

# Nutritional Aspects of Non-Human Primate Care - Barbara Henry



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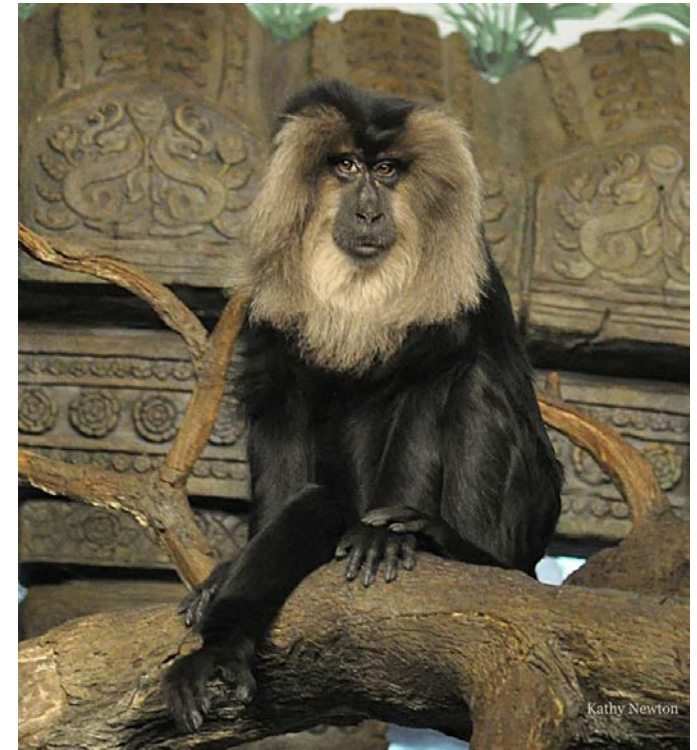




# Overview



- Know your animal
- Target nutrient values & BMR calculations
- Common challenges



