



Zoo Animal Nutrition *upgrading our aims*



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EAZA Albufeira 2022



**University of
Zurich**^{UZH}



Clinic
of Zoo Animals, Exotic Pets and Wildlife



Semantics

words matter



Don't believe names, think for yourself



Don't believe names, think for yourself

What is an 'omnivore'?



Don't believe names, think for yourself

What is an 'omnivore'?

Mammal Review



Mammal Review ISSN 0305-1838

REVIEW



A review of wild boar *Sus scrofa* diet and factors affecting food selection in native and introduced ranges

Sebastián A. BALLARI* *Departamento de Diversidad Biológica y Ecología, Universidad Nacional de Córdoba-CONICET, Avenida Vélez Sársfield 299, 3er. Piso, Córdoba 5000, Argentina.*

The wild boar *Sus scrofa* is an omnivore



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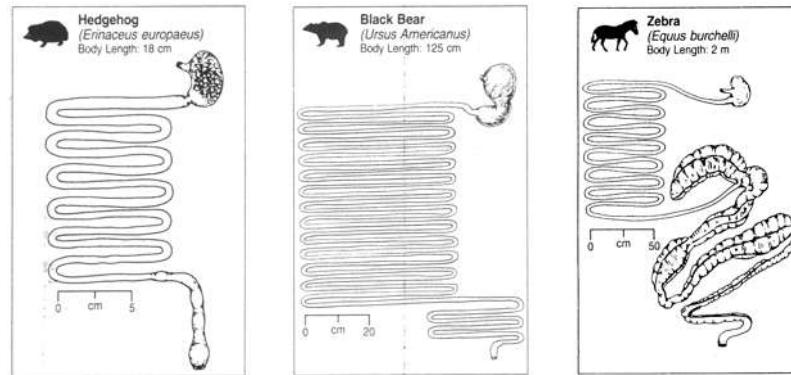
The wild boar *Sus scrofa* is an omnivore

Wild boar diet is dominated by plant material (~90%)



Don't believe names, think for yourself

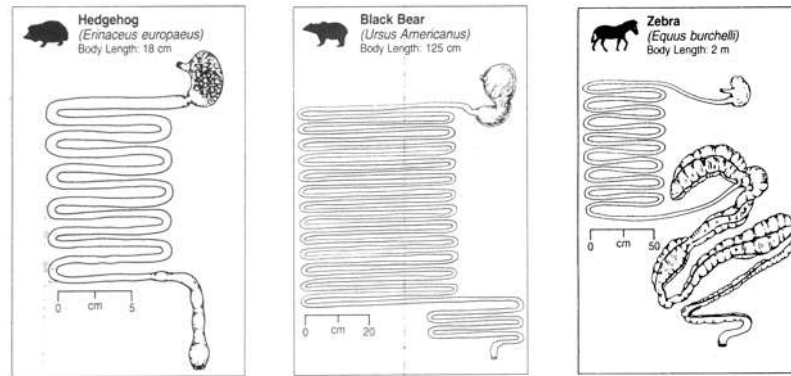
Sometimes we need generalisations
- for large-scale comparative studies





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Sometimes we need generalisations
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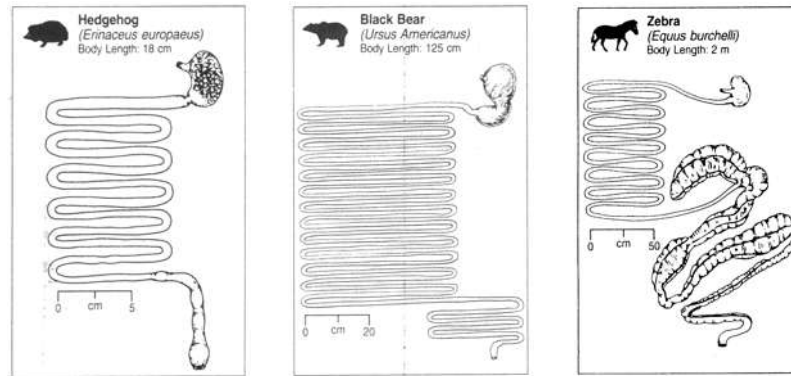


- but not for keeping a species over many years



Don't believe names, think for yourself

Sometimes we need generalisations
- for large-scale comparative studies



- but not for keeping a species over many years



*if you dedicate yourself to
the husbandry of a species,
you **MUST** be ready to read
up on its specialities*



Feeding has implications:
why do we feed ...
... and what happens when we feed



We feed zoo animals and we ...

meet energy requirements



We feed zoo animals and we ...

meet energy requirements



(**any food** that is eaten)
(enough)



We feed zoo animals and we ...

meet energy requirements



(**any food** that is eaten)
(enough)



imminent survival



We feed zoo animals and we ...

meet energy requirements



(**any food** that is eaten)
(enough)



imminent survival

meet nutrient requirements



We feed zoo animals and we ...

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(**any food** that is eaten)
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imminent survival

meet nutrient requirements



(**any food** that is eaten)
(**properly supplemented**)
(enough)



We feed zoo animals and we ...

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(**any food** that is eaten)
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imminent survival

meet nutrient requirements /
avoid toxicity



(**any food** that is eaten)
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We feed zoo animals and we ...

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imminent survival

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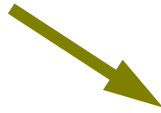


imminent health



We feed zoo animals and we ...

meet energy requirements



meet nutrient requirements /
avoid toxicity



(**any food** that is eaten)
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(enough)



imminent survival

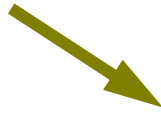


imminent health



We feed zoo animals and we ...

meet energy requirements



meet nutrient requirements /
avoid toxicity



meet physiological
requirements

(**any food** that is eaten)
(**properly supplemented**)
(enough)



imminent survival

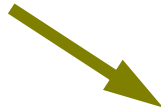


imminent health



We feed zoo animals and we ...

meet energy requirements



meet nutrient requirements /
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meet physiological
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(**any food** that is eaten)
(**properly supplemented**)
(enough)

(**appropriate amount**)
(**properly supplemented**)



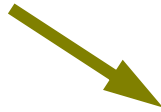
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(**properly supplemented**)
(enough)

(**species-appropriate food**)
(**appropriate amount**)
(**properly supplemented**)



imminent survival

imminent health



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imminent survival



imminent health



long-term
physical health

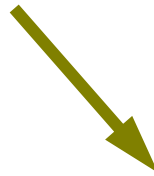


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meet nutrient requirements /
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(appropriate amount)
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imminent survival

imminent health

long-term
physical health



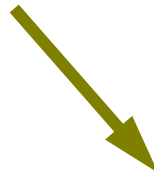
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meet physiological
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influence behaviour /
meet psychological
requirements



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imminent survival

imminent health

long-term
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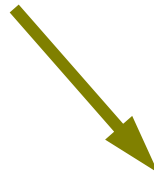
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imminent survival

imminent health

long-term
physical health



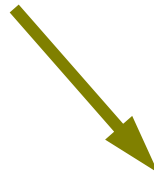
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(appropriate amount)
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(properly presented)



