ASSOCIATION OF ZOOS & AQUARIUMS

COLOBUS MONKEY
(*Colobus*)
CARE MANUAL

CREATED BY THE
AZA Guereza & Angola Colobus Monkey Species Survival Plans®
IN ASSOCIATION WITH THE
AZA Old World Monkey Taxon Advisory Group

Colobus Monkey (Cercopithecidae/*Colobus*) Care Manual

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This nutrition chapter is an excerpt from the complete Animal Care Manual available at the

Association of Zoos and Aquariums (AZA)'s website:

http://www.aza.org/animal-care-manuals/

Further information about diets and the nutrition of this and other species can be found at the

AZA's Nutrition Advisory Group (NAG)'s website:

http://nagonline.net

Chapter 5. Nutrition

5.1 Nutritional Requirements

A formal nutrition program is recommended to meet the behavioral and nutritional needs of all species and specimens in within the collection (AZA Accreditation Standard 2.6.2). Diets should be developed using the recommendations of nutritionists, The AZA Nutrition Advisory Groups Feeding Guidelines (http://www.nagonline.net/feeding_guidelines.htm), and veterinarians as well as AZA Taxon Advisory Groups, Species Survival Plans. Diet formulation criteria should address the animal's nutritional needs, feeding ecology, as well as individual and natural histories to ensure that species-specific feeding patterns and behaviors are stimulated.

> **AZA Accreditation Standard**
>
> **(2.6.2)** A formal nutrition program is recommended to meet the behavioral and nutritional needs of all species and specimens within the collection.

Feeding Strategy and Foraging Behavior: It is important to understand the feeding ecology and gastrointestinal tract characteristics of colobus when assessing their diets.

Colobus angolensis and *Colobus guereza* inhabit east and central Africa concentrating on the lowland rain, coastal, gallery, and montane forests. More specifically populations occur from Sengal in the west to Zanzibar in the east, and from the Ethiopian Highlands to the southern edge of the Congo Basin (Oates, 1994). They exhibit seasonal variation in consumption based on food availability (Fashing, 2011). It has been suggested that colobus lead a lethargic lifestyle. Fashing (2011) reported *C. angolensis* spent 32-43% resting, 27-42% feeding, 20-24% moving, and 2-10% either social or other. For *C. guereza* it was 52-63% resting, 19-26% feeding, 5-22% moving, and 7-18% either social or other. Some have suggested that colobus have abnormally low basal metabolic rate (Müller, 1983) which may follow their lower activity level.

All species of colobus are leaf-eating primates. *C. guereza* appear to have the most varied and flexible diet, however *C. angolensis* vary in their selection as well which can include as much lichen as leaves at one mountainous location. Food items selected vary by site. Their natural diet consists of predominately leaf material, followed by fruits, and seeds. Long-term field studies have shown that young leaves are preferred and eaten much more frequently than mature leaves. Fruits are often eaten unripe. From these studies, ranges for food items were for *C. guereza* and *C. angolensis*, respectively, 53-87% and 38-72% total leaves, 5-39% and 17-28% fruits, 0-22% for both species seeds, 1-9% and 1-7% flowers, and 3-5% and 6-37% (Fashing, 2011). In general, colobus consume a varied diet, appear to be adaptable to different foods though never existing 100% of the time on any one food group.

The predominantly folivorous diet of *C guereza* and *C angolensis* provides a good source of most nutrients (Appendix G). Some studies have suggested wild colobus prefer leaves that have high protein-to-fiber ratios (Chapman et al., 2002). The protein content of young and mature leaves (20-30%, Wasserman et al., 2003; Baranga, 1982; Rode et al., 2003; Fashing, 2007) appears to exceed the suggested protein requirements for nonhuman primates (15-22%, NRC 2003). This is also the case with the leaf eating hind gut fermenting howler (Oftedal, 1991). Oftedal (1991) proposed protein may be limiting for lactating animals consuming foods with significant phenolic content. He cautioned the lack of data on protein digestibility, amino acid patterns, energy concentration, and metabolism of non-protein nitrogen compounds still remains to be determined and could affect diet selection. Limited data on fruits and seeds suggest some fruits are not significant sources of protein (6% protein, Wrangham et al, 1991) while other fruits and seeds (14-39% protein, Dasilva, 1994) can be. These diet items also appear to be a good source of most minerals (Appendix G). Of note, sodium may be low in many leaves and copper and zinc marginal (Wasserman et al., 2003; Baranga, 1982; Rode et al., 2003; Fashing, 2007; Rode et al., 2003). It has been suggested colobus seek swamp plants, bark, and drink water from mud puddles to ingest adequate levels of minerals lacking in their primary food components (Fashing et al., 2007)

Digestive System Morphology and Physiology: Colobus possess a complex stomach that has the ability to digest leaves. The wall of the stomach contains two bands of longitudinal muscle that result in a series of pouches (haustra). Figure 1 presents the different regions of the stomach. A small area of the stomach contains stratified squamous epithelium which may function in a protective manner from mechanical abrasion (Stevens & Hume, 1995). The stomach includes a large cardiac region, where fermentation of plant material occurs, typical of the folivorous primates including Francois' and dusky lemurs and proboscis monkeys (Stevens & Hume, 1995).

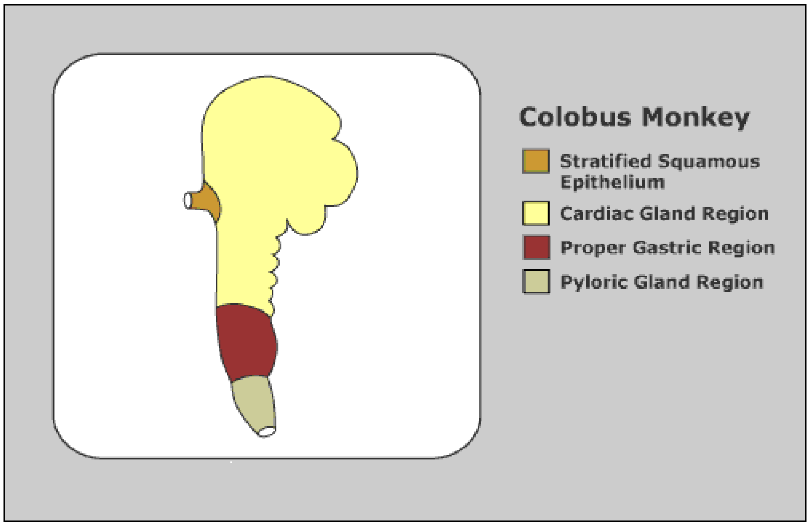

Figure 1. Stomach of the colobus monkey (Stevens & Hume, 1995)

Figure 2 provides a picture of the complete gastrointestinal system as outlined in Stevens & Hume (1995 and 1998). The hindgut is a long sacculated colon and cecum of moderate size (Kay & Davies, 1994). Digestion of food and passage of the digesta would require the secretion of large quantities of fluid and electrolytes by the salivary glands, stomach, pancreas, and intestine.