**Carnivore**

**Omnivore**

**Herbivore**

Insectivorous

Bamboo Only

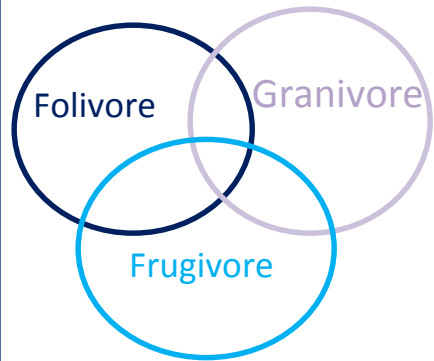
Gum Dominant

Plant/Fruit Dominant

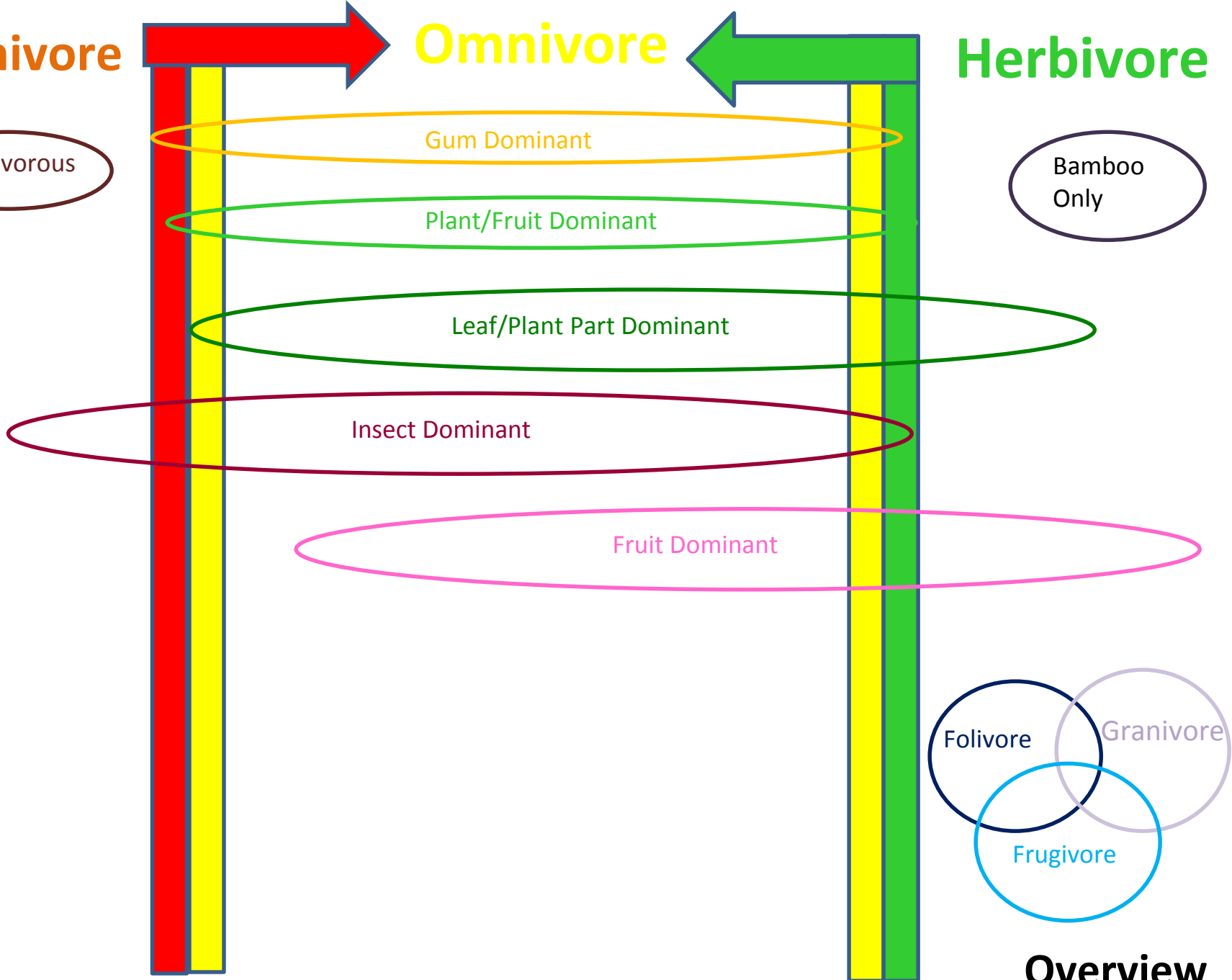
Leaf/Plant Part Dominant

Insect Dominant

Fruit Dominant



**Overview**



**Carnivore**

**Omnivore**

**Herbivore**



Insectivorous

*Tarsius sp.*  
-Tarsiers



Insect Dominant

**MOSTLY INSECTIVOROUS**

*Galagoides sp.*

-Bush babies

*Loris tardigradus*

-Slow Loris

**FRUIT = INSECT**

*Callithrix sp.*

-Marmosets

**INSECT > FRUIT**

*Saimiri sp.*

-Squirrel monkeys

**FRUIT > INSECT**

*Leontopithecus sp.*

-Lion tamarin



Fruit Dominant

**Omnivore-Frugivore**

*Daubentonia madagascariensis*

-Aye-aye

**FRUGIVORE**

*Ateles sp.*

Spider Monkey

**Insectivore**



**Carnivore**

**Omnivore**

**Herbivore**

Insectivorous

Bamboo Only

Gum Dominant

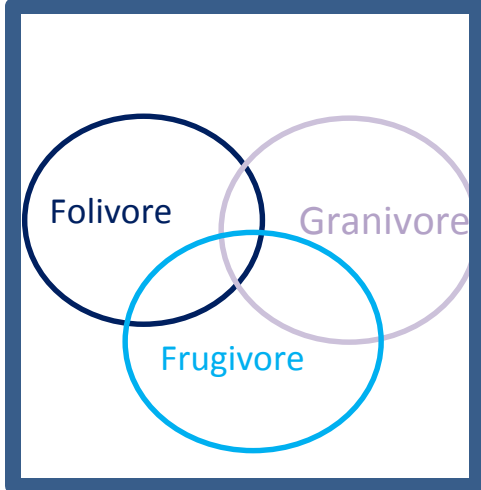
Plant/Fruit Dominant

Leaf/Plant Part Dominant

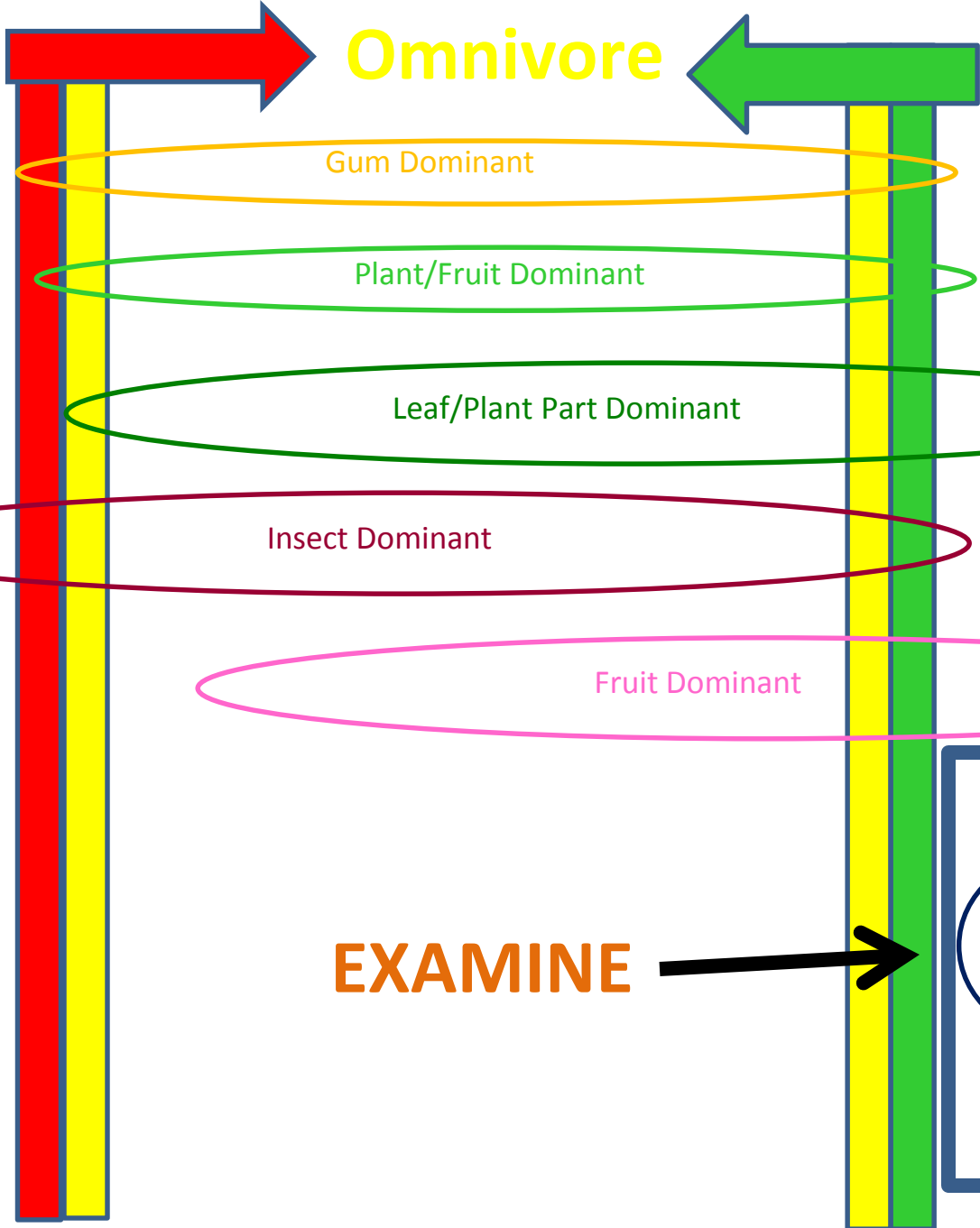
Insect Dominant

Fruit Dominant

**EXAMINE**



**Overview**





# FOLIVORE

# GRANIVORE

*Colobus guereza*  
 -Abyssinian colobus  
*Colobus vellerosus*  
 -Geoffrey's colobus

*Colobus angolensis*  
 -Angolan black and white colobus  
*Colobus polykomos*  
 -King colobus  
*Colobus satanas*  
 -Black colobus

*Aotus trivirgatus*  
 -Northern gray-necked owl monkey  
*Callicebus sp.*  
 -Titi monkey  
*Cebus albifrons*  
 -White-fronted capuchin

*Nasalis larvatus*  
 -Proboscis monkey  
*Presbytis sp.*  
 -Leaf monkeys  
*Pygathrix sp.*  
 -Douc langur and Snub-nosed monkeys