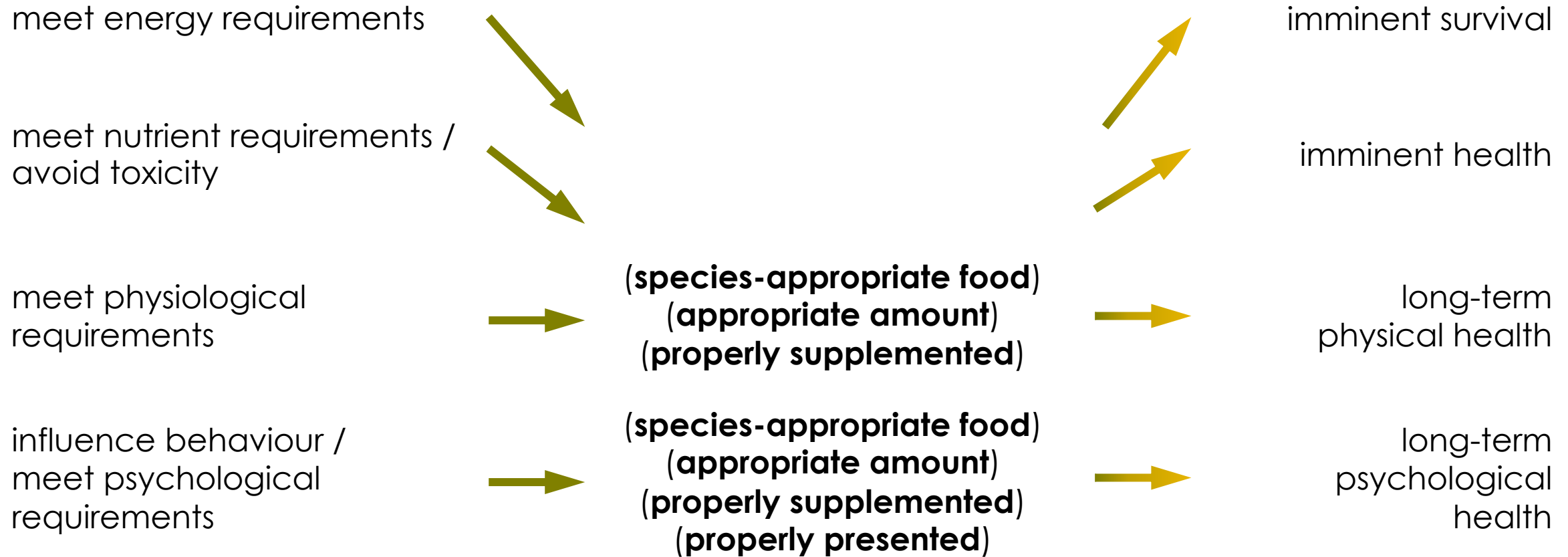
imminent survival

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imminent survival

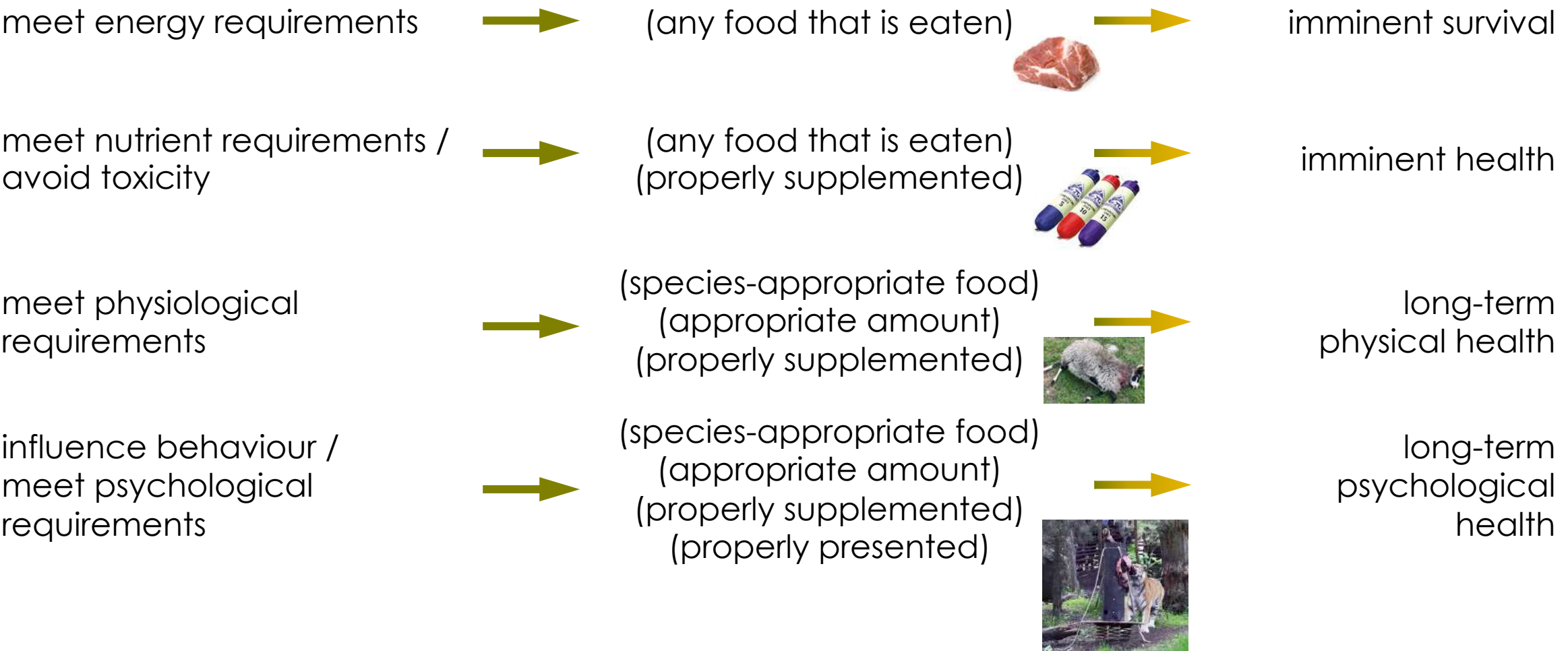
imminent health

long-term
physical health

long-term
psychological
health

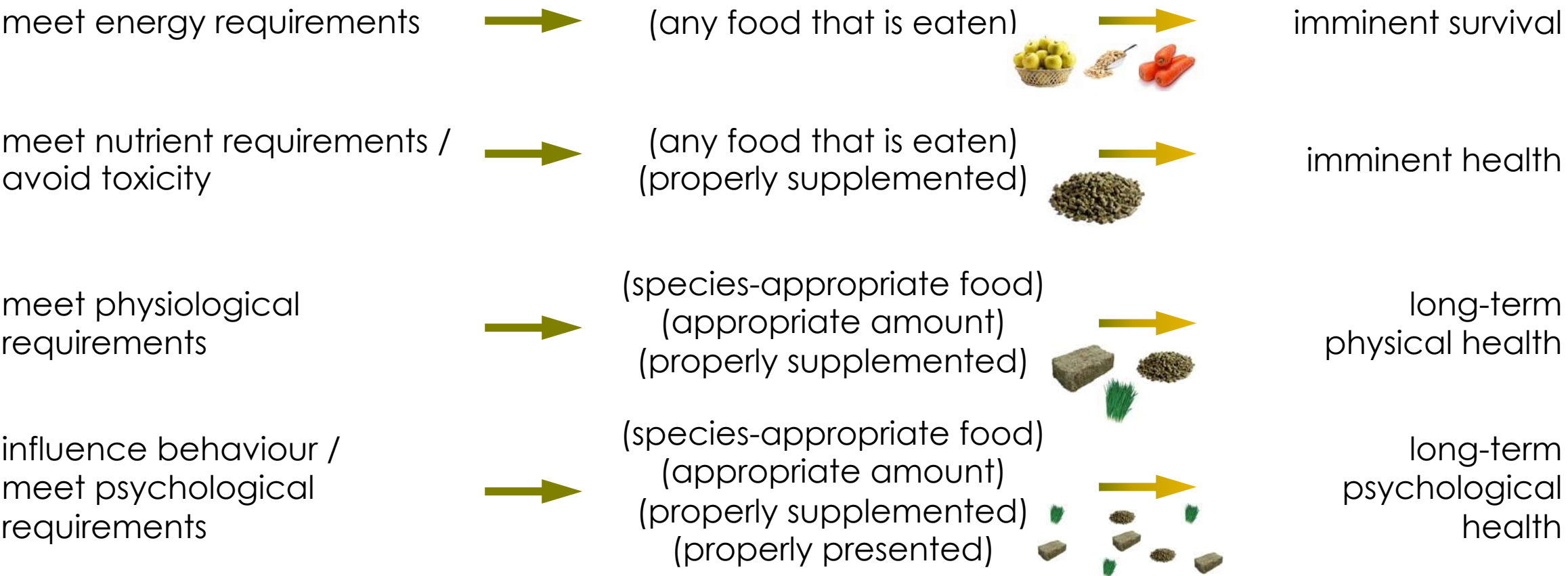


We feed zoo animals and we ...





We feed zoo animals and we ...