Microbial fermentation occurs in the foregut and in the cecum of this species that allowing the digestion of the plant material; the bacterial counts in colobus are similar to those in ruminants (Kay et al., 1976; Ohwaki et al., 1974; Stevens & Hume, 1998). Protozoa appear to be absent (Ohwaki et al., 1974; Bauchop & Martucci, 1968). The pH is reported to range from 5.5-6.7 in the foregut of the free ranging colobus on diets ranging from seeds to leaves (Kuhn, 1964, Ohwaki et al., 1974). In zoos, *C gureza* fed leaves had a foregut pH range of 6.5-7.0 (Kay et al, 1976). In zoo langurs, *P. cristatus* and *P. entellus* on an alfalfa based diet had foregut pH range of 5.0 to 6.5 (Bauchop & Martucci, 1968). Clinically normal colobus and langurs had a pH range of 6.5-8.0 while clinically abnormal langurs had a larger range, 4.5-8.5 (Sutherland-Smith et al., 1998). Short-chained fatty acids, 53-219 mmole/l, (Kay et al., 1976; Kuhn 1964, Ohwaki, 1974) have been measured in the forestomach of the colobus, also reflecting the diet consumed. The lower level is from colobus on a 100% leaf diet while the higher levels are from free ranging colobus consuming seeds. Colobus also possess digestive enzymes specific to foregut fermenting ruminants (Schienman, 2006). Volatile fatty acids are also produced in the cecum/proximal colon (47-80 mmole/l) indicating the moderate size lower gut also contributes to fermenting a high fiber diet (Kay et al, 1976). Considering the similarities with ruminants, it is appropriate to critically evaluate food items and feeding schedules for their effect on the fermentation environment. The gastrointestinal tract (GI) appears to be flexible based on free ranging animals consuming a diet with seeds generating a lower pH in the stomach as well as diets high in leaves generating a higher pH. It is important to consider these data on free ranging animals only capture one moment in time and may not reflect the entire feeding schedule. However when making changes in diets, it is important to be cautious at making drastic changes in food offered giving time for the GI tract to adapt.

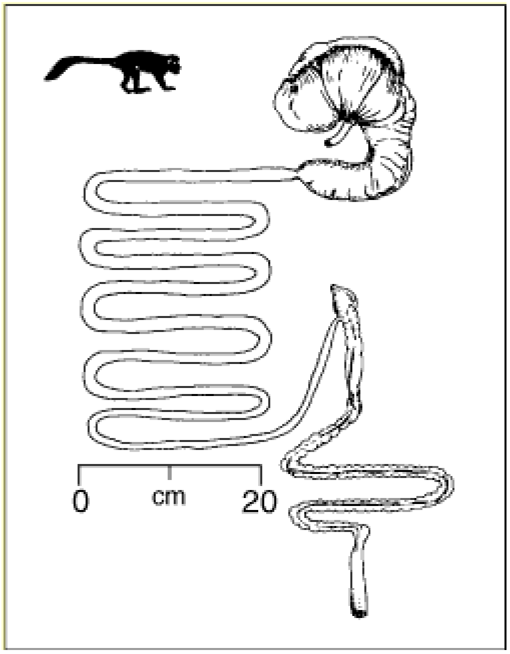

Figure 2. Colobus monkey (*Colobus abyssinicus*) digestive tract (Stevens & Hume 1995 and 1998)

It is apparent that fiber is important to meeting the nutrient needs of colobus as well as maintaining proper microbial fermentation. Studies in zoos have indicated colobus are extremely efficient digesting high fiber diets with many values exceeding those reported for ruminants consuming high quality forage and concentrate diets. Levels reported for digestibility of dry matter, crude protein, neutral detergent fiber, acid detergent fiber are: 65-87%, 55-84%, 57-81%, and 56-69%, respectively (Watkins et al., 1985, Nijboer, 2006, Oftedal, 1982). Ranges are due to differences in protein and fiber content of the diet fed.

Energy: Animals require energy for basal metabolic functions which include vital cell activity, respiration, and cardiovascular distribution of the blood, while in a resting, unstressed, post-absorptive state and in a thermoneutral environment (no shivering or special activity to maintain body temperature). Basal energy expenditure is related to total body surface area; Kleiber (1975) concluded fasting homeotherms produce 1,000 kcal of heat per square meter body surface. Kleiber (1975) used previously published research to establish the equation 70 $BW_{kg}^{0.75}$ to express kilocalories needed per day for basal metabolic functions (BW represents body weight). Müller (1983) suggests a colobus specific basal metabolic rate (BMR) of $59.5BW^{0.75}$.

To account for additional needs including muscular activity, tissue accretion, thermoregulation, reproduction, and lactation, BMR is often multiplied by a factor(s). A multiple of basal metabolic rate to meet maintenance energy requirements for colobus has not been established. A general factor used for mammals ranging in body size from weasels to moose is 2XBMR (Robbins, 1994). Applying this factor to Müller (1983) generates an estimated maintenance requirement of $119(BW^{0.75})$. Other researchers have suggested 96 $BW^{0.75}$ (Oftedal et al., 1982), and $125(BW^{0.75})$ as a maintenance energy level for foregut fermenting colobidae (Edwards & Ullrey 1999). A rough estimate of energy needs for active free-ranging colobus (Wasserman, 2003) was 261 $BW^{0.75}$. For animals in zoos an appropriate range of energy needs for maintenance might be $96(BW_{kg}^{0.75})$ to $125(BW^{0.75})$. For example a 10.8 kg (23.87 lb) colobus may require 572-745 kilocalories per day to meet maintenance metabolizable energy needs. Colobus (*Colobus guereza*) in zoos have been offered diets between 451-888 kcals/day (Appendix H). In addition to calculating possible energy needs, it is important to adjust calorie ranges based on body condition, body mass, and food offered.

Body Condition: Body condition normal scores were not found for free-ranging animals. Considering animal-to-animal variation, each animal should be assessed as an individual with regard to body weight and overall health in conjunction with the diet offered.

Target Nutrients: Several factors affect nutrient requirements. These factors include: physiological state, health status, environment, activity, and group dynamics. The target nutrient levels in these standard recommendations encompass the needs for maintenance adults, reproducing animals (pregnancy and lactation), as well as the needs for growing animals.

Group dynamics often play a role in the nutrient content of the consumed diet. Feeding should be observed to ensure the subordinate animals receive the correct proportions of ingredients. Actions such as increasing the number of feeds per day, placing food in several locations, distracting some animals with food items to allow others adequate access, or separating animals when possible to ensure adequate biscuit consumption by subordinates may be necessary in a group of animals.

Table 4. Target nutrients ranges for *Colobus sp.* on a dry matter basis[a]

Nutrient	Target Nutrients
Protein, %	15–22[b]
Essential n-3 Fatty Acids, %	0.5
Essential n-6 Fatty Acids, %	2
NDF, %	30[c]
ADF, %	15[c]
Vitamin A, IU/g	8
Vitamin D, IU/g	2.5[d]
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[e]
Calcium, %	0.5–0.8
Phosphorus, %	0.4–0.6[f]
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

[a]Probable requirements are based on NRC, 2003.
[b]Lactation and growing young –Required concentrations are greatly affected by protein quality (amounts and proportions of essential amino acids), and this issue must be considered. Taurine appears to be a dietary essential for some primates through the first postnatal year.
[c]Although not nutrients, NDF and ADF when used at the concentrations shown for model species were positively related to gastrointestinal health.
[d]Exposure to natural sunlight and or artificial UV radiation should be considered as a contributing source for the requirement.
[e]Ascorbyl-2-polyphosphate is a source of Vitamin C that is biologically active and relatively stable during extrusion and storage.
[f]Much of the phytate phosphorus found in soybean meal and some cereals appears to be of limited bioavailability.

Protein - Similar to ruminants, it is suspected that nitrogen recycling and synthesis of microbial protein may contribute to meeting protein needs. Colobines may exhibit a similar pattern based on the limited information available (Kay & Davies, 1994).

Fiber - Colobus are some of the most folivorous of primates even though they have a flexible diet. Consequently adequate fiber is important to maintain healthy animals. The 15% acid detergent fiber (ADF) suggested in Table 4 is a minimum considering free-ranging diets contain at least 20% ADF (Appendix G). ADF is a chemical analysis that determines the amount of residue (primarily cellulose, lignin and variable amounts of silica which are the least digestible components) remaining after boiling a feed sample in an acid detergent solution. The ADF value is used to predict the energy content (total digestible nutrients (TDN) and net energy (NE)) of forages. Neutral detergent fiber (NDF) - the insoluble fraction containing all plant cell wall components left after boiling a feed sample in a neutral detergent solution. NDF is of low digestibility but can be broken down somewhat by the digestive tract microorganisms. NDF value is used to predict ruminant feed intake.