*Lagothrix sp.*  
 -Woolly monkey  
*Cacaja sp.*  
 -Uscari  
*Chiropotes albinasus*  
 -White-nosed saki  
*Chiropotes satanas*  
 -Bearded saki  
*Pithecia pithecia*  
 -White-faced saki

# FRUGIVORE

*Ateles sp.*  
 Spider Monkey

# Herbivore

**Carnivore**

**Omnivore**

**Herbivore**



Insectivorous

Bamboo Only

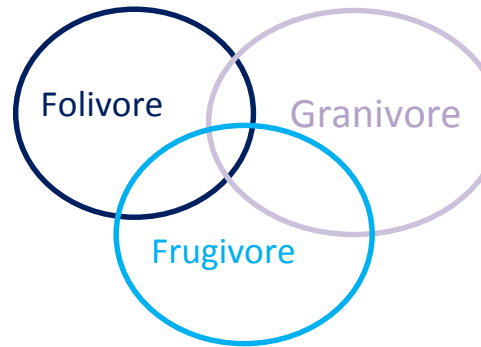
Gum Dominant

Plant/Fruit Dominant

Leaf/Plant Part Dominant

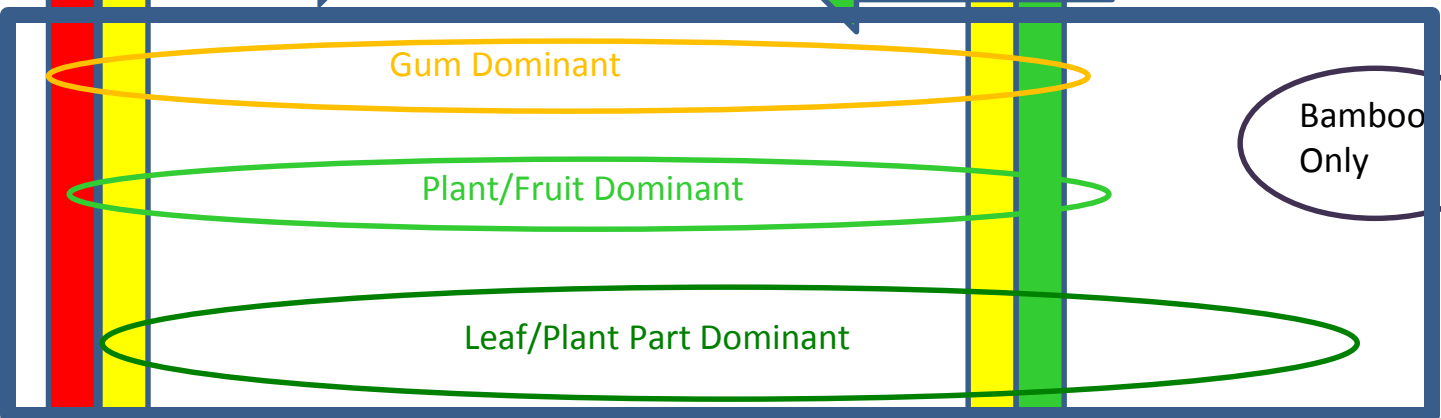
Insect Dominant

Fruit Dominant



Overview

**EXAMINE**



# GUM DOMINANT

# LEAF/PLANT PART DOMINANT

- Euoticus elegantulus*  
-S. needle-clawed bush baby
- Euoticus palludus*  
-N. needle-clawed bush baby
- Galago senegalensis*  
-N. lesser bush baby
- Galago moholi*  
-S. lesser bush baby
- Otolemur crassicaudatus*  
-Thick-tailed greater bush baby
- Phaner furcifer*  
-Fork-marked lemur

*Eulemur coronatus*  
-Crowned lemur

*Nycticebus pygmaeus*  
-Pygmy loris

*Nycticebus coucang*  
-Slow loris  
*Hylobates sp.*  
-Gibbon/Siamang

*Pongo sp.*  
--Orangutan  
-*G.g. gorilla*  
--W. Lowland gorilla  
-*Pan*  
--Bonobo/Chimp

*Callithrix sp.*  
-marmoset  
*Lenotopithecus sp.*  
-Lion tamarin

*Otolemur garnetti*  
-Garnett's greater bush baby  
*Cheirogaleus major*  
-Greater dwarf lemur  
*Galago alleni*  
-Allen's bush baby  
*Lemur catta*  
-Ring-tailed lemur

*Perodicticus potto*  
-Potto  
*Varecia variegata*  
-Ruffed lemur  
*Microcebus sp.*  
-Mouse lemur

# FRUIT DOMINANT

# OMNIVORE

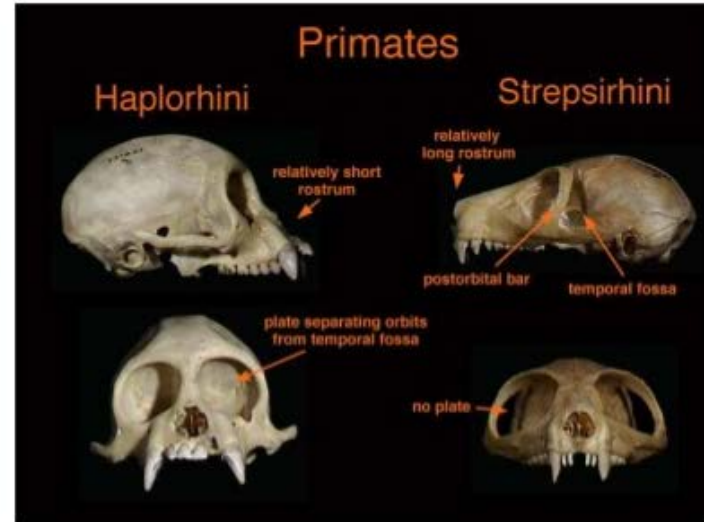
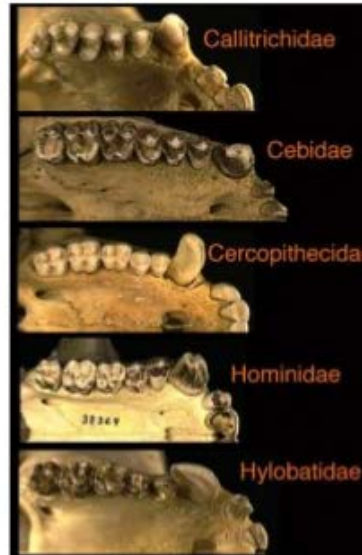