*Superfast
zoo animal nutrition
history*



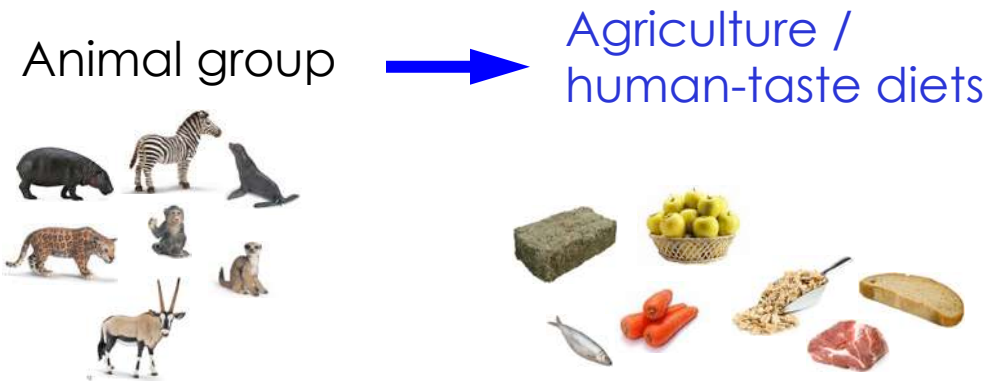
The basic feeding approach

Animal group





The basic feeding approach





The basic feeding approach





The basic feeding approach



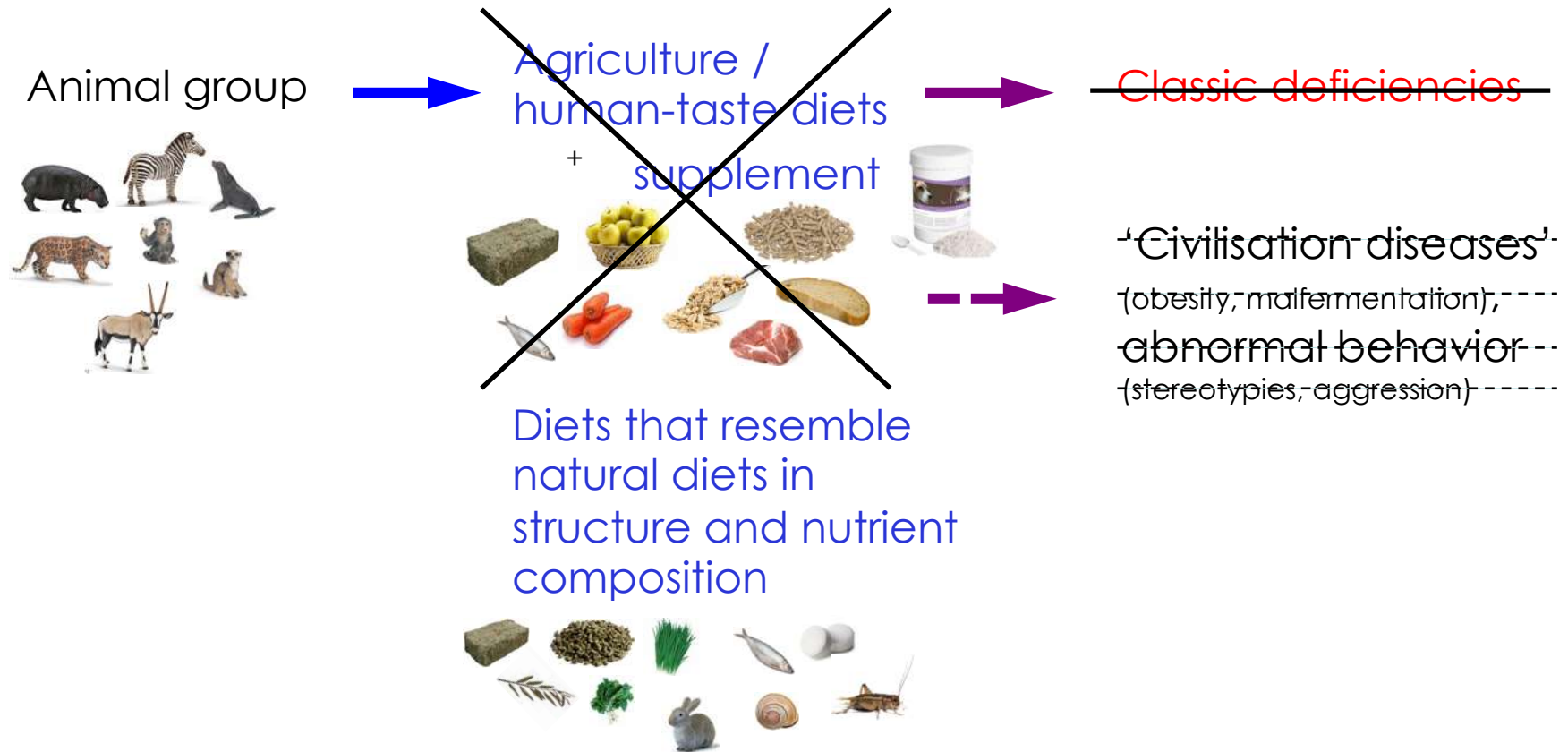


The basic feeding approach



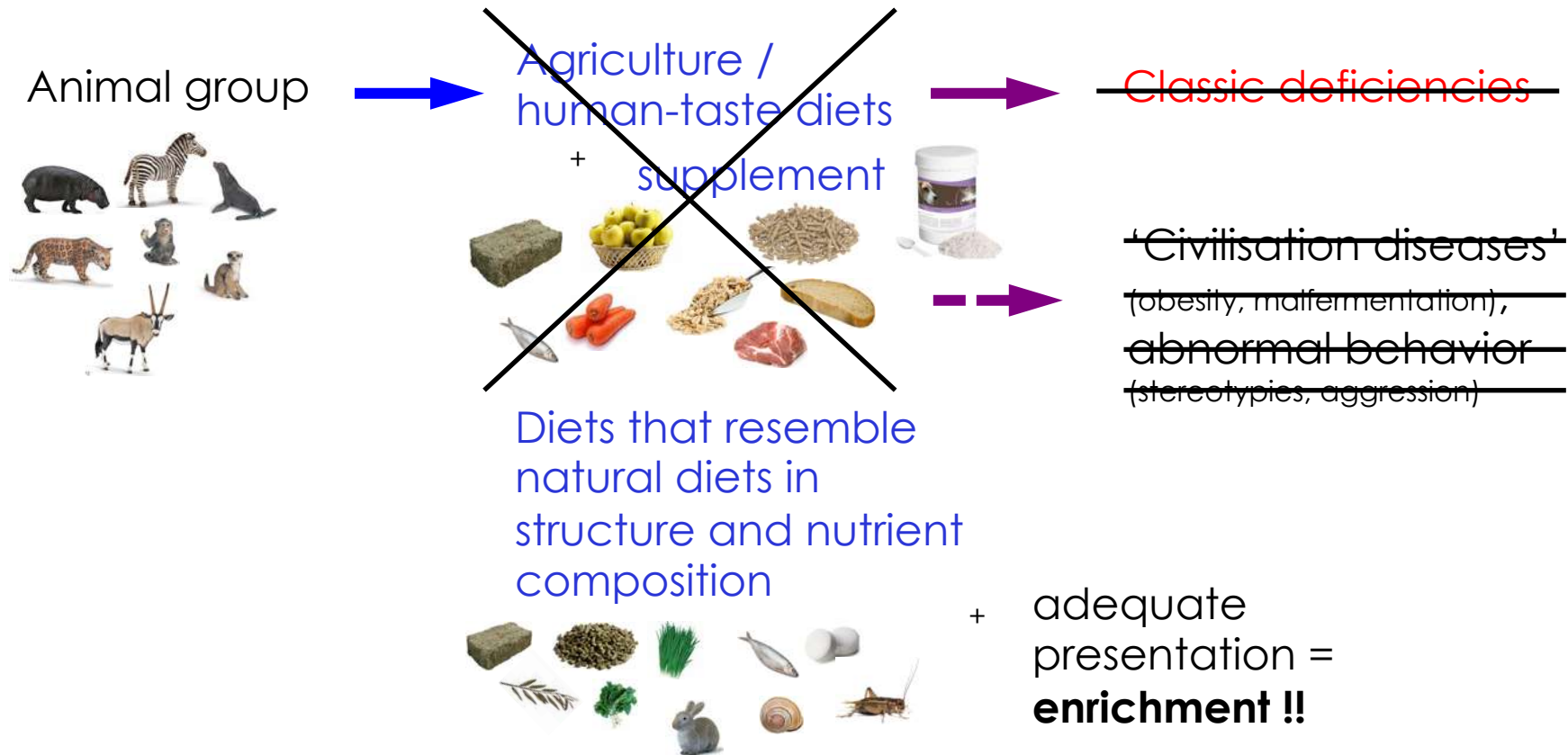


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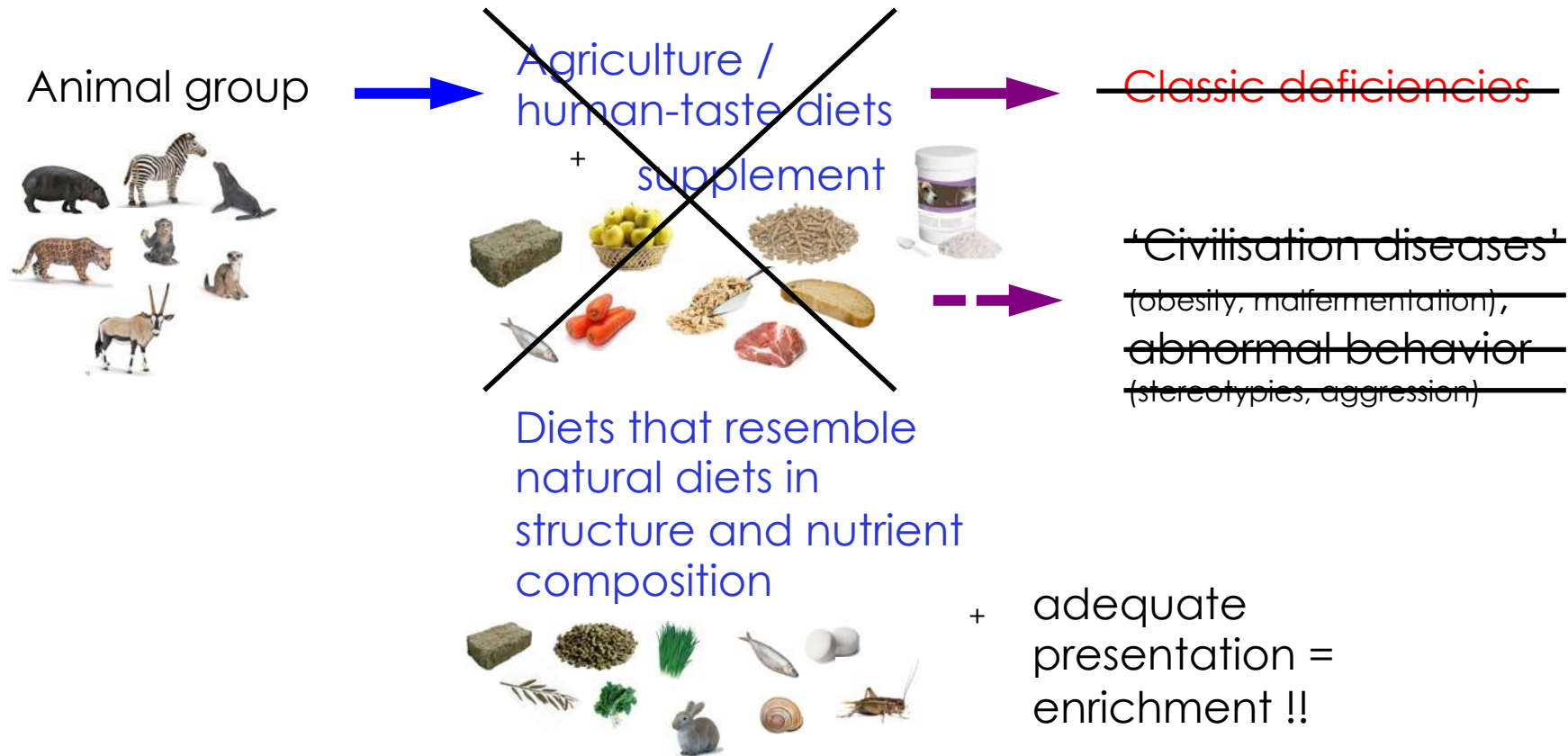


The basic feeding approach





The basic feeding approach



Enrichment should ***not*** be the ***addition*** of something (like human-taste items) but ***the presentation of the diet on a challenging and meaningful way !***



*What do we need to achieve our
aims ?*



We feed zoo animals and we need ...

to meet energy requirements



We feed zoo animals and we need ...

to meet energy requirements → info on what others did



We feed zoo animals and we need ...

to meet energy requirements



info on what others did



old school



We feed zoo animals and we need ...

to meet energy requirements



info on what others did



old school

to meet nutrient requirements /
avoid toxicity



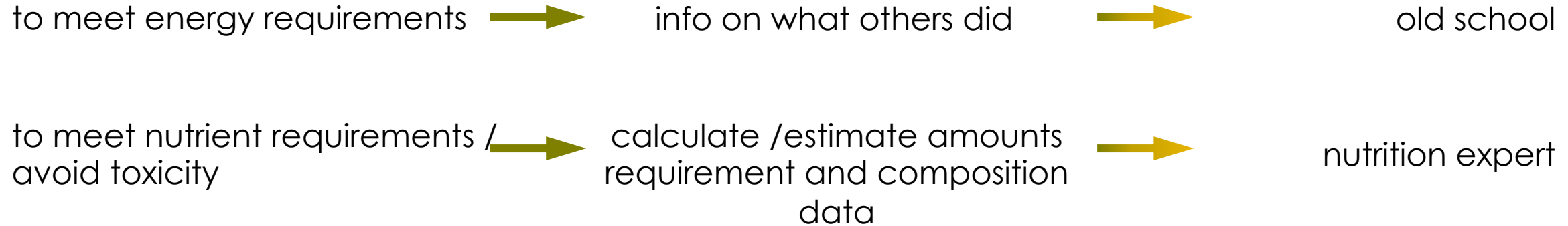
We feed zoo animals and we need ...

to meet energy requirements → info on what others did → old school

to meet nutrient requirements /
avoid toxicity → calculate /estimate amounts
requirement and composition
data



We feed zoo animals and we need ...



Nutrient	Quality Prime ^a Alfalfa	Quality 1 ^a Alfalfa	Quality 3-4 ^{ab} Grass	Low Fiber Herbivore Pellet
Moisture, %	9.0-10.7	8.2-9.6	7.4-10.0	10.6
Crude protein, %	18.0-21.8	15.9-17.0	9.8-11.2	17.4
Neutral detergent fiber, %	29.1-36.5	37.2-42.8	51.0-67.4	29.3
Acid detergent fiber, %	24.6-27.3	25.3-33.5	31.2-36.3	17.3
Vitamin A, IU/g ^c	*	*	*	5
Vitamin D, IU/g ^c	*	*	*	1.2
Vitamin E, IU/kg ^c	*	*	*	400
Calcium, %	1.13-1.33	1.2-1.5	0.41-0.67	0.88
Phosphorus, %	0.26-0.27	0.26-0.27	0.19-0.38	0.64
Sodium, %	0.057-0.53	0.014-0.08	0.003-0.03	0.4
Magnesium, %	0.27-0.28	0.24-0.31	0.15-0.21	0.29
Potassium, %	2.1-2.2	1.4-1.7	1.9-2.4	1.5
Copper, mg/kg	7-12	5-9	5-11	23
Iron, mg/kg	166-240	106-138	69-85	394
Manganese, mg/kg	28-38	25-33	25-36	120
Zinc, mg/kg	25-29	17-20	15-31	136

^a These are classifications of the Hay Market Task Force of the American Forage and Grassland Council (see NAG Fact Sheet 001).

^b Grasses include timothy, coastal bermudagrass, and sudan.

^c The vitamin levels in hays are variable; values in pellets were specified concentrations.