Vitamin D – The vitamin D content of colobus milk is unknown. Human milk contains very little vitamin D (Holick, 1999). Some colobus, with or without exposure to sunlight or ultraviolet light via transmissible UVB bulbs/skylight, developed rickets (Morrisey et al., 1995). It is recommended if colobus are not exposed to direct sunlight or UVB transmissible light they receive supplementation. Vitamin D is a fat soluble vitamin, stored in the body, and may be toxic in large quantities. Toxic levels are usually 10 times the requirement provided continually. It is important to not over supplement. An appropriate dose for colobus may be 400 IU/day. The dose to be administered to the infant colobus should correspond with the body weight. Thus if a human infant receives 400 IU/d and the average weight of a new born is (2.7-3.6 kg), an appropriate level for a 500 gram non-human primate would be 63 IU/d or 441 IU/week.

B Vitamins – It is not known, if, and to what extent endogenous production (microbial synthesis) of B complex vitamins occurs in this foregut fermenting primate. As summarized by Kay and Davies ruminants have a high serum vitamin B_{12} and colobines have a higher serum vitamin B_{12} than other non-foregut fermenting primates (Oxnard, 1966).

Factors affecting nutrient needs:

Seasonal Influence**:** Increased or decreased requirements for thermoregulation, or activity can be met by offering diets *ad libitum* and monitoring body condition. In general diets should be offered so that a small amount of food is remaining at the end of the feeding period.

Growth/Reproduction/Lactation: Colobus species specific data on growth, reproduction, and lactation do not exist. Infant non-human primates require more energy than adults do of their species (NRC, 2003). Without species specific data colobus could be fed a diet to support normal growth for primates in general. An appropriate growth rate for primates may be $Y=0.2165X^{0.35}$ where X equals adult body weight in grams and Y = growth rate in grams per day (Robbins, 1993). Lactation is the most energy demanding phase of reproduction. Based on humans, increases in dry matter intake for pregnancy and lactation range from 13-23% (Oftedal & Allen, 1996).

AZA Accreditation Standard

(2.6.3) Animal diets must be of a quality and quantity suitable for each animal's nutritional and psychological needs. Diet formulations and records of analysis of appropriate feed items should be maintained and may be examined by the Visiting Committee. Animal food, especially seafood products, should be purchased from reliable sources that are sustainable and/or well managed.

5.2 Diets

The formulation, preparation, and delivery of all diets must be of a quality and quantity suitable to meet the animal's psychological and behavioral needs (AZA Accreditation Standard 2.6.3). Food should be purchased from reliable, sustainable, and well-managed sources. The nutritional analysis of the food should be regularly tested and recorded.

Food preparation must be performed in accordance with all relevant federal, state, or local regulations (AZA Accreditation Standard 2.6.1). The appropriate Hazard Analysis and Critical Control Points (HACCP) food safety protocols for the diet ingredients, diet preparation, and diet administration should be established for the taxa or species specified. Diet preparation staff should remain current on food recalls, updates, and regulations per USDA/FDA. Remove food within a maximum of 24 hours of being offered unless state or federal regulations specify otherwise and dispose of per USDA guidelines.

AZA Accreditation Standard

(2.6.1) Animal food preparations must meet all local, state/provincial, and federal regulations.

Diet Composition: Colobus in zoos can be maintained on diets consisting of commercially available nutritionally complete high fiber biscuit, high fiber produce items, and appropriate browse. These ingredients fed in combination should meet the target nutrient ranges for colobus (see Table 4). High sugar fruits or foods that are high in starch should be avoided. (Edwards & Ullrey, 1999; Nijboer, 2006). Water should be available at all times.

Nutritionally Complete Foods: The nutritionally complete portion of the diet is the most significant vector to supply fiber in the diet except for browse. All diets should include a high fiber (15% ADF, minimum) primate biscuit (Edwards et al., 1997; Edwards & Ullrey, 1999). These products have been formulated to meet the needs of primates and thus contain an appropriate array of nutrients (protein, fats, vitamins and minerals). When included in the diet at appropriate levels, additional vitamin and mineral supplementation is not necessary. Colobus in zoos have been adequately maintained on diets consisting of 6–44% biscuit on an "as fed" basis.

Produce: Produce should be restricted to leafy green vegetables/high fiber vegetable material (low starch, non-gas producing) with low to no domestic fruits (Edwards, 1997; Edwards & Ullrey, 1999). The addition of commercially available produce items that are high in water, have readily fermentable sugars and contain complex carbohydrates in the form of starch may cause digestive upset in foregut fermenting primates such as colobus (Nijboer, 2006; Oftedal & Allen, 1996). The digestion of the fruits and starchy vegetables may result in the rapid formation of volatile fatty acids (VFA) which lower pH in the stomach. This may result in an increased absorption of the VFA and production of lactic acid causing acidosis. Fruits, seeds, and leaves consumed by free ranging colobus are significantly higher in fiber than most commercially available fruits and vegetables (Table 5).

Table 5: Dry matter and fiber content (acid detergent fiber/ADF and neutral detergent fiber/NDF) of seeds and fruits consumed by free ranging colobus compared to common domestic fruits and vegetables, nutritionally complete biscuit and browse.

	Dry matter, %	ADF,%	NDF%
Unripe seeds/fruit[a]	-	26.4	-
Ripe fruit[b]	-	-	40.3
Young leaves[c]	-	28.4	39.1
Mature leaves[c]	-	40.4	53.8
Apple, red delicious[d]	12.9	6.0	10.2
Orange[d]	16.2	7.1	11.0
Sweet potato[d]	23.8	4.9	20.0
Carrot[d]	11.8	8.9	9.7
Zucchini[d]	4.4	10.2	15.1
Tomato[d]	4.7	14.2	16.6
Cucumber[d]	4.0	15.5	18.6
Green beans[d]	6.5	18.3	21.9
Spinach[d]	8.9	11.7	20.1
Romaine[d]	7.0	14.1	16.3
Alfalfa sprouts[d]	4.6	20.8	27.7
High fiber primate biscuit[e]	90	18	30
Weeping willow leaves[f]	40.1	24.2	37.5
Hackberry leaves[f]	48.2	28.7	44.5

[a]Dasilva, 1994.
[b]Wrangham et al., 1991.
[c]Wasserman et al., 2003; Baranga, 1982; Rode et al., 2003; Fashing, 2007.
[d]Schmidt et al., 1999.
[e]Average values for multiple biscuits formulated for leaf eating primates, Ward, 2012.
[f]Nijboer & Dierenfeld, 1996.

Browse: When browse plants are offered to colobus, all plants must be identified and assessed for safety. The responsibility for approval of plants and oversight of the program should be assigned to at least one qualified individual (AZA Accreditation Standard 2.6.4) in addition to a team of nutritionists, veterinarians, and animal management staff. In addition to ensuring the plant species are safe for colobus, the program should identify if the individual plants have been treated with any chemicals or have been near any point sources of pollution. If animals have access to plants in and around their exhibits, there should be a staff member responsible for ensuring that toxic plants are not available. Several sources for identifying toxic plants are available including *Toxic Plants of North America* (Burrows & Tyrl, 2006).

> **AZA Accreditation Standard**
>
> **(2.6.4)** The institution should assign at least one person to oversee appropriate browse material for the collection.