# Jaw Structure

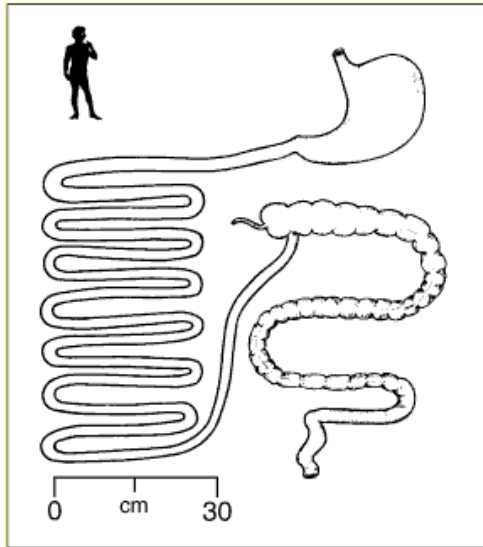


Generalized teeth, four kinds, many functions

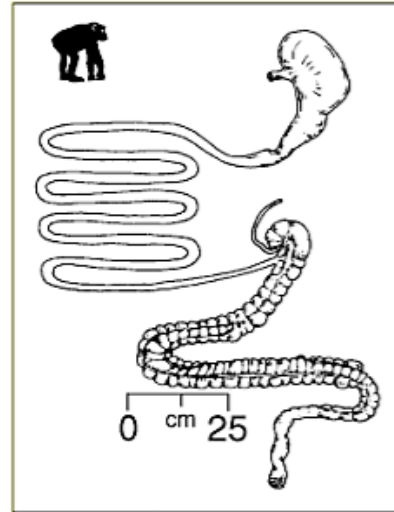
Enclosed bony eye sockets



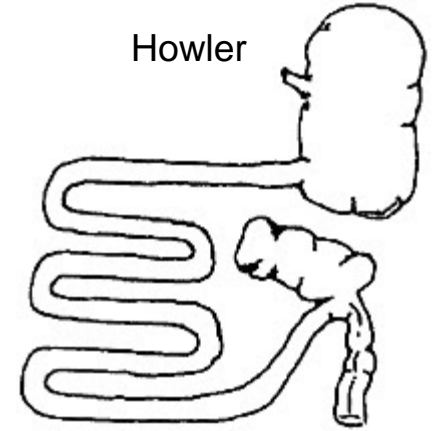
# GI Tract Morphology



(adult human (*homo sapiens*) digestive tract, Stevens & Hume, 199)

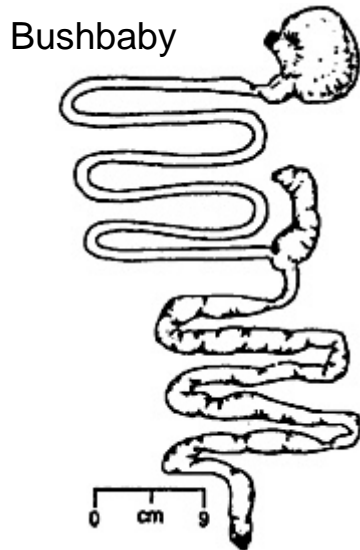


(chimpanzee (*Pan troglodytes*) digestive tract, Stevens & Hume, 1995)