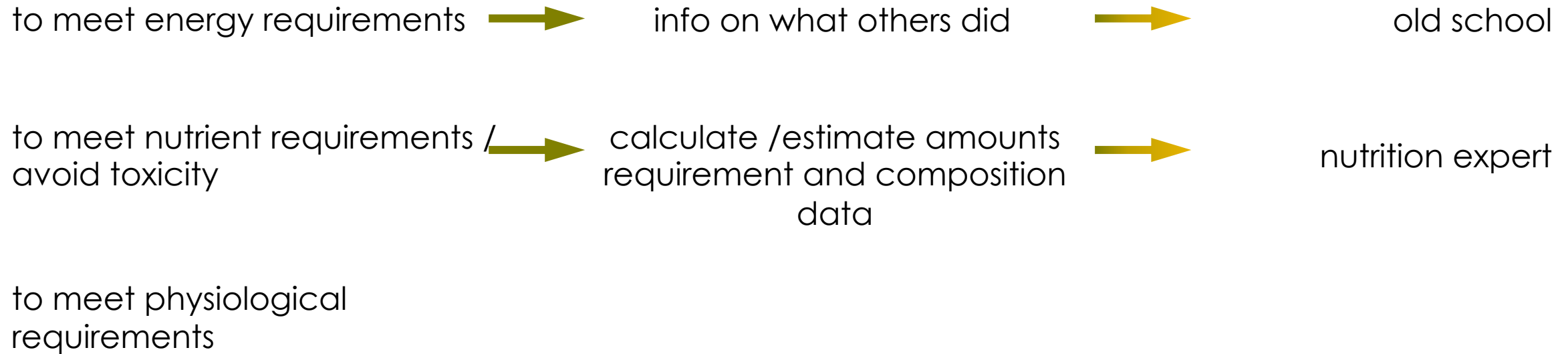
* Value not determined.

Body Size	Concentrate Selectors	Medium Large Browsers	Medium Intermediate Browsers	Medium Intermediate Grazers	Medium Large Grazers	
Ruminant/Nonruminant	Ruminant	Ruminant	Nonruminant	Ruminant	Nonruminant	
Species	Bongo, Kipspringer	Giraffe, Kudu, Sitatunga, Grevy's, Reindeer, Okapi	Lepus, Bb. Rhino, Pigmy Hippo	Goats, Ibex, Eland, Springbok, Dama Gazelle	Sheep, Addax, Pere David's Deer	Waterbuck, Topi, Llama, Camel, Cape Buffalo, Banteng
Suggested Diet, % ^a	50-75P 25-50AHP	30-40P 60-70AHP	30P 40-50AHPQ1 20-30GH	30-40P 60-70AHPQ1	30-40P 40-50AHPQ1 30GH	30-40P 60-70GH
Intake as %DMI	3-4%	2%	1.5%	2-3.5%	2-3.5%	1.5-2.5%
Nutrient	Nutrient Profiles					
Protein, %	15-18	15-19	13-18	15-19	14-17	15-13
NDF, %	23-33	25-34	31-37	25-36	30-33	37-49
Vitamin A, IU/g	2.5-3.8	1.5-2.2	1.5	1.5-2.0	1.5-2.0	1.2-2.0
Vitamin D, IU/g	0.6-0.9	0.4-0.5	0.4	0.4-0.5	0.4-0.5	0.3-0.5
Vitamin E, IU/kg	200-300	120-178	120	120-160	120-160	100-120
Thiamin, mg/kg	-	-	2.4	-	-	2.0-3.2
Riboflavin, mg/kg	-	-	2.7	-	-	2.2-3.6
Calcium, %	0.65-0.87	0.70-0.97	0.80-0.90	0.90-1.10	0.90-1.00	0.56-0.63
Phosphorus, %	0.44-0.54	0.36-0.40	0.35-0.40	0.36-0.41	0.35-0.40	0.30-0.38
Magnesium, %	0.18-0.22	0.16-0.24	0.20-0.22	0.23-0.24	0.21-0.22	0.16-0.19
Potassium, %	1.3-1.5	1.6-1.8	1.5-1.7	1.2-1.8	1.3-1.7	1.4-1.8
Sodium, %	0.16-0.39	0.10-0.44	0.09-0.36	0.10-0.44	0.09-0.36	0.07-0.12
Iron, mg/kg	107-125	126-139	82-126	98-139	93-126	75-84
Zinc, mg/kg	77-106	54-68	52-58	51-67	51-68	50-64
Copper, mg/kg	13-16	10-12	10-12	11-13	11-12	9-14
Manganese, mg/kg	57-75	54-57	45-51	44-57	43-56	43-55
Selenium, mg/kg	0.20-0.30	0.12-0.18	0.12	0.12-0.16	0.12-0.16	0.10-0.16
Iodine, mg/kg	0.5-0.8	0.3-0.4	0.3	0.3-0.4	0.3-0.4	0.2-0.4

^a P = Low Fiber Pellets; AHP = alfalfa hay quality prime; AHPQ1 = alfalfa hay quality grade 1; GH = grass hay.



We feed zoo animals and we need ...



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Acid detergent fiber, %	24.6-27.3	25.3-33.5	31.2-36.3	17.3
Vitamin A, IU/g ^c	*	*	*	5
Vitamin D, IU/g ^c	*	*	*	1.2
Vitamin E, IU/kg ^c	*	*	*	400
Calcium, %	1.13-1.33	1.2-1.5	0.41-0.67	0.88
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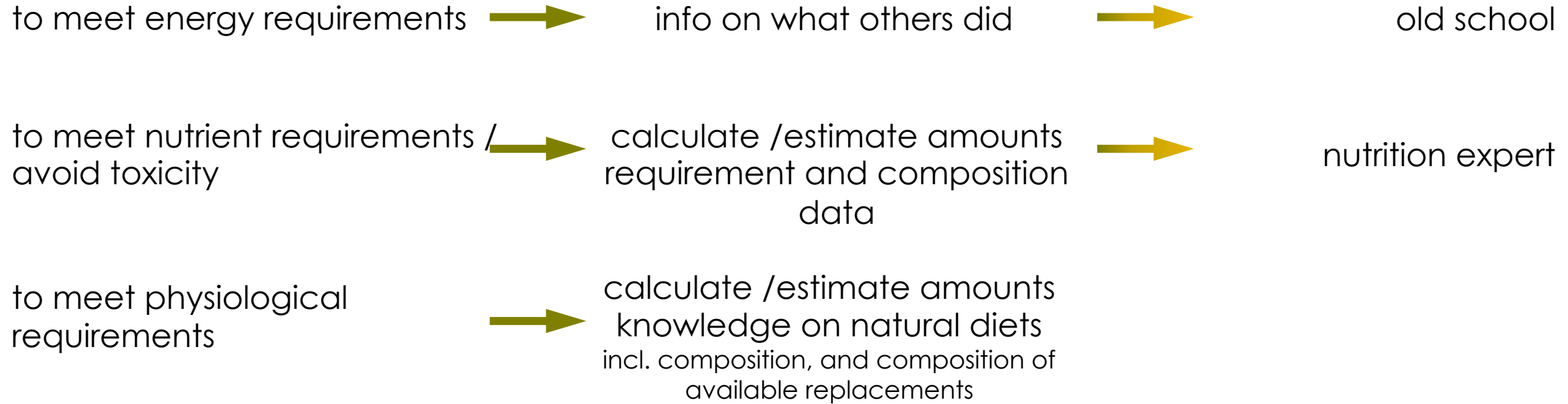
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Ruminant/Nonruminant	Ruminant	Ruminant	Nonruminant	Ruminant	Ruminant	Nonruminant	Nonruminant	Nonruminant
Species	Bongo, Klipspringer	Giraffe, Kudu, Sitatunga, Grevy's, Reindeer, Okapi	Tapir, Bk Rhinos, Pigmy Hippo	Goats, Ibex, Eland, Springbok, Dama Gazelle	Sheep, Addax, Pere David's Deer	Waterbuck, Topi, Llama, Camel, Cape Buffalo, Hartebeest	Zebu, White Rhinos	Nolo Hippo
Suggested Diet, % ^a	50-75P 25-50AHP	30-40P 60-70AHP	30P 40-50AHPQ1 20-30GH	30-40P 60-70AHPQ1	30-40P 40-50AHPQ1 30GH	30-40P 60-70GH	25-40P 60-75KH	25-30P 20AHPQ1 50-55KH
Intake as %DMI	3-4%	2%	1.5%	2-3.5%	2-3.5%	1.5-2.5%	1.5-5.0%	1.5%
Nutrient	Nutrient Profiles							
Protein, %	15-18	15-19	13-18	15-19	14-17	13-13	12-14	12-15
NDF, %	23-33	25-34	31-37	25-36	30-33	37-49	37-51	36-44
Vitamin A, IU/g	2.5-3.8	1.5-2.2	1.5	1.5-2.0	1.5-2.0	1.5-2.0	1.2-2.0	1.2-1.5
Vitamin D, IU/g	0.6-0.9	0.4-0.5	0.4	0.4-0.5	0.4-0.5	0.4-0.5	0.3-0.5	0.3-0.4
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Thiamin, mg/kg	-	-	2.4	-	-	-	2.0-3.2	2.0-2.4
Riboflavin, mg/kg	-	-	2.7	-	-	-	2.2-3.6	2.2-2.7
Calcium, %	0.65-0.87	0.70-0.97	0.80-0.90	0.90-1.10	0.80-1.00	0.55-0.63	0.55-0.63	0.55-0.63
Phosphorus, %	0.44-0.54	0.36-0.40	0.35-0.40	0.36-0.41	0.35-0.40	0.30-0.38	0.30-0.38	0.31-0.33
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Potassium, %	1.3-1.5	1.6-1.8	1.5-1.7	1.2-1.8	1.3-1.7	1.4-1.8	1.4-1.8	1.6-1.7
Sodium, %	0.16-0.39	0.10-0.44	0.09-0.36	0.10-0.44	0.09-0.36	0.07-0.12	0.07-0.12	0.08-0.20
Iron, mg/kg	107-125	126-139	82-126	98-139	93-126	75-84	75-84	77-99
Zinc, mg/kg	77-106	54-68	52-58	51-67	51-68	44-71	44-71	45-60
Copper, mg/kg	13-16	10-12	10-12	11-13	11-12	9-14	9-14	48-50
Manganese, mg/kg	57-75	54-57	45-51	44-57	43-56	43-55	40-55	41-50
Selenium, mg/kg	0.20-0.30	0.12-0.18	0.12	0.12-0.16	0.12-0.16	0.10-0.16	0.10-0.16	0.10-0.12
Iodine, mg/kg	0.5-0.8	0.3-0.4	0.3	0.3-0.4	0.3-0.4	0.3-0.4	0.2-0.4	0.2-0.3