The nutrient content of the browse plants that contributes to the total diet should be determined in house or by a commercial laboratory. An analysis should be completed on any browse is offered at a level of 2% or higher in the diet is recommended (Toddes et al., 1997). Though browse plants may contribute to an appropriate fiber level, secondary plant compounds such as tannins, alkaloids, and saponins also may be present within these plants. The browse plants should be offered in an appropriate manner. Bark and stems can contribute to the formation of phytobezoars, which cause physical obstructions in the gastrointestinal tract (Janssen, 1994). Stems placed in a PVC tube where stems and bark cannot be stripped off by the animal is one method of avoiding this problem (Edwards, 1997). Ropes of indigestible acacia fiber are also a concern, as the inclusion of acacia leaves in the diet of langur monkeys has resulted in impaction and the deaths of several individuals (Ensley et al., 1982). When moving animals to a new exhibit the plants and trees should be evaluated even if they are on an approved list. One colobus died due to consumption of the fibrous parts of an approved browse plant due to ingesting the entire plant (leaves, buds, stems, and flowers) in a very brief time (Irlbeck et al., 2001).

Table 6. Nontoxic plant species fed to colobus in AZA institutions

Species	Common Name
Celtis sp.	Hackberry
Cotoneaster lacteus	Cotoneaster
Ficus benjamina	Weeping fig
Ficus nitida	Ficus
Forsythia sp.	Forsythia
Gleditsia triacanthos	Honey locust
Hibiscus sp.	Hibiscus
Liquidambar styraciflua	Sweet gum
Morus sp.	Mulberry
Platanus sp.	Sycamore
Populus sp.	Poplar
Populus sp.	Cottonwood
Rosa sp.	Rose
Salix sp.	Willow
Tilia sp.	Linden basswood
Ulmus sp.	Elm
Vitis sp.	Grape

Provision of Variability in Food Type and Presentation: Free-ranging colobus spend large portions of the day foraging (40-60%). While it is not possible to mimic the same environment for specimens in zoos, it is recommended to offer the diet in as many feedings as feasible over the course of a day. As previously discussed, the microbial population in the stomach is sensitive to change, similar to ruminant animals. Multiple feedings of mixed items per day promote steady fermentation in the stomach, and will also allow for more opportunities to adequately distribute food items to animals within a group. It has been noted that some Angolan colobus have had digestive upset with sensitivity to timing of food items offered (M. Campbell, personal communication 2010). When this happens, a total browse diet is offered to those individuals to stabilize their digestive system followed by slow introduction of the other diet items. Food should be offered in containers that are cleaned and sanitized after each use. Some institutions cut food items in long strips to facilitate ease of handling by colobus, although this is not necessary. Colobus can easily manipulate items that are diced. The form in which food is presented is an institutional decision to be made based on group size and social make-up.

Table 7. Diets offered to *Colobus sp.* at 8 zoos summarized from Appendix G

C. guereza	Range
Food Group	
Nutritionally Complete Food, %	7.11-44.44
Fruits, %	0-4.90
Vegetables, %	7.20-33.80
Starch Vegetables, %	0-22.54
Leafy Vegetables, %	15.24-63.89
Browse, %	0
Other/Misc., %	0-19.25
Grams Offered	
Male, g/d n=1 animal	1070
Female, g/d n=1 animal	714
Juveniles, g/d n=1 animal	415
Infants, g/d n=1 animal	270
Unknown sex/Unisex, g/d n=7 zoos	556-1477
C. angolensis	Range
Food Group	
Nutritionally Complete Food, %	5.78-30.8
Fruits, %	0
Vegetables, %	7.48-20.80
Starch Vegetables, %	4.90-21.90
Leafy Vegetables, %	11.86-43.46
Browse, %	6.20-57.70
Grams Offered	
Male, g/d n=1 animal	11.85
Female, g/d n=1 animal	1105
Unknown sex/Unisex, g/d n=7 zoos	831-872

In 2010, there were two occasions where Angolan colobus had fetuses too large to pass through the birthing canal. In both cases the infants did not survive the birth. These fetuses were already showing signs of black hair and had teeth, unusual for a newborn. To date we do not have any information on what factors contributed to the increased fetus size and development as these individuals were not on any types of medications that may have affected the gestation of the infant.

7.4 Birthing Facilities

As parturition approaches, animal care staff should ensure that the mother is comfortable in the area where the birth will take place, and that this area is "baby-proofed," as described below. Stress from housing changes can cause individual colobus to abort fetuses and should be avoided during pregnancy if possible. However, if a female must be relocated, this should occur no more than a month prior to the expected parturition date. Changes of group members may also cause stress during a pregnancy and introductions are not advised during this time. , This may not apply to the reintroduction of familiar animals that have been temporarily removed for various reasons depending on the situation and the individual animal.

Colobus do not nest and no added materials are recommended for birthing. Institutions should inspect their facilities prior to a birth to look for any issues that may cause harm to a baby. These may include gaps where an infant's head can get stuck, ropes that can loop around a neck, hard enrichment items that may be thrown, etc. As noted previously, baby Angolan colobus can fit through 5.1 x 5.1 cm (2 x 2 in.) mesh when properly motivated.

7.5 Assisted Rearing

Although mothers may successfully give birth, there are times when they are not able to properly care for their offspring, both in the wild and in *ex situ* populations. Fortunately, animal care staff in AZA-accredited institutions is able to assist with the rearing of these offspring if necessary.

Some of the situations that may prevent a mother from rearing her offspring are injury or illness to the infant, maternal dysfunction, injury, illness or death of the mother, or insufficient lactation. When there is an issue of injury or illness to the infant and prompt veterinary and caretaker intervention is available, reintroduction to an attentive dam should be attempted in the first 72 hours (Read & Myer, 1996).

Hand-rearing is not advantageous for any monkey. Little documentation exists regarding this process, but reintroduction through howdy cages (areas that allow visual and olfactory, but limited contact) and surrogating can be effective. In any hand-rearing process care should be taken not to imprint infants on humans. Precautions to ensure as little development of "human behaviors" should be initiated. This can be achieved by ensuring the infants are in daily visual, auditory, and olfactory range of conspecifics from an early age, and that reintroductions are done as quickly as possible. At this time, there are no standards for hand-rearing colobus monkeys, although there are written histories created by institutions and sanctuaries that have had to hand raise an infant. Further information on a hand rearing case study can be found in Appendix K. As this is just one example and there are variations in types of formulas and feeding schedules, it is recommended that you discuss further with the AZA Colobus SSP coordinator before deciding on a protocol.

7.6 Contraception

Many animals cared for in AZA-accredited institutions breed so successfully that contraception techniques are implemented to ensure that the population remains at a healthy size. The recommendation for long-term contraception by the AZA Contraception Advisory Group (CAG) for all AZA Old World Monkeys is a MGA (melengestrol acetate) implant. MGA implants need to be administered every two years and have shown no deleterious effects. These implants should be inserted between the scapulae, intra-muscularly if possible. Suturing the implant in place at the time of insertion may control migration of the implant. The implant's presence should be confirmed each time the animal is handled (AZA, 2004). Individuals given an MGA implant should be separated from other individuals for approximately 14 days until the hormones take full effect. There have been no side effects from an MGA implant noted in colobus. Individuals who have become pregnant while on the implant (due to lack of proper separation during the initial stages of the implant) have had normal pregnancies and given birth to normally developed infants (C. Ketz-Riley, personal communication 2010).

Recently at the recommendation of the AZA CAG (as part of a research study) several institutions have used Suprelorin®, which contains the GnRH agonist, deslorelin, as a contraception technique for both species of colobus monkeys (S. Boutelle, personal communication 2010). Deslorelin functions by stopping the production of sex hormones. As of 2011, there were no confirmed pregnancies in animals

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Appendix G: Nutrient Content of Foods Consumed by Free-ranging Colobus

This table details the Crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), fat, ash, sodium (Na), magnesium (Mg), phosphorus (P), potassium (K), calcium (Ca), manganese (Mn), iron (Fe), cobalt (Co), copper (Cu), and zinc (Zn) content of leaves, fruits, and bark consumed by free ranging *C guereza* and *C angolensis* and unripe seeds/fruits consumed by *C polykomos*, on a dry matter basis.