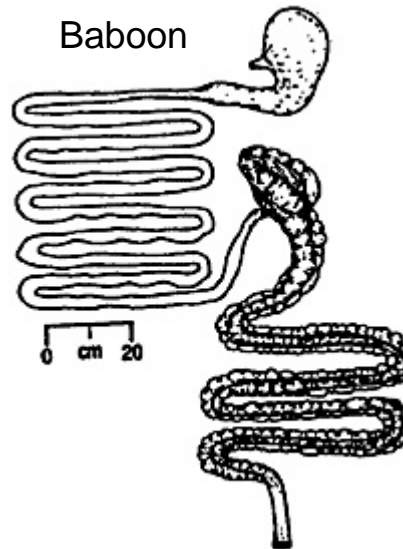


Howler

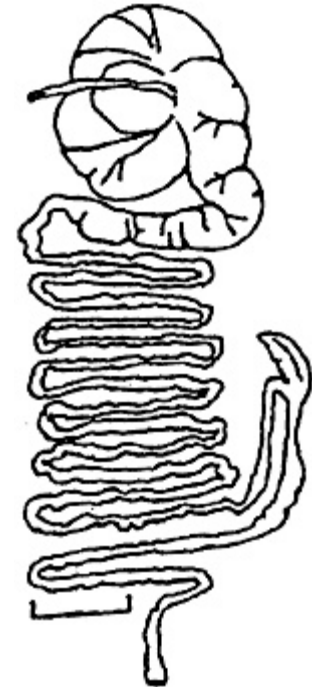
Northern Douc Langur



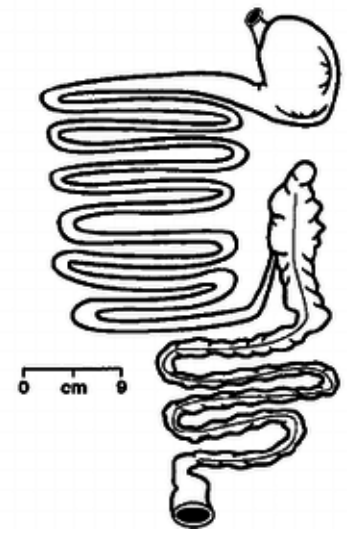
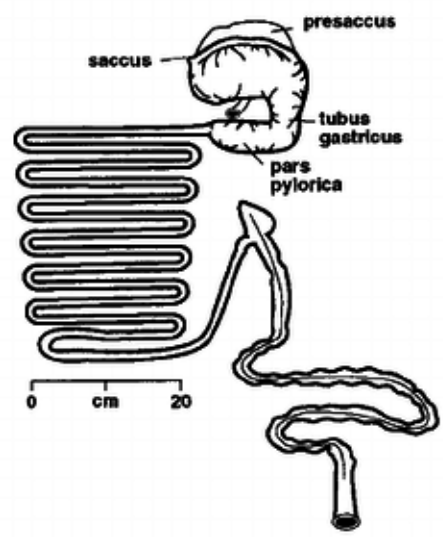
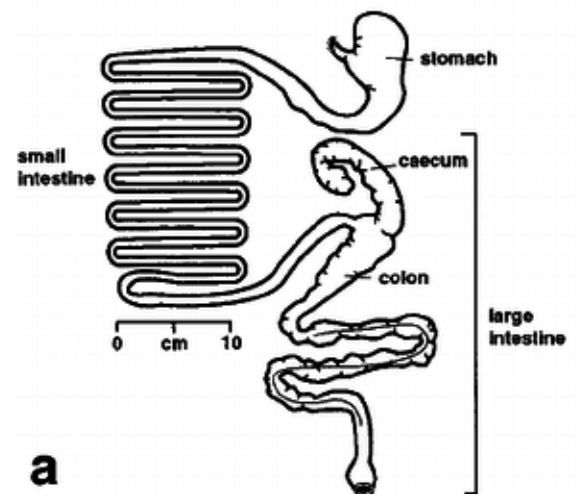
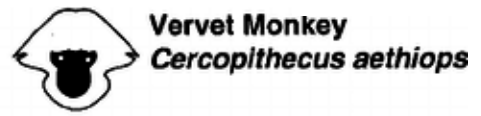
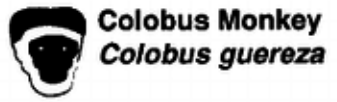
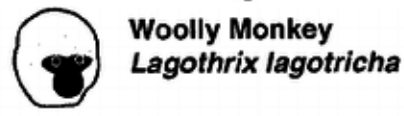
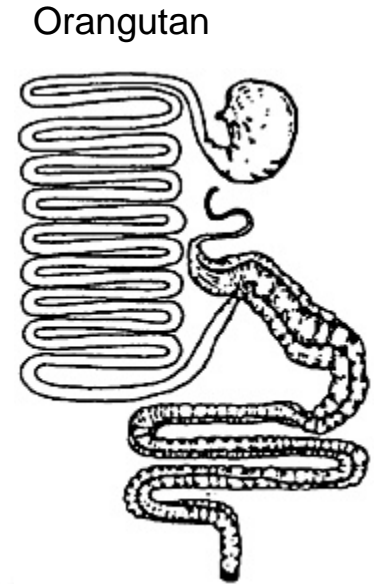
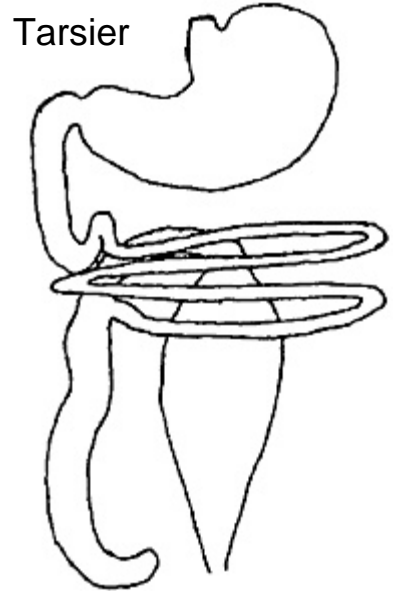
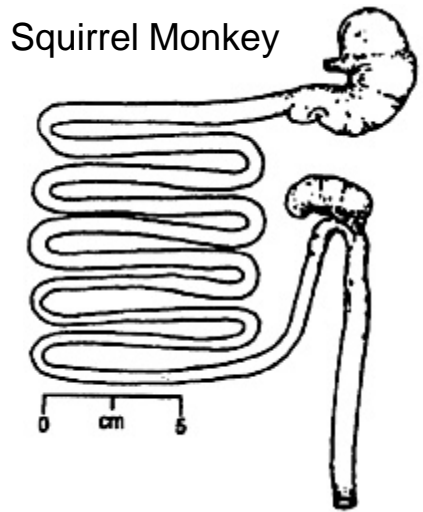
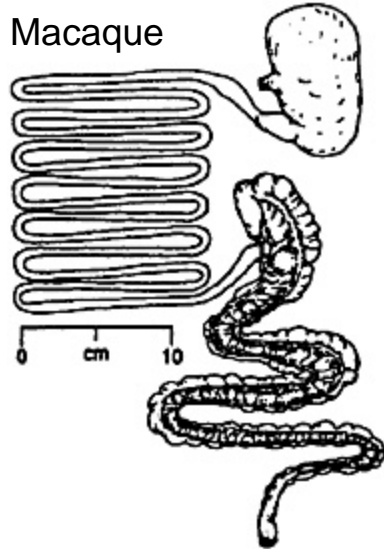
Bushbaby

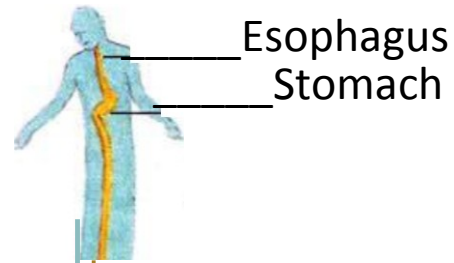


Baboon



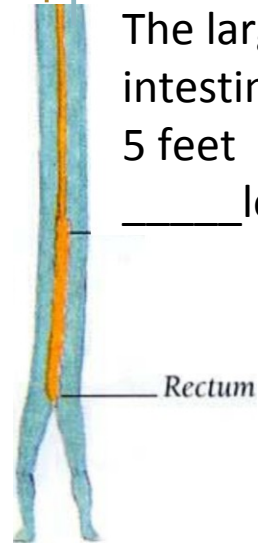
# GI Tract Morphology





The small intestine  
is about 17 feet or  
5-6 meters long

The large  
intestine is about  
5 feet or (1.5 m)  
\_\_\_\_\_ long



# Gut Health

- Gut health = fiber and carbohydrate (sugar/starch)?
- Fiber is ingested material that is resistant to vertebrate digestive enzymes
- Carbohydrate constitutes 50-80% of the dry matter in leaves, fruits, and seeds. Also ~40% of the metabolizable energy of the diet for most primates.