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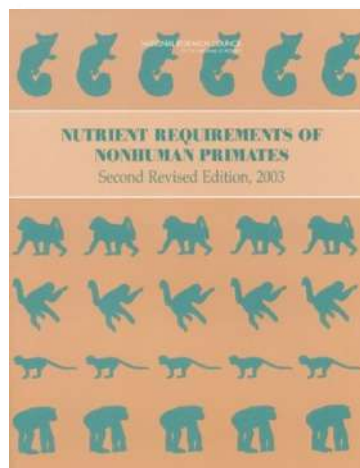
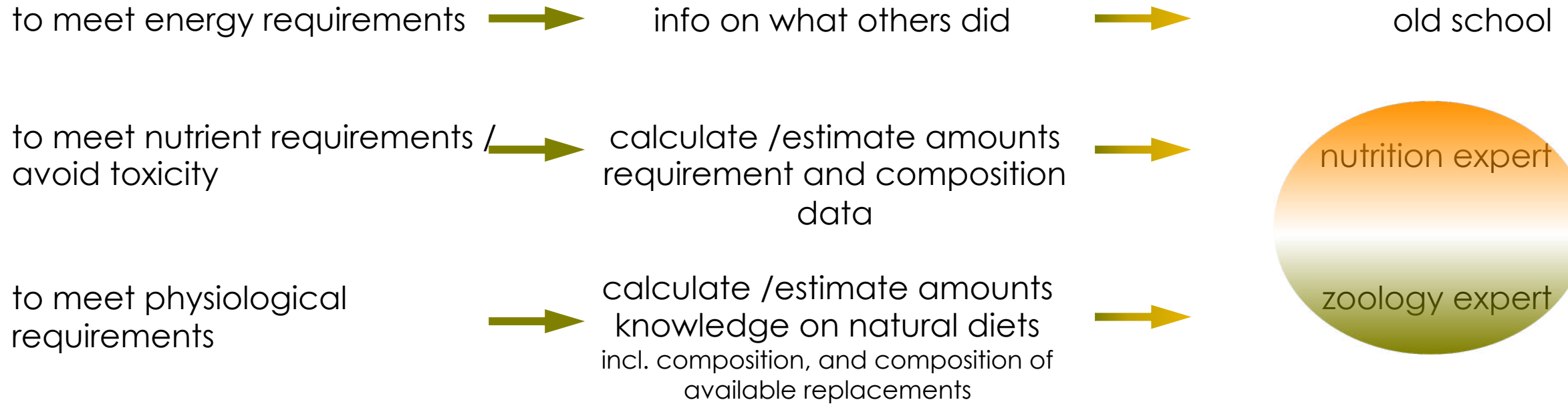
* Value not determined.

Body Size	Concentrate Selectors	Medium Large Browsers		Medium Intermediate Browsers	Medium Intermediate Grazers	Medium Large Grazers		
Ruminant/Nonruminant	Ruminant	Ruminant	Nonruminant	Ruminant	Ruminant	Ruminant	Nonruminant	Nonruminant
Species	Bongo, Kipspringer	Giraffe, Kudu, Sitatunga, Grevy's, Reindeer, Okapi	Tapir, Bb Rhinos, Pigmy Hippo	Goats, Ibex, Eland, Springbok, Dama Gazelle	Sheep, Addax, Pere David's Deer	Waterbuck, Topi, Llama, Camel, Cape Buffalo, Hartebeest	Zebu, White Rhinos	Nolo Herbivores
Suggested Diet, % ^a	50-75P 25-50AHP	30-40P 60-70AHP	30P 40-50AHPQ1 20-30GH	30-40P 60-70AHPQ1	30-40P 40-50AHPQ1 30GH	30-40P 60-70GH	25-40P 60-75GH	25-30P 20AHPQ1 50-55GH
Intake as %DMI	3-4%	2%	1.5%	2-3.5%	2-3.5%	1.5-2.5%	1.5-5.0%	1.5%
Nutrient	Nutrient Profiles							
Protein, %	15-18	15-19	13-18	15-19	14-17	13-13	12-14	12-15
NDF, %	23-33	25-34	31-37	25-36	30-33	37-49	37-51	36-44
Vitamin A, IU/g	2.5-3.8	1.5-2.2	1.5	1.5-2.0	1.5-2.0	1.5-2.0	1.2-2.0	1.2-1.5
Vitamin D, IU/g	0.6-0.9	0.4-0.5	0.4	0.4-0.5	0.4-0.5	0.4-0.5	0.3-0.5	0.3-0.4
Vitamin E, IU/kg	200-300	120-178	120	120-160	120-160	120-160	100-120	100-120
Thiamin, mg/kg	-	-	2.4	-	-	-	2.0-3.2	2.0-2.4
Riboflavin, mg/kg	-	-	2.7	-	-	-	2.2-3.6	2.2-2.7
Calcium, %	0.65-0.87	0.70-0.97	0.80-0.90	0.90-1.10	0.90-1.00	0.55-0.63	0.55-0.63	0.55-0.63
Phosphorus, %	0.44-0.54	0.36-0.40	0.35-0.40	0.36-0.41	0.35-0.40	0.30-0.38	0.30-0.38	0.31-0.33
Magnesium, %	0.18-0.22	0.16-0.24	0.20-0.22	0.22-0.24	0.21-0.22	0.16-0.19	0.16-0.19	0.16-0.20
Potassium, %	1.3-1.5	1.6-1.8	1.5-1.7	1.2-1.8	1.3-1.7	1.4-1.8	1.4-1.8	1.6-1.7
Sodium, %	0.16-0.39	0.10-0.44	0.09-0.36	0.10-0.44	0.09-0.36	0.07-0.12	0.07-0.12	0.08-0.20
Iron, mg/kg	107-125	126-139	82-126	98-139	93-126	75-84	75-84	77-99
Zinc, mg/kg	77-106	54-68	52-58	51-67	51-68	44-71	44-71	45-60
Copper, mg/kg	13-16	10-12	10-12	11-13	11-12	9-14	9-14	48-61
Manganese, mg/kg	57-75	54-57	45-51	44-57	43-56	43-55	40-55	41-50
Selenium, mg/kg	0.20-0.30	0.12-0.18	0.12	0.12-0.16	0.12-0.16	0.10-0.16	0.10-0.16	0.10-0.12
Iodine, mg/kg	0.5-0.8	0.3-0.4	0.3	0.3-0.4	0.3-0.4	0.3-0.4	0.2-0.4	0.2-0.3

^a P = Low Fiber Pellets; AHP = alfalfa hay quality prime; AHPQ1 = alfalfa hay quality grade 1; GH = grass hay.



We feed zoo animals and we need ...



Nutrient	Quality Prime ^a Alfalfa	Quality 1 ^a Alfalfa	Quality 3-4 ^{ab} Grass	Low Fiber Herbivore Pellet
Moisture, %	9.0-10.7	8.2-9.6	7.4-10.0	10.6
Crude protein, %	18.0-21.8	15.9-17.0	9.8-11.2	17.4
Neutral detergent fiber, %	29.1-36.5	37.2-42.8	51.0-67.4	29.3
Acid detergent fiber, %	24.6-27.3	25.3-33.5	31.2-36.3	17.3
Vitamin A, IU/g	*	*	*	5
Vitamin D, IU/g	*	*	*	1.2
Vitamin E, IU/kg	*	*	*	400
Calcium, %	1.13-1.33	1.2-1.5	0.41-0.67	0.88
Phosphorus, %	0.26-0.27	0.26-0.27	0.19-0.38	0.64
Sodium, %	0.057-0.53	0.014-0.08	0.003-0.03	0.4
Magnesium, %	0.27-0.28	0.24-0.31	0.15-0.21	0.29
Potassium, %	2.1-2.2	1.4-1.7	1.9-2.4	1.5
Copper, mg/kg	7-12	5-9	5-11	23
Iron, mg/kg	166-240	106-138	69-85	394
Manganese, mg/kg	28-38	25-33	25-36	120
Zinc, mg/kg	25-29	17-20	15-31	136

^a These are classifications of the Hay Market Task Force of the American Forage and Grassland Council (see NAG Fact Sheet 001).

^b Grasses include timothy, coastal bermudagrass, and sudan.

^c The vitamin levels in hays are variable; values in pellets were specified concentrations.

* Value not determined.