	Young leaves[a]	Mature leaves[a]	Fruit from Kibale[b]	Fruits[c]	Unripe seed/fruits[d]	Bark[e]
CP, %						
N	11	14			7	2
Mean	29.9	19.6	6.3		22.29	2.3
SD	5.7	3.7			8.61	0.57
Range	23.0-39.0	13.5-25.5			13.7-39.1	1.9-2.7
ADF, %						
N	11	14			7	2
Mean	28.4	40.4			26.44	50.2
SD	8.0	10.2			19.47	2.3
Range	16.4-47.9	25.8-55.6			12.0-66.4	48.6-51.8
NDF, %						
N	8	12				2
Mean	39.1	53.8	40.3			75.2
SD	7.3	11.7				1.9
Range	25.1-50.1	35.1-73.6				73.8-76.5
Fat, %						
N	2	3				
Mean	3.5	1.9				
SD	2.4	0.7				
Range	1.75-5.18	1.4-2.4				
Ash, %						
N	20	13				3
Mean	8.1	9.3	3.1			10.3
SD	2.7	3.7				1.9
Range	4.5-14.4	5.5-15.6				8.3-12.0
Na, %						
N	21	15		2		3
Mean	0.18	0.05		0.53		0.91
SD	0.36	0.07		0.62		0.48
Range	0.01-1.65	0.01-0.25		0.09-0.96		0.41-1.37
Mg, %						
N	19	13		2		3
Mean	2.62	3.57		2.94		2.46
SD	0.94	1.39		0.88		0.48
Range	0.99-3.40	1.80-5.81		2.32-3.57		1.92-2.81
P, %						
N	10	14				2
Mean	3.57	1.94				0.21
SD	1.64	0.93				0.08
Range	1.03-5.98	0.30-2.96				0.15-0.26
K, %						
N	21	15		2		3
Mean	18.50	15.17		11.24		5.29
SD	6.74	10.29		0.30		1.12
Range	11.81-25.12	1.40-41.48		11.0-11.46		4.26-6.49
Ca, %						
N	21	15		2		3
Mean	7.02	14.78		11.32		28.16
SD	6.67	8.26		1.32		2.08
Range	0.5-26.78	2.5-18.33		10.39-12.25		25.91-28.55

	Young leaves[a]	Mature leaves[a]	Fruit from Kibale[b]	Fruits[c]	Unripe seed/fruits[d]	Bark[e]
Mn, ppm						
N	20	13		1		3
Mean	75.65	164.21		317.69		518.55
SD	62.91	174.94				648.35
Range	10.0-237.2	22.0-609				86-1264
Fe, ppm						
N	20	13		2		3
Mean	135.18	128.14		118.06		266.17
SD	55.98	30.34		30.86		197.90
Range	50.0-269.66	82.0-162		96.24-139.88		137.0-494
Co, ppm						
N	10	12				2
Mean	0.16	0.21				0.47
SD	0.12	0.21				0.11
Range	0.04-0.34	0.05-0.68				0.39-0.55
Cu, ppm						
N	20	13		2		3
Mean	13.54	10.15		7.56		4.08
SD	6.79	5.57		3.61		2.86
Range	6.79-17.11	5.0-22.3		5.0-10.11		1.7-3.3
Zn, ppm						
N	20	13		2		3
Mean	36.05	17.78		17.33		17.14
SD	11.89	9.27		9.10		11.39
Range	11.89-41.64	9.0-34.0		10.89-23.76		4.0-24.0

[a]Wasserman et al, 2003; Baranga, 1982; Rode et al, 2003; Fashing, 2007.
[b]Wrangham et al, 1991.
[c]Due to small sample sizes, ripe and unripe fruit were combined; Rode et al, 2003.
[d]Dasilva, 1994.
[e]Rode et al, 2003; Fashing, 2007.

Appendix H: Individual Zoo Diets and Nutrient Analysis

Sample daily diets from AZA institutions housing *Colobus* sp.*

Species	Common Name	Institution	Food Item[1]	grams/day	% of diet
C. guereza	Black & White Colobus	A	Banana	36	4.9
			Sweet Potato raw	23	3.1
			Sweet Potato cooked	31	4.2
			Collard greens	209	28.1
			Escarole	191	25.6
			Broccoli	54	7.3
			Carrot raw	12	1.6
			Carrot cooked	43	5.8
			ZuPreem primate canned	39	5.2
			Mazuri Leafeater 5M02 biscuit	39	5.2
			Marion Leafeater biscuit	66	8.9
			Total	**744**	**100**
		B—Male	Escarole	119	11.12
			Grapes	50	4.67
			Green Beans	110	10.30
			Kale	120	11.21
			Marion Leafeater biscuit	129	12.06
			PMI Labdiet 5038 biscuit	53	4.95
			Romaine	120	11.21
			Spinach	120	11.21
			Sweet Potato	88	8.22
			ZuPreem primate canned	161	15.05
			Total	**1070**	**100**
		B—Female	Escarole	79	11.13
			Grapes	34	4.68
			Green Beans	73	10.28
			Kale	80	11.21
			Marion Leafeater biscuit	86	12.06
			PMI Labdiet 5038 biscuit	36	4.96
			Romaine	80	11.21
			Spinach	80	11.21
			Sweet Potato	59	8.22
			ZuPreem primate canned	107	15.05
			Total	**714**	**100**
		C	Alfalfa hay	120	19.25
			Beans, snap green	33	5.29
			Broccoli	16	2.57
			Carrots	30	4.81
			Corn	16	2.57
			Cucumber	16	2.57
			Kale	95	15.24
			Mazuri Leafeater 5M02 biscuit	225	36.09
			Potato, white	27	4.33
			Sweet Potato	30	4.81
			ZuPreem primate canned	15	2.49
			Total	**623**	**100**
		D	HMS high fiber biscuit	227	40.78
			Kale	85	15.30
			Spinach	85	15.30
			Celery	91	16.32
			Carrot	40	7.20
			Yam	28	5.10
			Total	**556**	**100**

Species	Common Name	Institution	Food Item[1]	grams/day	% of diet
C. guereza	Black & White Colobus	E	PMI Labdiet 5045 biscuit	151	22.53
			White potato	76	11.27
			Sweet potato	76	11.27
			Rutabaga	66	9.78
			Romaine	61	9.03
			Kale	61	9.03
			Escarole	61	9.03
			Spinach	61	9.03
			Endive	61	9.03
			Total	**674**	**100**
		F—Adult	Veggie – used carrot	90	16.21
			Starch – used sweet potato	75	13.51
			Romaine	37.5	6.76
			Escarole	37.5	6.76
			Kale	37.5	6.76
			Endive	37.5	6.76
			Mazuri growth and reproduction	160	28.83
			Mazuri Browse biscuit	80	14.41
			Total	**555**	**100**
		F—Juvenile	Veggie – used carrot	60	14.46
			Starch – used sweet potato	50	12.05
			Romaine	31.25	7.53
			Escarole	31.25	7.53
			Kale	31.25	7.53
			Endive	31.25	7.53
			Mazuri growth and reproduction	120	28.91
			Mazuri Browse biscuit	60	14.46
			Total	**415**	**100**
		F—Infant	Veggie – used carrot	45	16.67
			Starch – used sweet potato	30	11.11
			Romaine	18.75	6.94
			Escarole	18.75	6.94
			Kale	18.75	6.94
			Endive	18.75	6.94
			Mazuri growth and reproduction	80	29.63
			Mazuri Browse biscuit	40	14.81
			Total	**270**	**100**
		G	Spinach	83	12.2
			Kale	83	12.2
			Collards	83	12.2
			Broccoli	83	12.2
			Carrots	67	9.8
			Marion Leafeater biscuit	1637	24.4
			Egg, hard-boiled	4	0.5
			Green beans	40	5.9
			Sweet peas	40	5.9
			Yam	33	4.7
			Total	**683**	**100**
		H	Carrot – 7 day/week (d/wk)	80	5.41
			Peppers – 7 d/wk	66	4.47
			Tomatoes – 7 d/wk	154	10.42
			Broccoli – 3 d/wk	34	2.32
			Eggplant – 1 d/wk	11	0.77
			Celery – 1 d/wk	23	1.55
			Cucumber – 2 d/wk	46	3.09
			Green Beans – 3 d/wk	17	1.16
			Zucchini – 1 d/wk	6	0.39
			Yellow Squash – 1 d/wk	6	0.39
			Turnips – 1 d/wk	6	0.39
			Pea Pods – 1 d/wk	3	0.19
			Romaine – 2 d/wk	150	10.18

