerable loathing and disgust.

Let the advocate of animal food force himself to a decisive experiment on its fitness, and, as Plutarch recommends, tear a living lamb with his teeth, and plunging his head into its vitals, slake his thirst with the steaming blood; when fresh from the deed of horror, let him revert to the irresistible instinct of nature that would rise in judgment against it, and say, Nature formed me for such work as this. Then, and only, would he be consistent.”
Gleanings from Paleoanthropology

- Fossil evidence seems to indicate that proto-humans (more than 2 million years ago) were almost exclusively vegetarian.
- With the first human use of tools (about 2 million years ago) and with human use of fire about 200,000 years ago humans were able to avail themselves of a wider variety of foods including tough roots as well as animal flesh.
- Humans were extraordinary opportunists.
- Meat represented concentrated nutrients and calories.
- Humans were scavengers well before they were hunters (development of endurance running).
- It was this that enabled humans to move from a natural proclivity for plant foods to increased consumption of animal flesh and led to human expansion to extreme climates – deserts to the frozen north.
Big-Brained Humans

- There is no conclusive evidence that eating meat led to the development of big brains (what about T-Rex?)
- The brain runs on glucose. Glucose is obtained from carbohydrates: fruits, nuts, grains, legumes, and vegetables
  - Your brain cells need two times more energy than the other cells in your body
  - Although the brain represents only 2% of the body weight, it receives 15% of the cardiac output, 20% of total body oxygen consumption, and 25% of total body glucose utilization.
- The only animal foods containing a significant amount of carbohydrates are dairy products (so how could meat eating have led to bigger brains?)
- No wonder those on low-carb, “paleo” diets are sluggish!
- Fruits are a great source of timed-release, complex carbs to keep your brain smoothly chugging along
Gorillas Eat Termites
And Rabbits Eat Their Own Poop

Ella Bella
Why? Because of

protein

water

carbs

glycogen

Omega-6

B12

cholesterol

phosphorus

calcium

saturated fat

sodium

polyunsaturated fat

iron

iron

DHA

lecitins

tryptophan

potassium

Vitamin C

lysine

histidine

threonine

methionine

phenylalanine

zinc

niacin

thiamine

methionine

threonine

Vitamin C

Vitamin K

thiamine

B12

fiber

polyunsaturated fat

DHA

threonine

Vitamin D

phytic acid

antioxidants

threonine

niacin

tryptophan

thiamine

methionine

threonine

Vitamin D

phytic acid

antioxidants

threonine

niacin

tryptophan

thiamine
B-12 Not Found in Plants

• Water soluble B-vitamin also known as Cobalamin
  – key role in the normal functioning of the brain and nervous system, and the formation of blood.
  – involved in the metabolism of every cell of the human body, especially affecting DNA synthesis and regulation, and fatty acid synthesis and energy production

• In nature B-12 is only created by bacteria

• Where different animals get it:
  – Foregut fermenters get it from the foregut fermentation
  – Hindgut fermenters get it from their diet or from coprophagy
  – Carnivores and omnivores from eating other animals
  – Humans produce lots and lots of B12 in their colons
  – Some animals get B12 from coprophagy

• Coprophagy
  – consumption of cecotropic (from the cecum) feces
  – capybara, rabbits, hamsters (koalas, pandas, elephants, hippos)

• B12 supplements are cheap and easily manufactured!
# The Omnivorous Human

## As “naturally” evolved animals

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## As opportunistic hunter-gatherers

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## In “civilized” societies

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“What with our hooks, snares, nets, and dogs, we are at war with all living creatures, and nothing comes amiss but that which is either too cheap or too common; and all this is to gratify a fantastical palate.”

~ Lucius Annaeus Seneca, 4 BC – 65 AD
Vegan Power

Tarahumara runner Arnulfo Quimare runs alongside ultra-runner Scott Jurek in Mexico's Copper Canyons
Vegan Power

Scott Jurek wins the 135-mile Badwater - yet again!

Joni Purmonen – Finland’s Strongest Man
Vegan Power

Alexander Dargatz
vegan bodybuilder

Jim Morris, vegan bodybuilder - at age 60
We Can Choose

✓ We are a very, very long way from our hunter-gatherer days seeking out the next nutritionally dense meal
✓ Even if humans are adaptable omnivores we can still choose to eat vegan and thrive
✓ We have a cornucopia of nutritionally dense vegan choices
✓ Vegan choices are ethically the right choice, great for our health, and far, far better for the health of this precious planet
✓ Vegans should supplement with B12 (or start eating termites)
Gorillas also Drink Wine

Kwitondo, 99% vegan gorilla
Drunk on fermented bamboo sap