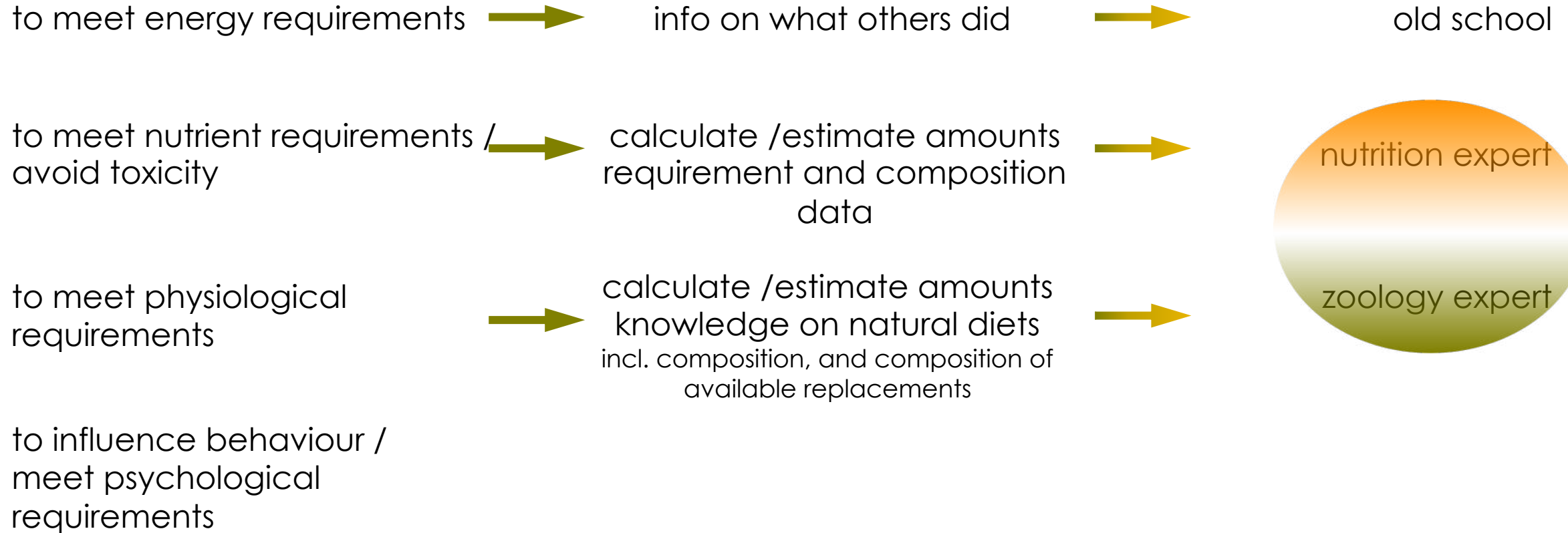
Body Size	Concentrate Selectors	Medium Large Browsers	Medium Intermediate Browsers	Medium Intermediate Grazers	Medium Large Grazers			
Ruminant/Nonruminant Species	Ruminant Bongo, Klipspringer	Ruminant Giraffe, Kudu, Sitatunga, Grevy's, Rondek, Okapi	Nonruminant Tapir, Blk Rhino, Pigmy Hippo	Ruminant Goats, Ibex, Eland, Springbok, Dama Gazelle	Ruminant Sheep, Addax, Pere David's Deer	Ruminant Waterbuck, Topi, Llama, Camel, Cape Buffalo, Banteng	Nonruminant Zebra, White Rhino	Nonruminant Nilg Hippo
Suggested Diet, % ^a	50-75P 25-50AHP	30-40P 60-70AHP	30P 40-50AHP 20-30GH	30-40P 60-70AHP	30-40P 40-50AHP 30GH	30-40P 60-70GH	25-40P 60-75GH	25-30P 20AHP 50-55GH
Intake as %DMI	3-4%	2%	1.5%	2-3.5%	2-3.5%	1.5-2.5%	1.5-3.0%	1.5%
Nutrient	Nutrient Profiles							
Protein, %	15-18	15-19	13-18	15-19	14-17	12-13	13-14	12-15
NDF, %	23-33	25-34	31-37	25-36	30-33	37-49	37-51	38-44
Vitamin A, IU/g	2.5-3.8	1.5-2.2	1.5	1.5-2.0	1.5-2.0	1.5-2.0	1.2-2.0	1.2-1.5
Vitamin D, IU/g	0.6-0.9	0.4-0.5	0.4	0.4-0.5	0.4-0.5	0.4-0.5	0.3-0.5	0.3-0.4
Vitamin E, IU/kg	200-300	120-178	120	120-160	120-160	120-160	100-120	100-120
Thiamin, mg/kg	-	-	2.4	-	-	-	2.0-3.2	2.0-2.4
Riboflavin, mg/kg	-	-	2.7	-	-	-	2.2-3.6	2.2-2.7
Calcium, %	0.65-0.87	0.70-0.97	0.80-0.90	0.90-1.10	0.90-1.00	0.56-0.63	0.55-0.63	0.68-0.72
Phosphorus, %	0.44-0.54	0.36-0.40	0.35-0.40	0.36-0.41	0.35-0.40	0.32-0.38	0.30-0.38	0.31-0.35
Magnesium, %	0.18-0.22	0.16-0.24	0.20-0.22	0.22-0.24	0.21-0.22	0.16-0.19	0.16-0.19	0.16-0.20
Potassium, %	1.3-1.5	1.6-1.8	1.5-1.7	1.2-1.8	1.3-1.7	1.4-1.8	1.4-1.8	1.6-1.7
Sodium, %	0.16-0.39	0.10-0.44	0.09-0.36	0.10-0.44	0.09-0.36	0.09-0.12	0.07-0.12	0.08-0.20
Iron, mg/kg	107-125	126-139	82-126	98-139	93-126	75-84	73-84	77-99
Zinc, mg/kg	77-106	54-68	52-58	51-67	51-68	50-64	44-71	45-60
Copper, mg/kg	13-16	10-12	10-12	11-13	11-12	9-14	8-14	9-12
Manganese, mg/kg	57-75	54-57	45-51	44-57	43-56	43-55	40-55	41-50
Selenium, mg/kg	0.20-0.30	0.12-0.18	0.12	0.12-0.16	0.12-0.16	0.10-0.16	0.10-0.16	0.10-0.12
Iodine, mg/kg	0.5-0.8	0.3-0.4	0.3	0.3-0.4	0.3-0.4	0.3-0.4	0.2-0.4	0.2-0.3

^aP = Low Fiber Pellets; AHP = alfalfa hay quality prime; AHP1 = alfalfa hay quality grade 1; GH = grass hay.



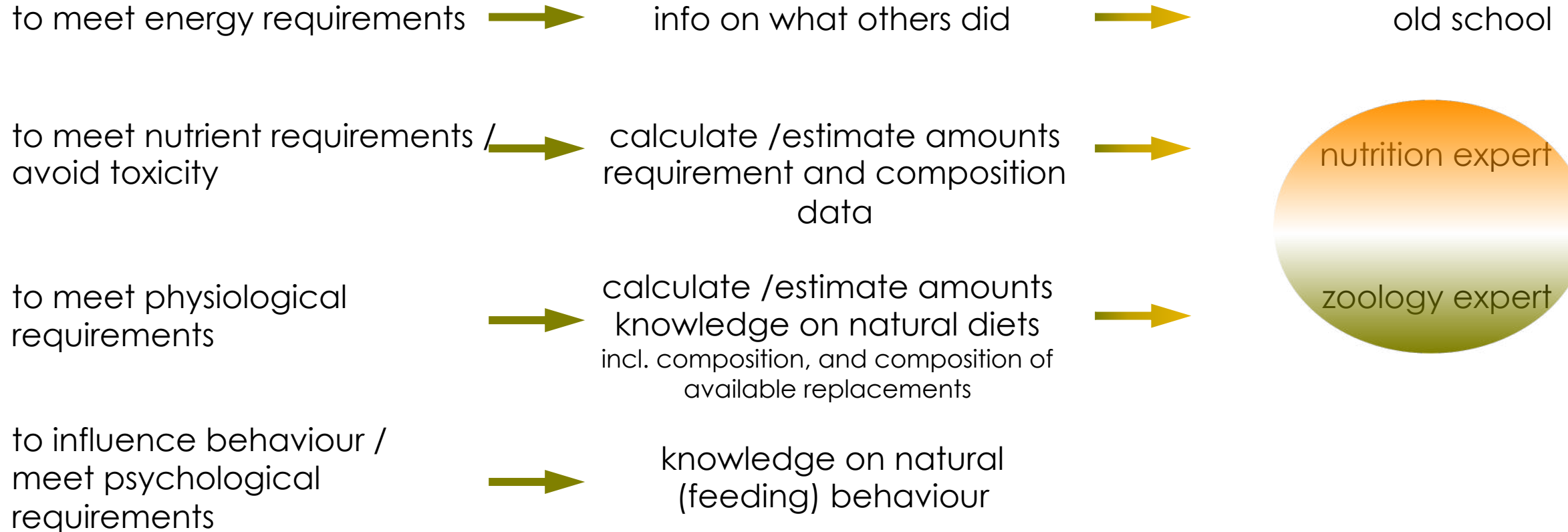


We feed zoo animals and we need ...



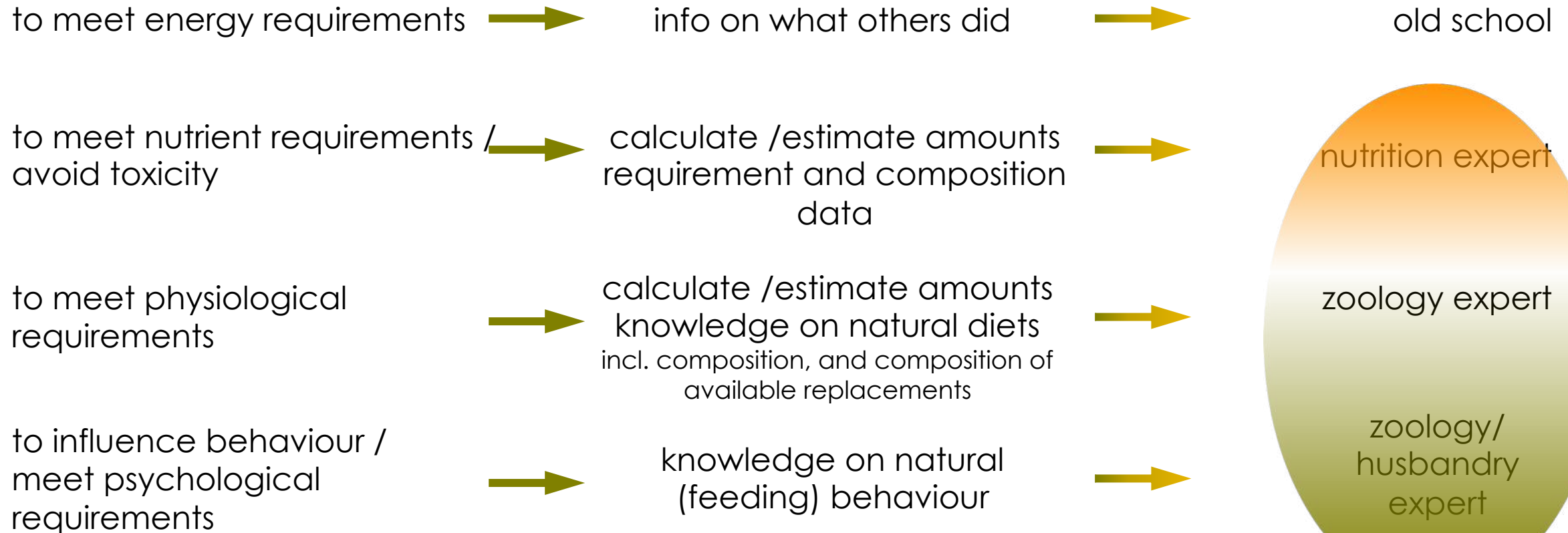


We feed zoo animals and we need ...