Species	Common Name	Institution	Food Item[1]	grams/day	% of diet
			Iceberg lettuce – 2 d/wk	130	8.78
			Endive – 1 d/wk	83	5.62
			Escarole – 2 d/wk	161	10.89
			Kale – 2 d/wk	73	4.92
			Collards – 2 d/wk	130	8.78
			Mustard Greens – 3 d/wk	195	13.17
			Marion Leafeater – 7 d/wk	105	7.11
			Total	**1477**	**100**
C. angolensis	Angolan Colobus	I	Marion Leafeater gorilla size	269	30.8
			Kale – 3 d/wk	91	10.4
			Collard Greens – 3 d/wk	141	16.1
			Cabbage – 1 d/wk	54	6.1
			Turnip – 2 d/wk	55	6.3
			Carrot – 3 d/wk	42	4.8
			White potato – 2 d/wk	37	4.3
			Green beans/snow peas – 2 d/wk	32	3.7
			Corn on cob – 2 d/wk	14	1.6
			Broccoli – 1 d/wk	16	1.8
			Celery – 1 d/wk	30	3.5
			Cucumber – 1 d/wk	37	4.2
			Browse - estimated	54	6.2
			Total	**872**	**100**
		J - male	Marion Leafeater biscuit	175	14.77
			Kale	37.5	3.17
			Escarole	37.5	3.17
			Romaine	37.5	3.17
			Collard greens	37.5	3.17
			Carrot	45	3.80
			Broccoli	45	3.80
			Green beans	45	3.80
			Sweet Potato	30	2.53
			Turnip	30	2.53
			White Potato	30	2.53
			Browse – estimated	635	53.59
			Total	**1185**	**100**
		J—female	Marion Leafeater biscuit	150	12.57
			Kale	32.5	2.94
			Escarole	32.5	2.94
			Romaine	32.5	2.94
			Collard greens	32.5	2.94
			Carrot	38.3	3.47
			Broccoli	38.3	3.47
			Green beans	38.3	3.47
			Sweet Potato	25	2.26
			Turnip	25	2.26
			White Potato	25	2.26
			Browse – estimated	635	57.47
			Total	**1105**	**100**
		K	Sweet Potato	182	21.90
			Green beans – 4 /wk	43	5.16
			Carrot - 3 d/wk	19	2.32
			Kale	256	30.81
			Escarole – 3 d/wk	52	6.29
			Endive – 4 d/wk	53	6.33
			Marion Leafeater	48	5.78
			Browse – keeper weighed	178	21.42
			Total	**831**	**100**

[1] Zupreem, Shawnee, KS 66214; PMI Nutrition International, Grays Summit, MO 63039. Marion Zoological 03 E. Center Circle, Plymouth, MN 55441; HMS Zoo Diets 222 Echo Lane Bluffton, IN 46714.
* The AZA Old World Monkey Taxon Advisory Group (OWMTAG) does not specifically endorse the use of any mentioned products.

The following tables detail the nutrient content of sample *Colobus* sp. diets[1] (dry matter basis)

Nutrient	*C.guereza* Institution A	*C. guereza* Institution B: Male	*C. guereza* Institution B: Female	*C. guereza* Institution C	Target Nutrients[1]
Protein (%)	20.3	16.9	16.9	21.5	15–22
Essential n-3 Fatty Acids (%)	0.5	0.6	0.6	0.11	0.5
Essential n-6 Fatty Acids (%)	1.7	1.5	1.5	1.8	2
NDF (%)	10.0	7.6	7.6	30.1	10–30
ADF (%)	11.3	8.1	8.1	21.9	5–15
Vitamin A (IU/g)	155[2]	76.6[2]	76.6[2]	59.6[2]	8
Vitamin D (IU/g)[3]	1.5	2.0	2.0	1.9	2.5
Vitamin E (mg/kg)	175	136	136	136	50–100
Thiamin (mg/kg	14.2	20.4	20.4	8.9	3
Riboflavin (mg/kg)	9.3	8.4	8.4	8.3	4
Pantothenic acid (mg/kg)	30.5	25.8	25.8	38.8	12
Niacin (mg/kg)	67.5	63.7	63.7	75.7	25
Pyridoxine (mg/kg)	9.0	7.3	7.3	8.2	4
Folacin (mg/kg)	5.8	2.8	2.8	6.9	4
Biotin (mg/kg)	0.17	0.18	0.18	0.19	0.11–0.2
Vitamin B_{12} (mg/kg)	0.03	0.03	0.03	0.03	0.01–0.03
Calcium (%)	0.85	0.70	0.70	1.07	0.5–0.8
Phosphorus (%)	0.50	0.45	0.45	0.54	0.4–0.6
Potassium (%)	1.3	1.0	1.0	1.5	0.4
Sodium (%)	0.24	0.26	0.26	0.20	0.2
Magnesium (%)	0.15	0.14	0.14	0.22	0.08
Iron (mg/kg)	183	115	115	328	100
Zinc (mg/kg)	85.8	80.0	80.0	99.8	20–100
Copper (mg/kg)	16.5	15.0	15.1	17.4	12–20
Iodine (mg/kg)	0.49	0.43	0.43	0.72	0.35
Selenium (mg/kg)	0.25	0.24	0.24	0.21	0.11–0.30

Nutrient	*C. guereza* Institution D	*C. guereza* Institution E	*C. guereza* Institution F: Adult	*C. guereza* Institution F: Juvenile	Target Nutrients
Protein (%)	25.0	23.5	21.4	21.6	15–22
Essential n-3 Fatty Acids (%)	n/d[4]	0.22	0.37	0.37	0.5
Essential n-6 Fatty Acids (%)	n/d[4]	1.0	2.4	2.4	2
NDF (%)	25.8	17.1	21.1	21.2	10–30
ADF (%)	15.1	7.2	12.3	12.4	5–15
Vitamin A (IU/g)	125[2]	170[2]	197[2]	184[2]	8
Vitamin D (IU/g)[3]	3.2	4.9	3.2	3.2	2.5
Vitamin E (mg/kg)	134	54.9	246	248	50-100
Thiamin (mg/kg)	4.8	15.8	14.0	14.2	3
Riboflavin (mg/kg)	9.8	8.9	14.2	14.3	4
Pantothenic acid (mg/kg)	22.4	45.4	69.1	69.6	12
Niacin (mg/kg)	52.4	103	107	108	25
Pyridoxine (mg/kg)	n/d[4]	12.9	17.5	17.6	4
Folacin (mg/kg)	n/d[4]	9.4	13.6	13.8	4
Biotin (mg/kg)	0.08	0.25	0.39	0.39	0.11–0.2
Vitamin B_{12} (mg/kg)	0.02	0.03	0.06	0.06	0.01–0.03
Calcium (%)	0.94	0.87	1.2	1.2	0.5–0.8
Phosphorus (%)	0.64	0.56	0.65	0.65	0.4–0.6
Potassium (%)	1.3	1.6	1.2	1.2	0.4
Sodium (%)	0.28	0.25	0.30	0.3	0.2
Magnesium (%)	0.26	0.22	0.17	0.17	0.08
Iron (mg/kg)	321	318	297	300	100
Zinc (mg/kg)	108	126	152	153	20–100
Copper (mg/kg)	12.9	20.9	33.1	33.3	12–20
Iodine (mg/kg)	0.56	0.47	1.9	1.9	0.35
Selenium (mg/kg)	0.20	0.09	0.49	0.49	0.11–0.30