# Sugar

## Monosaccharides

galactose   fructose   glucose

## Disaccharides

sucrose   fructose   lactose

## Oligosaccharides

verbascose   raffinose   stachyose

grains, leguminous  
seeds, nuts, vegetables

## Polysaccharides

**starch**   starch-like

**Non-starch**

Insoluble & soluble fiber



# Starch

- Starch digestion by endogenous mammals involving salivary and pancreatic  $\alpha$ -amylase
- Problems may arise when high starch leads to excessive rapid fermentation may lead to digestive upset or stool quality.
- Serious issues may arise high starch/low fiber in foregut fermentators.
- Starch-like = glycogen and dextrans



# Fiber (non starch)

- Cellulose and hemicellulose = insoluble fiber
  - ❖ Both can't be broken down by endogenous enzymes
  - ❖ Symbiotic GI anaerobes = microbial fermentation = VFA
  - ❖ VFA = A, P, and B
- Soluble non-starch poly sacch = soluble fiber
  - ❖ Fermented by ruminal and intestinal bacteria
  - ❖ Pectic substances
  - ❖ Gums/mucilages



# Fermentation

- Meeting the energy needs of herbivorous primates (colobus or howlers)
- Colon and cecum
- Marmosets and tamarins
- *Cebuella pygmaea* and *Callithrix spp.*
- *Saguinus spp.* And *Leontopithecus spp.*
- Microbial fermentation – protein from urea and vitamins?



# Fiber (non starch)

- Cellulose and hemicellulose = insoluble fiber
  - ✓ Cellulose cant be broken down by endogenous enzymes
- Constituents of plant cell walls (NDF and ADF)
- How to measure? Crude fiber, ADF, NDF, Lignin
- Fermentation and its products
- Wild fruits vs our fruits





# Fecal & Body Condition Scoring

- Not aware of a gold standard for primates
- Fecal score charts are nice to have to monitor any changes
- Tough to develop visual scoring on primates
- Essential to weigh animals and during PE get hands on
- Perhaps focal points
- Standard pose

# Target Nutrient Values

- Physiological state and body condition
  - reproduction increased energy need
- Age, health status, environment, group dynamics
- Sources of information on nutrient requirements
  - NRC - actual
  - AZA Husbandry manuals/nutrition recommendations
- Vitamin D





# Metabolism

- Individuals are different
- Life stages – different requirements
- Nutrient targets depend on both internal and external
- Nutrients interact
- Vitamin D needs
- Deficiency and toxicity



Nutrient	Target Nutrients <sup>a</sup>
Protein, %	15-22 <sup>b</sup>
Essential n-3 Fatty Acids, %	0.5
Essential n-6 Fatty Acids, %	2
NDF, %	10-30 <sup>c</sup>
ADF, %	5-15 <sup>c</sup>
Vitamin A, IU/g	8
Vitamin D, IU/g	2.5 <sup>d</sup>
Vitamin E, mg/kg	50-100
Thiamin, mg/kg	3
Riboflavin, mg/kg	4
Niacin, mg/kg	25
Pyridoxine, mg/kg	4
Folacin, mg/kg	4
Biotin, mg/kg	0.11-0.2
Vitamin B12, mg/kg	0.01-0.03
Pantothenic acid, mg/kg	12
Choline, mg/kg	750
Vitamin C, mg/kg	200 <sup>e</sup>
Calcium, %	0.5-0.8
Phosphorus, %	0.4-0.6 <sup>f</sup>
Magnesium, %	0.08
Potassium, %	0.4
Sodium, %	0.2
Iron, mg/kg	100
Zinc, mg/kg	20-100
Copper, mg/kg	12-20
Manganese, mg/kg	20
Iodine, mg/kg	0.35
Selenium, mg/kg	0.11-0.3



# What is a target nutrient?

- Minimal amount of nutrient to achieve some measurable outcome
  - Basic health
  - Normal growth
  - Reproduction
  - Slow senescence





# Energy

Energy is measured in calories and is the amount of energy required at 1 atmosphere of pressure to raise the temperature of 1 gram of water from 14.5°C to 15.5°C

BMR calculations base

- Kleiber
  - $70(\text{healthy BW [kg]})^{0.75}$
  - That 70 will change based on species and activity
  - Energy requirement of small primates is twice BMR
  - Factors for maintenance, growth, pregnancy/lactation
  - Just a baseline - variance

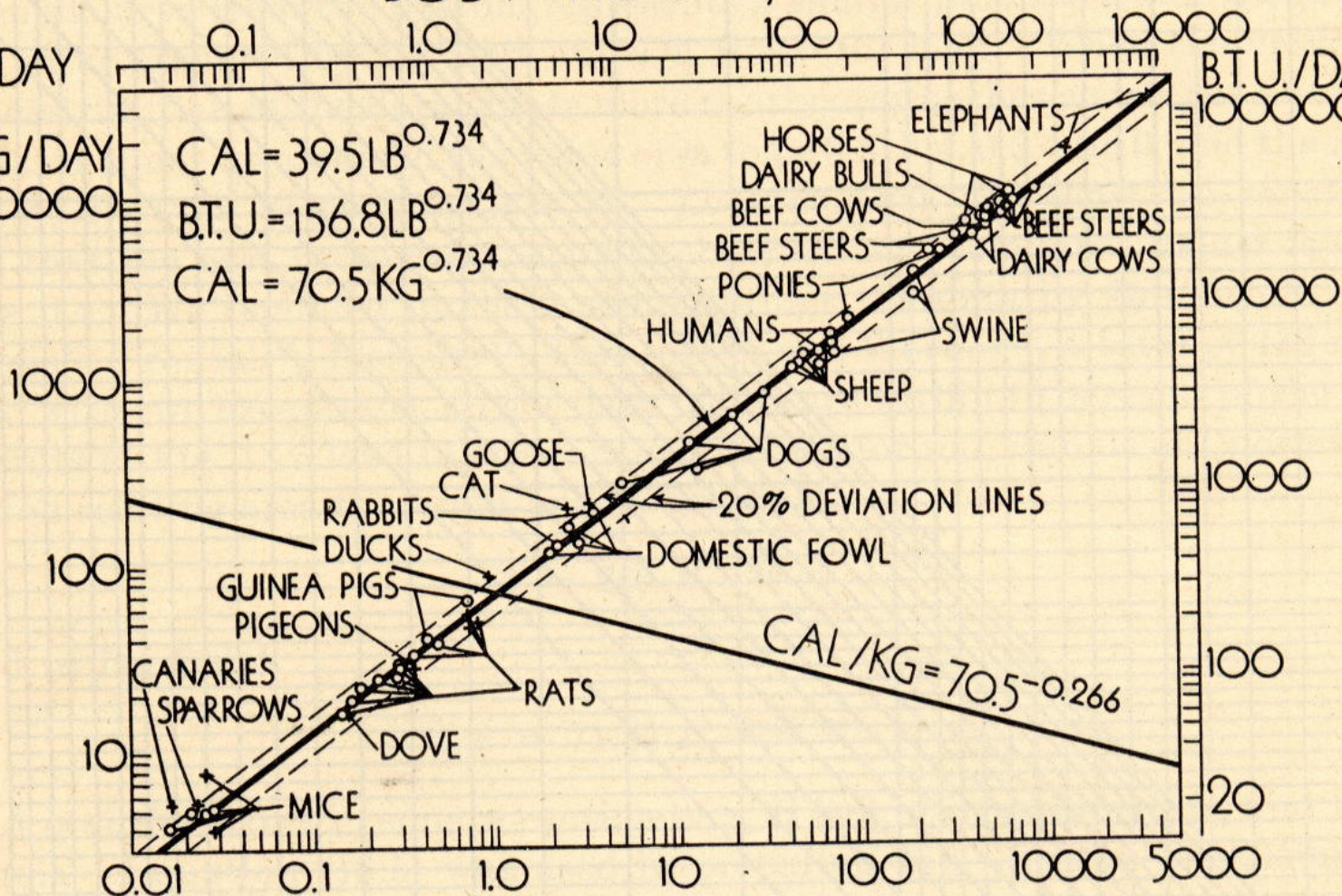
BODY WEIGHT, LBS.