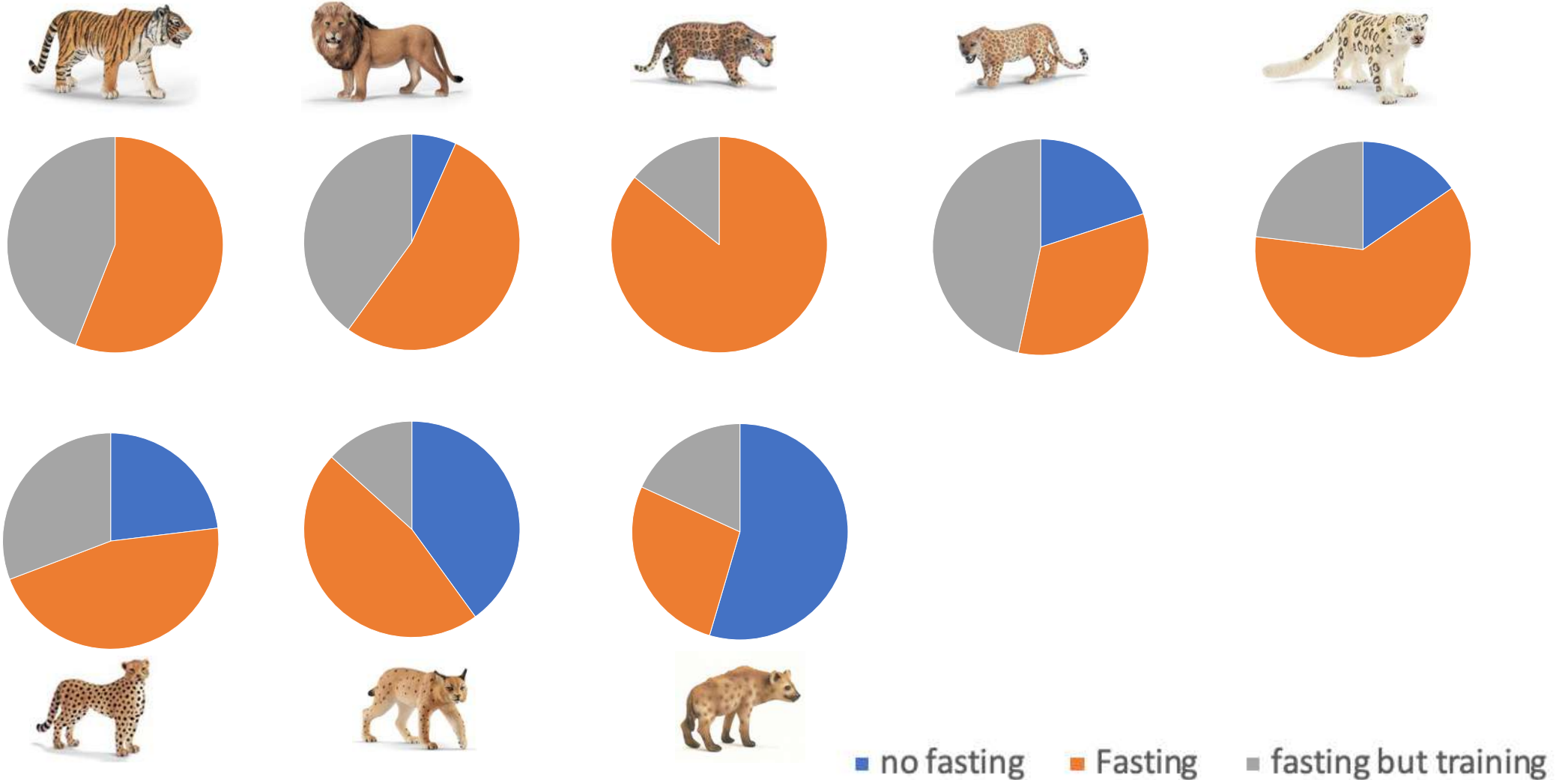


We feed zoo animals and we need ...



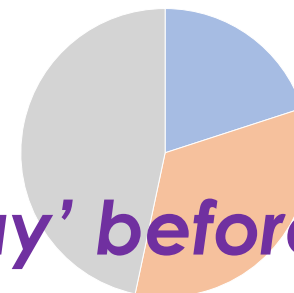
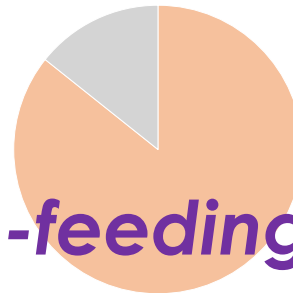
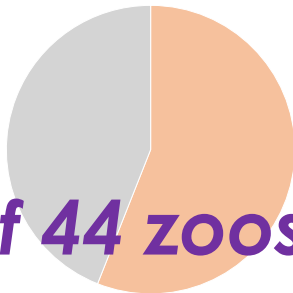


Example: Fasting in large carnivores

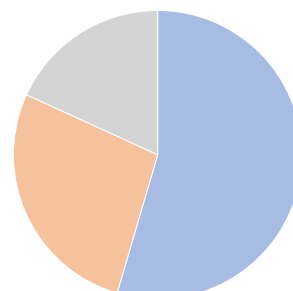
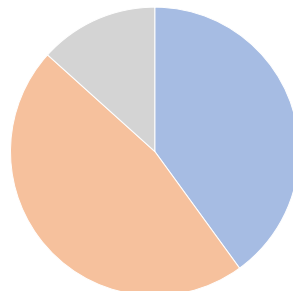
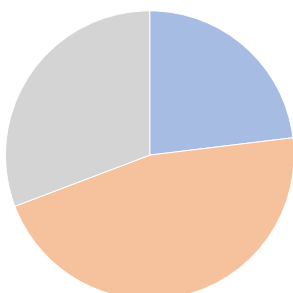




Example: Fasting in large carnivores



5 of 44 zoos had a 'gorge-feeding day' before a fasting day



■ no fasting ■ Fasting ■ fasting but training



*How do we monitor whether we
achieve our aims ?*



We monitor ...

to meet energy requirements



We monitor ...

to meet energy requirements



is it alive?



We monitor ...

to meet energy requirements



is it alive?



check enclosure





We monitor ...

to meet energy requirements



is it alive?



check enclosure

to meet nutrient requirements /
avoid toxicity



We monitor ...

to meet energy requirements →

is it alive?



check enclosure

to meet nutrient requirements /
avoid toxicity →

do we have deficiencies /
toxicities ?



We monitor ...

to meet energy requirements →

is it alive?



check enclosure

to meet nutrient requirements /
avoid toxicity →

do we have deficiencies /
toxicities ?



clinical signs
(eating/defecating/urinating)
blood, necropsy reports



We monitor ...

to meet energy requirements →

is it alive?



check enclosure

to meet nutrient requirements /
avoid toxicity →

do we have deficiencies /
toxicities ?



clinical signs
(eating/defecating/urinating)
blood, necropsy reports





We monitor ...

to meet energy requirements →

is it alive?



check enclosure

to meet nutrient requirements /
avoid toxicity →

do we have deficiencies /
toxicities ?

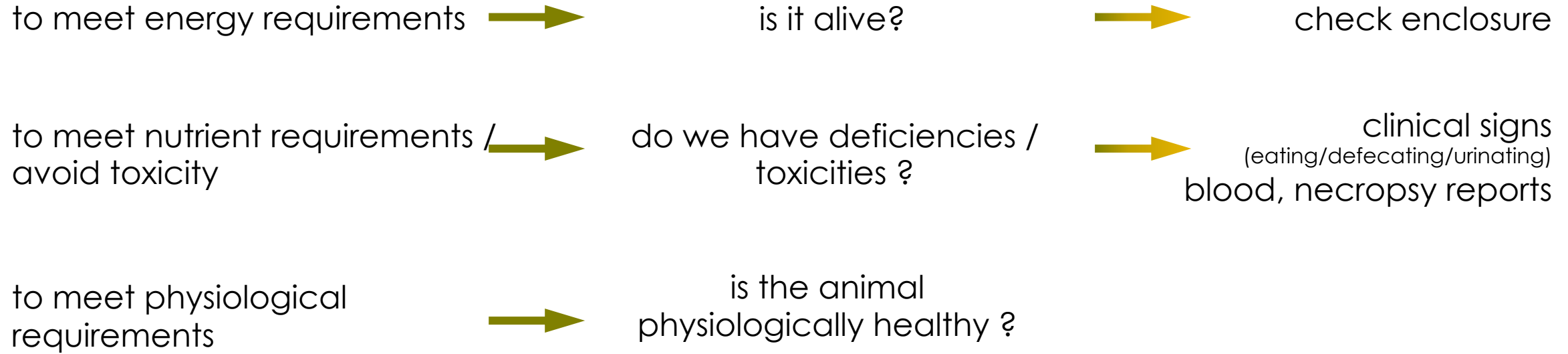


clinical signs
(eating/defecating/urinating)
blood, necropsy reports

to meet physiological
requirements



We monitor ...





We monitor ...

to meet energy requirements →

is it alive?



check enclosure

to meet nutrient requirements /
avoid toxicity →

do we have deficiencies /
toxicities ?



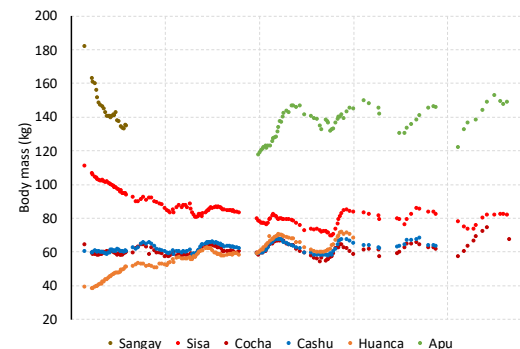
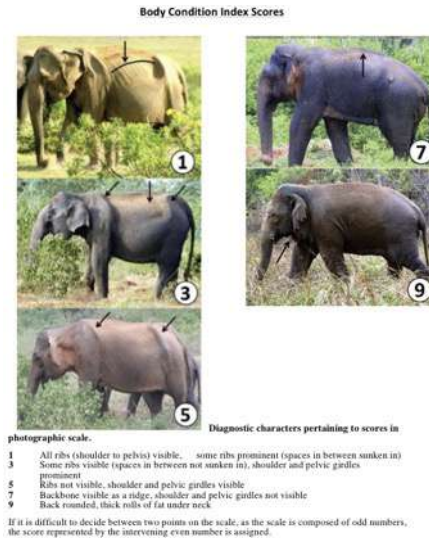
clinical signs
(eating/defecating/urinating)
blood, necropsy reports

to meet physiological
requirements →

is the animal
physiologically healthy ?