Nutrient	*C. guereza* Institution F: Infant	*C. guereza* Institution G	*C. guereza* Institution H	Target Nutrients
Protein (%)	21.6	24.9	24.5	15–22
Essential n-3 Fatty Acids (%)	0.37	n/d[4]	n/d[4]	0.5
Essential n-6 Fatty Acids (%)	2.4	1.9	1.6	2
NDF (%)	21.1	n/d[4]	8.6	10–30
ADF (%)	12.4	14.4	14.7	5–15
Vitamin A (IU/g)	189[2]	176[2]	291[2]	8
Vitamin D (IU/g)[3]	3.3	1.5	1.0	2.5
Vitamin E (mg/kg)	250	220	192	50–100
Thiamin (mg/kg)	14.2	6.9	8.3	3
Riboflavin (mg/kg)	14.3	8.3	9.3	4
Pantothenic acid (mg/kg)	69.8	20.7	26.2	12
Niacin (mg/kg)	108	59.3	67.2	25
Pyridoxine (mg/kg)	17.6	8.2	10.2	4
Folacin (mg/kg)	13.9	2.6	7.0	4
Biotin (mg/kg)	0.39	0.16	0.11	0.11–0.2
Vitamin B_{12} (mg/kg)	0.06	0.02	0.01	0.01–0.03
Calcium (%)	1.2	1.0	0.96	0.5–0.8
Phosphorus (%)	0.66	0.66	0.60	0.4–0.6
Potassium (%)	1.2	1.5	2.3	0.4
Sodium (%)	0.31	0.31	0.28	0.2
Magnesium (%)	0.17	0.23	0.21	0.08
Iron (mg/kg)	301	143	136	100
Zinc (mg/kg)	154	101	80.5	20–100
Copper (mg/kg)	33.5	25.8	21.2	12–20
Iodine (mg/kg)	1.9	3.8	2.6	0.35
Selenium (mg/kg)	0.50	0.35	0.26	0.11–0.30

Nutrient	*C. angolensis* Institution I	*C. angolensis* Institution J: Male	*C. angolensis* Institution J: Female	*C. angolensis* Institution K:	Target Nutrients
Protein (%)	24.2	19.7	19.4	16.2	15–22
Essential n-3 Fatty Acids (%)	0.13	n/d[4]	n/d[4]	n/d[4]	0.5
Essential n-6 Fatty Acids (%)	2.0	0.95	0.87	0.79	2
NDF (%)	n/d[4]	16.7	17.6	17.4	10–30
ADF (%)	17.2	19.8	20.2	15.3	5–15
Vitamin A (IU/g)	87.0	61.7	56.1	309[2]	8
Vitamin D (IU/g)[3]	1.6	0.76	0.70	0.43	2.5
Vitamin E (mg/kg)	222	103	94.9	69.7	50–100
Thiamin (mg/kg)	6.0	3.0	2.7	3.8	3
Riboflavin (mg/kg)	7.2	3.5	3.2	4.9	4
Pantothenic acid (mg/kg)	19.8	10.6	9.7	13.2	12
Niacin (mg/kg)	53.2	25.7	23.5	32.7	25
Pyridoxine (mg/kg)	6.7	3.1	2.9	6.8	4
Folacin (mg/kg)	1.7	0.86	0.79	1.4	4
Biotin (mg/kg)	0.16	0.08	0.07	0.04	0.11–0.2
Vitamin B_{12} (mg/kg)	0.02	0.01	0.01	0.01	0.01–0.03
Calcium (%)	1.1	0.77	0.76	0.69	0.5–0.8
Phosphorus (%)	0.65	0.38	0.36	0.29	0.4–0.6
Potassium (%)	1.3	1.0	0.99	1.1	0.4
Sodium (%)	0.3	0.14	0.14	0.14	0.2
Magnesium (%)	0.20	0.14	0.13	0.12	0.08
Iron (mg/kg)	143	97.3	94	100	100
Zinc (mg/kg)	112	83.5	81.7	61.9	20–100
Copper (mg/kg)	27.5	16.1	15.3	12.7	12–20
Iodine (mg/kg)	4.1	1.95	1.79	1.1	0.35
Selenium (mg/kg)	0.35	0.16	0.15	0.11	0.11–0.30

[1]Target nutrient levels listed in Table 4.
[2]This value is quite high due to beta-carotene in the vegetables in the diet.
[3]Exposure to sunlight or UVB radiation unknown.
[4]n/d = not determined due to missing some nutrient data from diet ingredients.

Appendix K: Hand Rearing Documentation Example

Sample *Colobus guereza* Hand-rearing Protocol

Basic Hand-rearing Information:

- Each morning the baby should be weighed and its rectal body temperature obtained (Normal= 36.6–38.3º C [98–101º F]).
- Hand-rearing clipboard should go everywhere the infant goes and should have:
  - Hand-rearing logs, record every feeding (offered and consumption), weight, temp, defecation and urination.
  - Record behavior changes and milestones. Reactions to new situations, conspecific howdies, feedings through mesh, mouthing solid foods, etc.
  - Communication between caregivers, animal keepers, and vet staff is important. A place to leave notes for each other is very helpful.
  - Hand-rearing protocol, current guidelines.
- Bottles should be disinfected daily. Bottles can be washed in the dishwasher or a commercial bottle sterilizer for disinfection (some that use steam and a microwave are inexpensive).
- The nipple should be washed with soapy water and soaked in boiling water each morning for disinfection.
- The baby should be stimulated to urinate after each feeding with a soft moistened cloth or tissue until it is urinating and defecating on its own.

Milk Formula:

1. Boil 10 ounces of distilled water and add an herbal fruit-flavored tea bag; let steep for 5 minutes.
2. Mix 120 ml of tea water with 120 ml of evaporated milk.
3. Add 1 tsp of rice flour and stir gently.
   - *Do Not Shake Formula*. This will produce bubbles and give the baby gas.
   - Any changes in formula should be done very gradually as major formula changes seem to cause problems with most infants.

Feeding Schedule:

- To start with the baby will be fed 7 times daily, slowly eliminating feedings as it weans.
- Feeding times are as follows: 6 AM, 9 AM, Noon, 3 PM, 6 PM, 9 PM, Midnight.
- If the baby wakes up between midnight and 6 AM and is crying for food, notify veterinary staff. We may need to adjust the feeding schedule so that there is a shorter time span between feedings throughout the night.
- For infants less than 3 weeks of age, feed on demand.

Volume of Formula to Feed:

See Table A and Table B at the end of this document. These are guidelines and every infant is different.

Supplements:

1. Poly-Vi-Sol Liquid Vitamins: Give as directed by mouth every morning. You can mix the Poly-Vi-Sol with a small volume of formula to improve the taste if necessary.
2. "Poop" Shake: Once a week (Thursday evening) you will need to mix a "pea-sized" volume of adult Colobus stool with 10 ml of formula and administer orally with a syringe. This will help establish a normal GI flora in the baby's stomach and intestines.
3. Ultraviolet Light: The baby should be taken outside on warm days (above 15.5º C [60º F]) for UV light exposure (15–30 minutes on 3 or more days a week). This will help ensure that the baby will produce adequate levels of Vitamin D for bone strength. UV light does not penetrate normal glass.