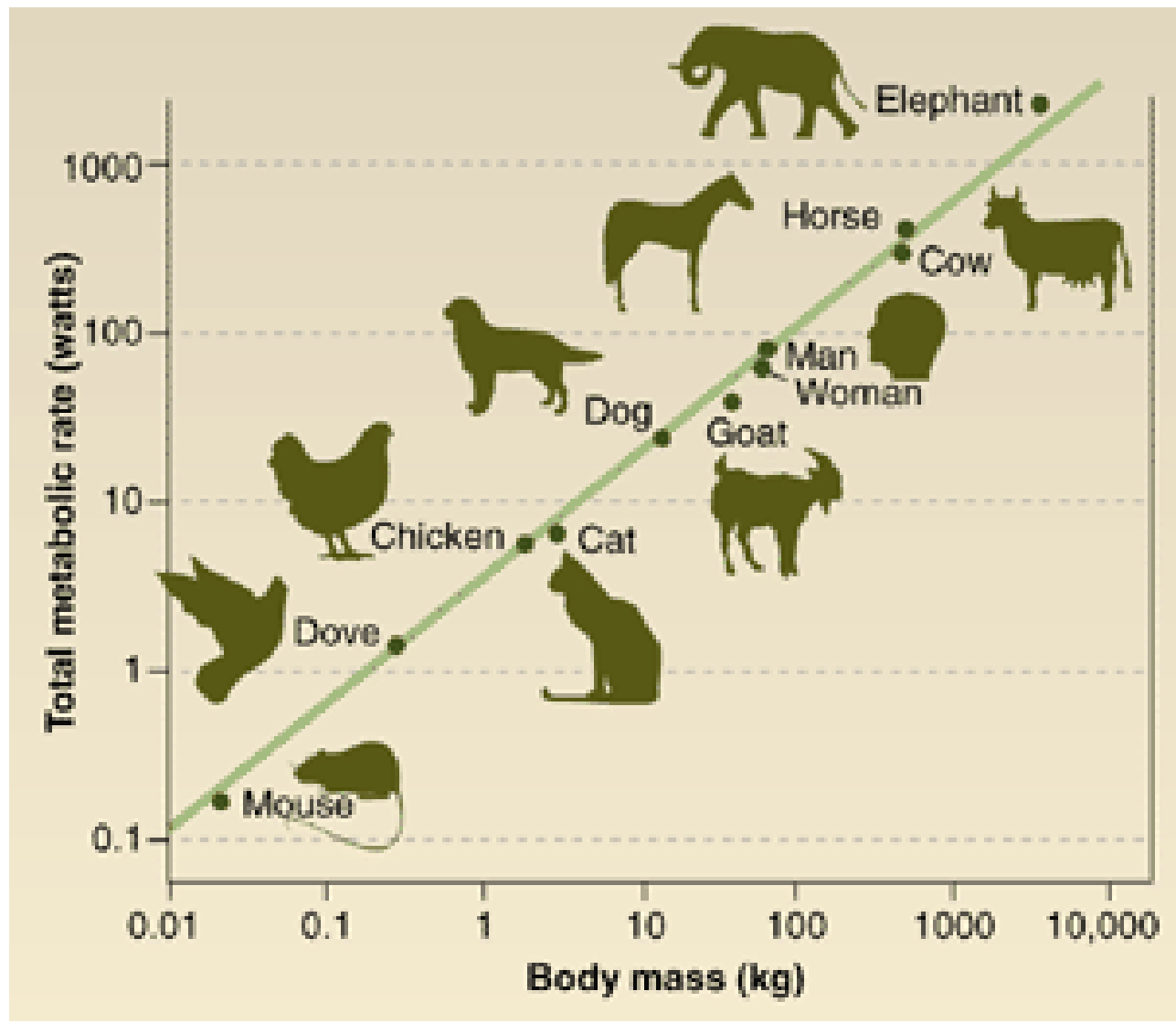
CAL/DAY  
&  
CAL/KG/DAY

B.T.U./DAY

BASAL METABOLISM

BASAL METABOLISM







# Practical Diet Formulation

- Free ranging diet information
- GI tract
- Specific to species/closest domestic
- Season
- Physiological state
- Health Status
- Management
- Foods Available
- Presentation



# How do you classify produce?

- Trained to fit into categories
  - Fruit
  - Vegetable
  - Leafy Green
  - Starch
- Some overlap between categories
- Not enough emphasis on sugar and fiber
- Earlier information on sugar, fiber, starch etc. now evaluated on how body breaks down and utilized



# Fruit

- Fruit = any seed bearing structure in a flowering plant formed from the ovary after flowering. Eating ovaries.....
  - Apples
  - Oranges
  - All beans
  - Tomato
  - Corn
  - Wheat Grains
- Domestic vs. wild



# Primates and Sweet Foods

- Love sweet foods
- Sweet foods high in sugar
- Glucose = most readily available source of energy
- Glucose present = choice for energy
- $\uparrow$  glucose  $\rightarrow$   $\uparrow$  insulin  $\rightarrow$  ENERGY  
( $\downarrow$  blood glucose +  $\uparrow$  intracellular glucose)