Where and how to feed:

1. The goal is to teach the infant to move away from a warm body toward a bottle/mesh/keeper when it is offered, to facilitate an early introduction to conspecifics.
2. Attempt to feed the baby through a sky-kennel door or den mesh/bars as early as possible as often as possible.
   - Baby can be clinging to a caregiver and turn its head and lean body in order to drink from a bottle. As the baby puts a hand on the mesh to steady him/herself transition slowly (over many feedings)

so that the baby is eventually leaving your body to hang on bars/mesh, or sit on floor/shelf; your hand on his/her back may be comforting for a while as another transition.

3. Another step, when baby is pretty mobile: have the baby held by one person and encourage it to move to a second person at the mesh/bars with the bottle. This distance should start out small (2 feet) and increase as the baby becomes more confident.
4. An additional step may be closing a shift door between the caregiver and infant for the duration of the feeding.
5. Baby should spend as much time as possible seeing, hearing, and smelling colobus as possible; hand-rearing should happen in exhibits and holding areas, all areas where potential introductions will take place.

Additional introduction and surrogacy information:

At an AZA Institution three infants were hand-reared over several years and surrogates were introduced at an early age while the infants were still doing bottle feedings. At first zoo staff did overnight hand-rearing and had the baby with the surrogate during day; and then the baby came over for feedings and was separated every night to go home with a caregiver. This was not ideal but they adjusted fairly well to it. When overnight feedings were no longer necessary, staff left the infant with the surrogate 24/7 and fed through mesh or separated for feedings as needed.

Some surrogates allowed babies to approach zoo staff, and at other times the baby may keep running back to the surrogate and not drink enough. In this case a shift door may be shut long enough for the feeding to take place. When the shift door is opened back up staff may have to walk away and listen to hear the baby and surrogate reunite – the infant would vocalize and then do a specific vocalization as she was scooped up. At that point the animals can be shifted back into the exhibit.

Offering Solid Foods and Weaning Information:

- Colobus infants start experimenting with solids at a very young age.
- Starting at 4–6 weeks of age: offer thin-cut produce (1/2 x 1/2 in. in diameter, cut into 3-inch-long slivers), also extra chow and greens.
    - During hand-rearing just having these items lying around in the hay along with some toys and enrichment seems to work well.
    - After introduction to surrogate, place a lot of these items in locations the infant feels comfortable jumping off of mom or surrogate.
- Infant favorites are often white potato, banana, and greens. They also eat carrots, yams and leaf eater chow.
- Many infants wean at about 6 months.
- See Table C as an example to record data.

Table A. Colobus Infant Feeding Amounts* – Hand-rearing Information

Infant Weight (g)	10% BW, 7 feeds/day	15% BW, 7 feeds/day	10% BW, 6 feeds/day	15% BW, 6 feeds/day	10% BW, 5 feeds/day	15% BW, 5 feeds/day
500	7	11	8	13	10	15
550	8	12	9	14	11	17
600	9	13	10	15	12	18
650	9	14	11	16	13	20
700	10	15	12	18	14	21
750	11	16	13	19	15	23
800	11	17	13	20	16	24
850	12	18	14	21	17	26
900	13	19	15	23	18	27
950	14	20	16	24	19	29
1000	14	21	17	25	20	30
1100	16	24	18	28	22	33
1200	17	26	20	30	24	36
1300	19	28	22	33	26	39
1400	20	30	23	35	28	42
1500	21	32	25	38	30	45
1600	23	34	27	40	32	48
1700	24	36	28	43	34	51
1800	26	39	30	45	36	54
1900	27	41	32	48	38	57
2000	29	43	33	50	40	60
2100	30	45	35	53	42	63

*Amount per feeding (mls)

Table B. Primate Infant Feeding Chart – Max volume per feeding

Body Weight (grams)	Max. Volume of Formula (mL) per feeding
600	30
625	31
650	33
675	34
700	35
750	38
800	40
850	43
900	45
950	48
1000	50
1100	55
1200	60
1300	65
1400	70
1500	75
1600	80
1700	85
1800	90
1900	95
2000	100

Sample Infant Hand-rearing Chart **Sex/Species:**

Year: Date	Time	Init.	Offered	Consumed (%)	Stool	Urine	Heart rate	Resp. rate	Temp. (F)	Weight (pounds)	Girth (inches)	Attitude	Comments:

Infant Name: _________ ISIS #: _____ DOB: _______ Page #: ____

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Appendix M: Examples of Enrichment Items

Common enrichment items for colobus monkeys

- Apple bags
- Banana pancakes, leeks
- Beach toys
- Big bouncy balls
- Black mesh bags
- Black tubs
- Blankets
- Boomer balls
- Bucket lids
- Bungees
- Butcher paper
- Canvas bag
- Cardboard boxes
- Cargo nets
- Chalk drawings on ground
- Children's plastic rocking horse
- Coconuts
- Cracked Corn Cheerios
- Dry or cooked pasta
- Dry or cooked rice
- Egg trays
- Extracts
- Firehose
- Firehose bungee
- Food coloring
- Forage piles (shredded paper, bark chips, shavings, mulch, leaves, alfalfa, etc)
- Frisbees
- Garlic Mashed Potatoes
- Hammocks
- Hanging bowls
- Hay feeder
- Ice blocks with treats inside
- Ice cube trays
- Jolly balls
- Kids car
- Kids picnic table
- Kong® toys
- Long PVC or paper towel tubes with holes cut out and treats inside
- Milk bottles
- Milk crates
- Mirrors
- Mobiles
- Nuts
- Paper bags
- Peanuts
- Phone books
- Pinecones
- Pitchers
- Plastic baskets
- Plastic bowls
- Plastic coconuts

- Plastic Easter eggs
- Playskool toys
- Pots and pans
- PVC caps
- PVC pieces
- Rabbit water lixits in new locations
- Raisin Bran
- Rice crispies
- Ropes
- Sheets
- Smear boards
- Spices
- Spindle
- Stuffed animals
- Sunflower seeds
- Toy trucks
- Traffic cones
- TV
- Various plastic toys
- Wood Wool
- Wooden bridge
- Yuki pole ladder


Photos provided by Pilar Hicks

Appendix N: Sample Enrichment Calendar

Daily Enrichment/Contrafeed Schedule
Species: Angolan Colobus

Date	Contrafeed Item	Daily Enrichment	Jan.	Feb.
	(1/3 of a.m. diet inside these items)			
1	Frozen peas/veggies	Hanging bucket		
2	Yellow pages	Grocery bag		
3	Cereal boxes	Hollie roller balls		
4	Sunflower seeds	Emergency cone - inside only		
5	Dimple paper	Upside down milkcrate		
6	Cooked food item	Mealworm bag		
7	PVC cups	Hanging pitcher - inside only		
8	Cardboard tubes	Sandwich feeder		
9	Mixed parrot seeds	Large trash can - inside only		
10	Spices/extracts	Hanging bucket		
11	Dimple paper	Grocery bag		
12	Mixed nuts	Hollie roller balls - inside only		
13	Hortzugels	Boxes with shredded paper		
14	Register tape	Upside down milkcrate		
15	Jello balls	Mealworm bag		
16	Frozen berries	Hanging pitcher - inside only		
17	Radio	Sandwich feeder		
18	Dried fruit bits	Large trash can - inside only		
19	Large box to lay inside of	Hanging bucket		
20	Oatmeal	Grocery bag		
21	Peach - fresh or frozen	Hollie roller balls		
22	Cereal boxes	Emergency cone - inside only		
23	Pinecones with seeds	Upside down milkcrate		
24	Teacher paper	Mealworm bag		
25	Orange	Hanging pitcher - inside only		
26	Hanging jolly ball	Sandwich feeder		
27	Cardboard tubes	Large trash can - inside only		
28	Iceberg lettuce	Hanging bucket		
29	Shredded paper in tubs	Grocery bag		
30	Raisins	Hollie roller balls		
31	Mixed nuts	Hanging pitcher - inside only		

Shaded Areas are items that need ordered or prepared ahead of time