# Vegetable

- Vegetable = any vegetative part of a plant that is not a fruit, nut, tuber, or grain.
  - Broccoli/cauliflower
  - Brussel sprouts
  - Radishes
  - Onions
  - Turnips
  - Beets
  - Artichoke



# Leafy Greens

- Leafy Greens = leaves, petioles, or shoots of vegetable plants.
  - Romaine
  - Spinach
  - Escarole
  - Kale
  - Cabbage
  - Celery
  - Endive
  - Collards

# Starchy Vegetable

- Starch vegetable = structure for energy storage for plant re-growth the following season. Readily broken down by the body or cooking into simple sugars
  - Sweet/white potato
  - Carrot

# Primate Biscuit Comparison

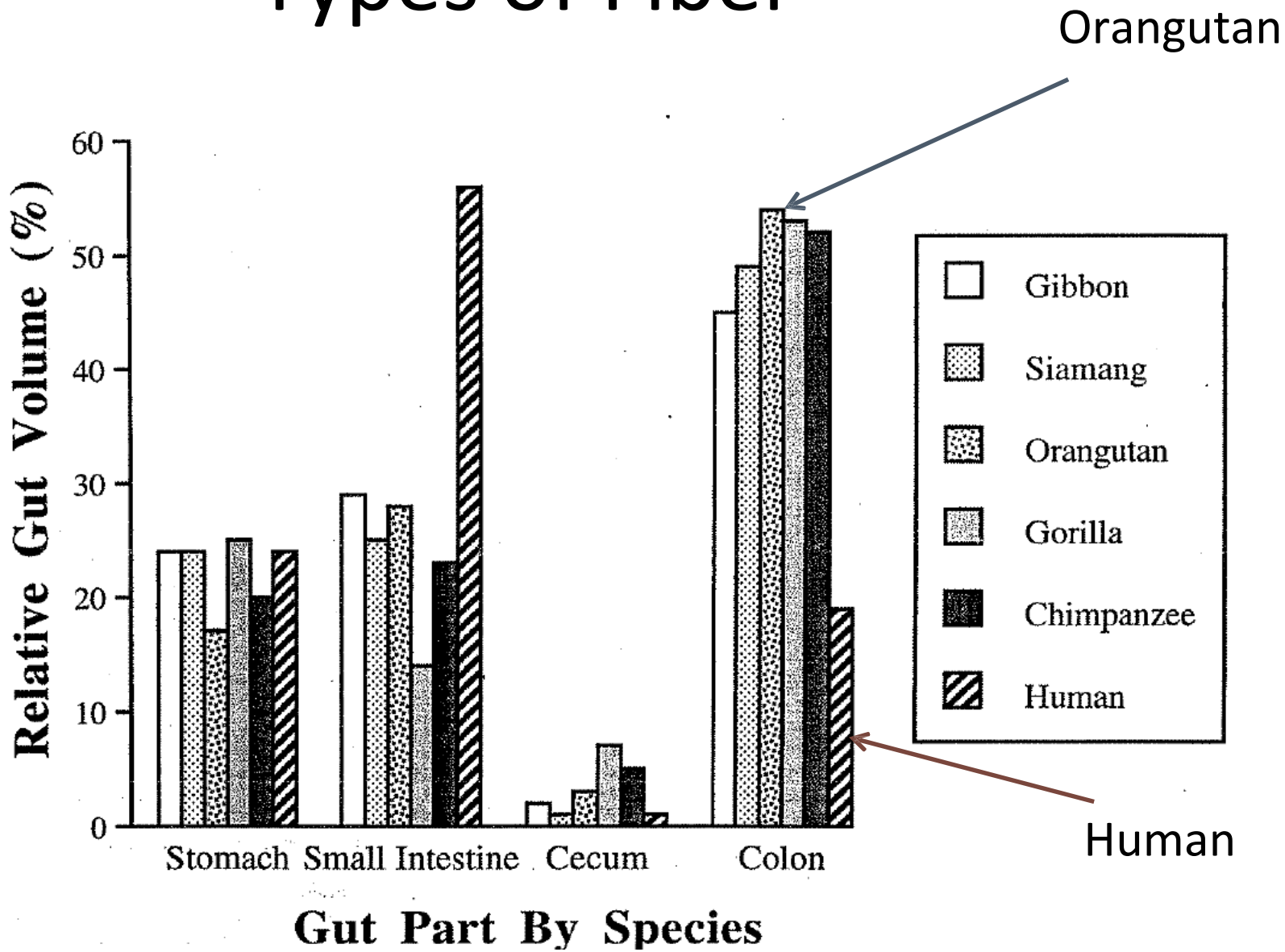
Nutrient	Biscuit 1	Biscuit 2	Biscuit 3	Biscuit 4	Biscuit 5
Protein, %	26	18	21	21	23
Fat, %	6.2	3	5.0	6.4	6.5
NDF, %	17	26	33	-	21
ADF, %	6.8	18	22	-	13
Sugar, %	2.8	17.3	5.5	1.9	-
Starch, %	32.2	16	6.0	-	-
Energy, kcal/g	3.15	2.73	2.65	3.9	-
Vitamin D3, IU/g	6.6	3.3	4.2	2.1	3.5
Vitamin A, IU/g	43	25	23	14	-
Vitamin C, mg/kg	500	475	795	605	-
Calcium, %	1.0	1.2	1.0	0.6	1.0
Phosphorus, %	0.6	0.7	0.6	0.4	0.7
Iron, mg/kg	440	385	225	86	100
Zinc, mg/kg	160	165	160	62	-
Selenium, mg/kg	0.4	0.3	0.3	0.4	0.3



# Balancing primate diets

- Consistent plane of nutrition
- Be cognizant of the sugar in the diet
- Know which food items contribute sugar
- Not too much sugar
- Balance sugar with fiber (type)

# Types of Fiber



# Dental Health

- Dry biscuits/pellets
- Whole vegetables
- Browse



Kathy Newton

# Common Nutrition Challenges

- Seasonal changes or not?
- Weight gain vs weight loss
- Vitamin D
- Obesity

# Common Diet Related Issues



**Obesity**



Periodontal Disease



Dental Caries



Cardiovascular Disease



Diabetes



Microbiome Shift