body weight / BCS
faeces consistency
intake
reproduction

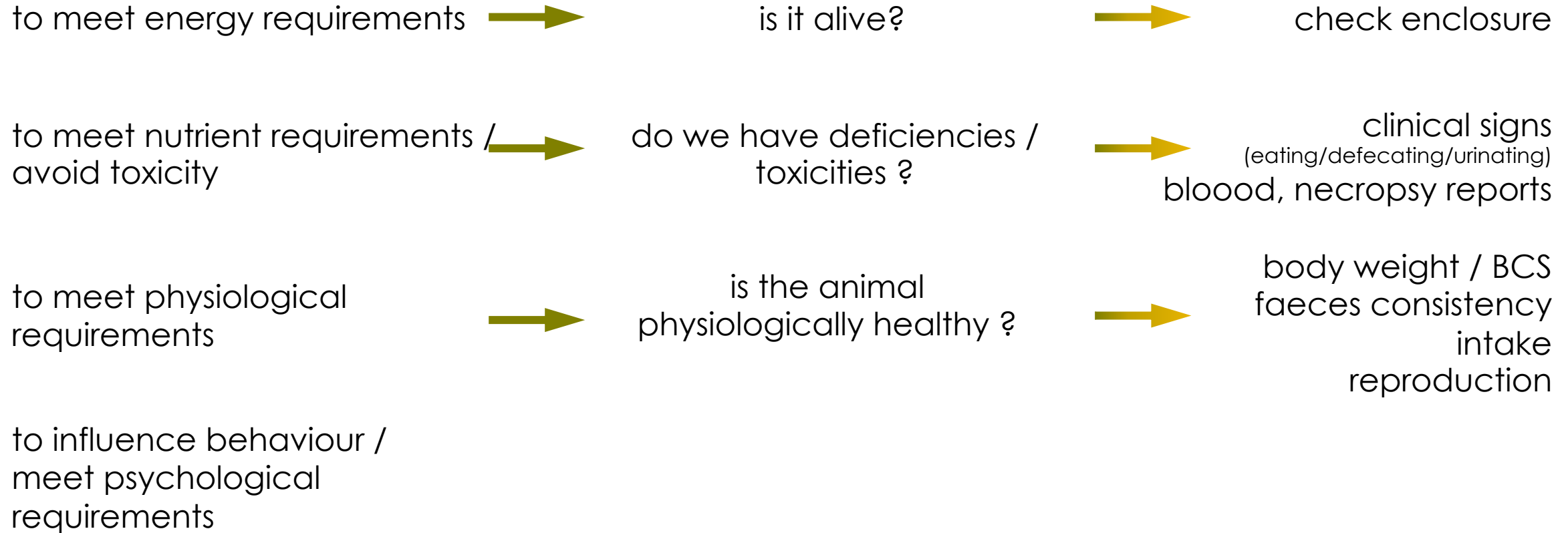


DATE	MAZURI MOOSE	BROWSE	STOOL	QUALITY	COMMENTS
1	8	1.9	4w/1w	1,2	
2	8	1.3	1	1,2,3	
3	8	1.3	1		
4	8	1.6	4w/1w		
5	8	1.6	1	2w/4(3)	
6	17	5.5	4w/1w	1,2	
7	17	6	4w/1w	1,2	
8	17	5.5	4w/1w	1,2	
9	17	5.5	4w/1w	1,2	
10	17	4.9	4w/1w	1,2	
11	17	4.9	4w/1w	1,2	
12	17	4.9	4w/1w	1,2	
13	17	4.9	4w/1w	1,2	
14	17	4.9	4w/1w	1,2	
15	17	4.9	4w/1w	1,2	
16	17	4.9	4w/1w	1,2	
17	17	4.9	4w/1w	1,2	
18	17	4.9	4w/1w	1,2	
19	17	4.9	4w/1w	1,2	
20	17	4.9	4w/1w	1,2	
21	17	4.9	4w/1w	1,2	
22	17	4.9	4w/1w	1,2	
23	17	4.9	4w/1w	1,2	
24	17	4.9	4w/1w	1,2	
25	17	4.9	4w/1w	1,2	
26	17	4.9	4w/1w	1,2	
27	17	4.9	4w/1w	1,2	
28	17	4.9	4w/1w	1,2	
29	17	4.9	4w/1w	1,2	
30	17	4.9	4w/1w	1,2	
31	17	4.9	4w/1w	1,2	

MOOSE DIET CHART FOR 10 MOOSE * 1918 "MOOSE"
MONTH/YEAR Feb 2019 DIET MOOSE SPAIN + 10% Boost

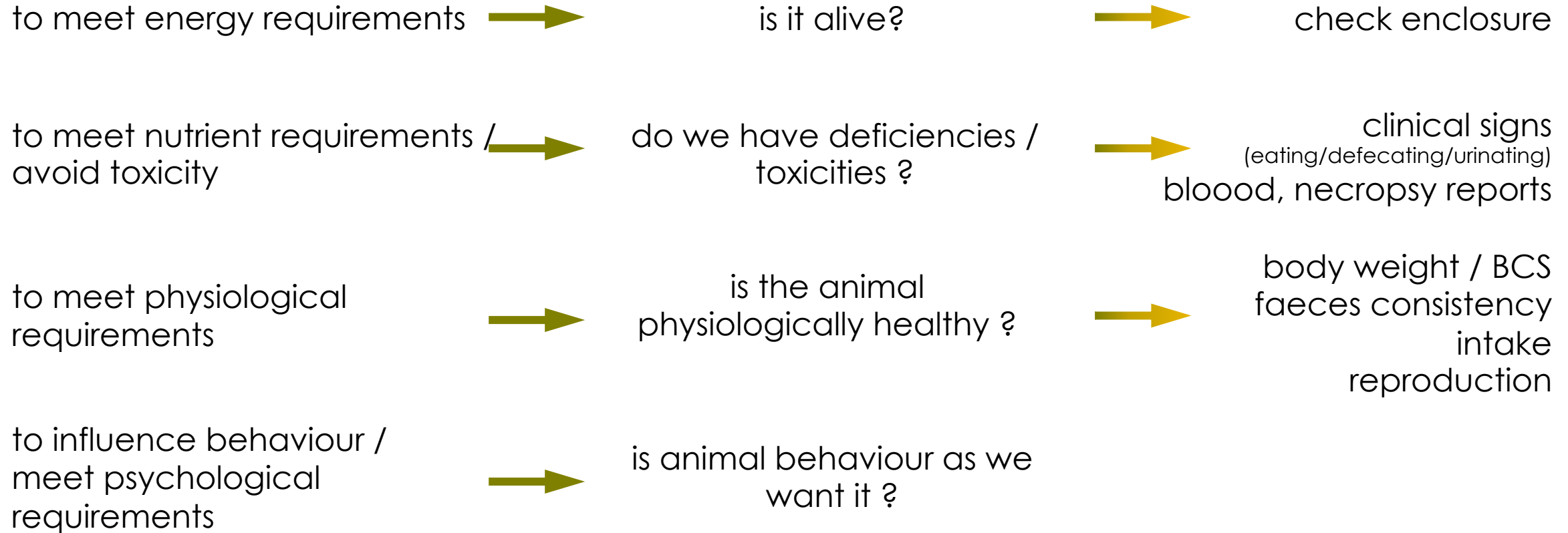


We monitor ...





We monitor ...





We monitor ...

to meet energy requirements →

is it alive?



check enclosure

to meet nutrient requirements /
avoid toxicity →

do we have deficiencies /
toxicities ?



clinical signs
(eating/defecating/urinating)
blood, necropsy reports

to meet physiological
requirements →

is the animal
physiologically healthy ?



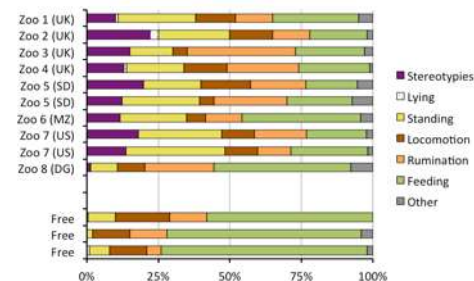
body weight / BCS
faeces consistency
intake
reproduction

to influence behaviour /
meet psychological
requirements →

is animal behaviour as we
want it ?



behavioural
monitoring
(abnormal as well as normal activity budget)





Imagine an interview



Imagine an interview

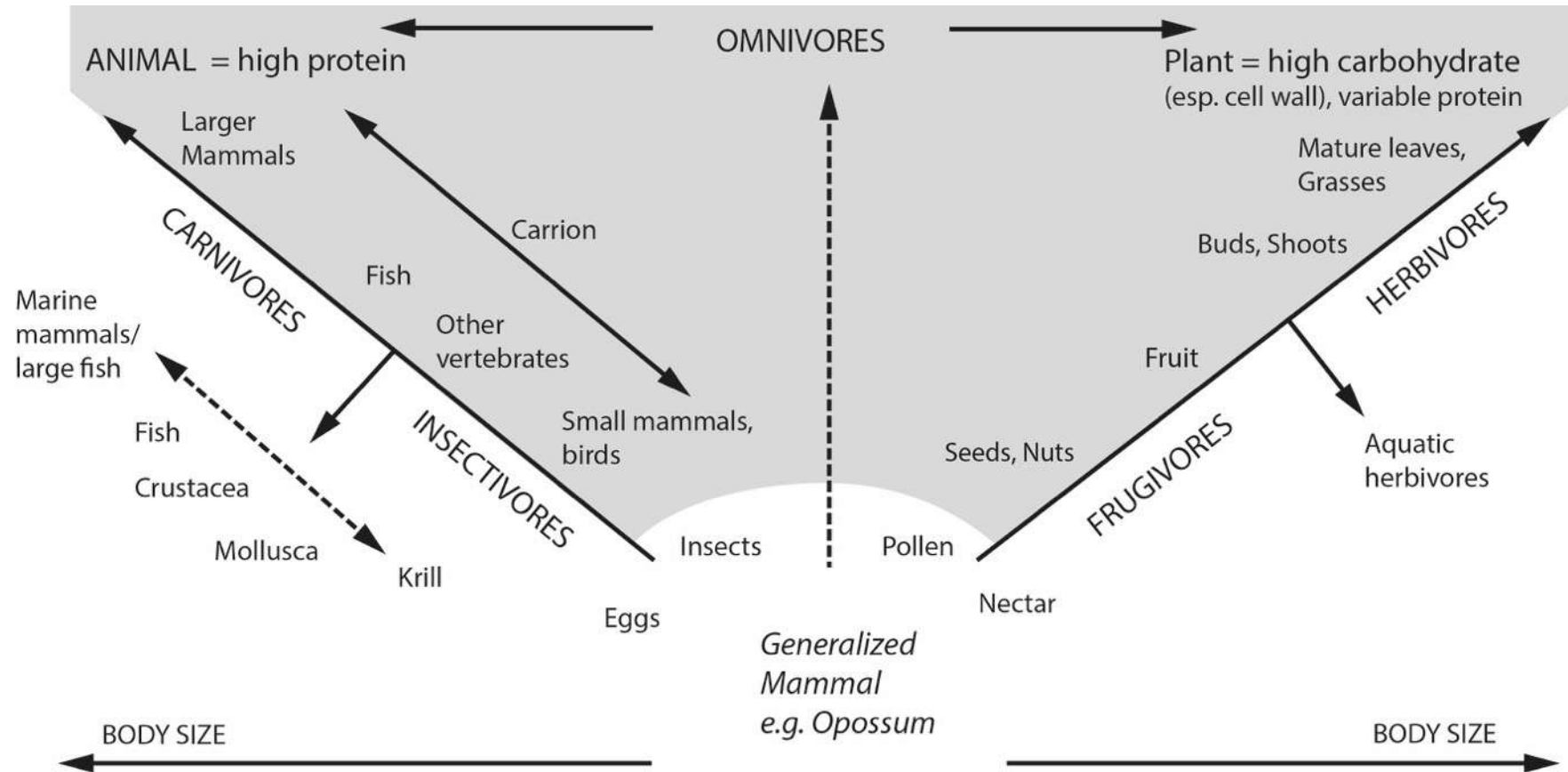
“We have no concrete idea how our animals should spend their day.”



*Diet niche,
feeding behaviour
&
feeding frequency*



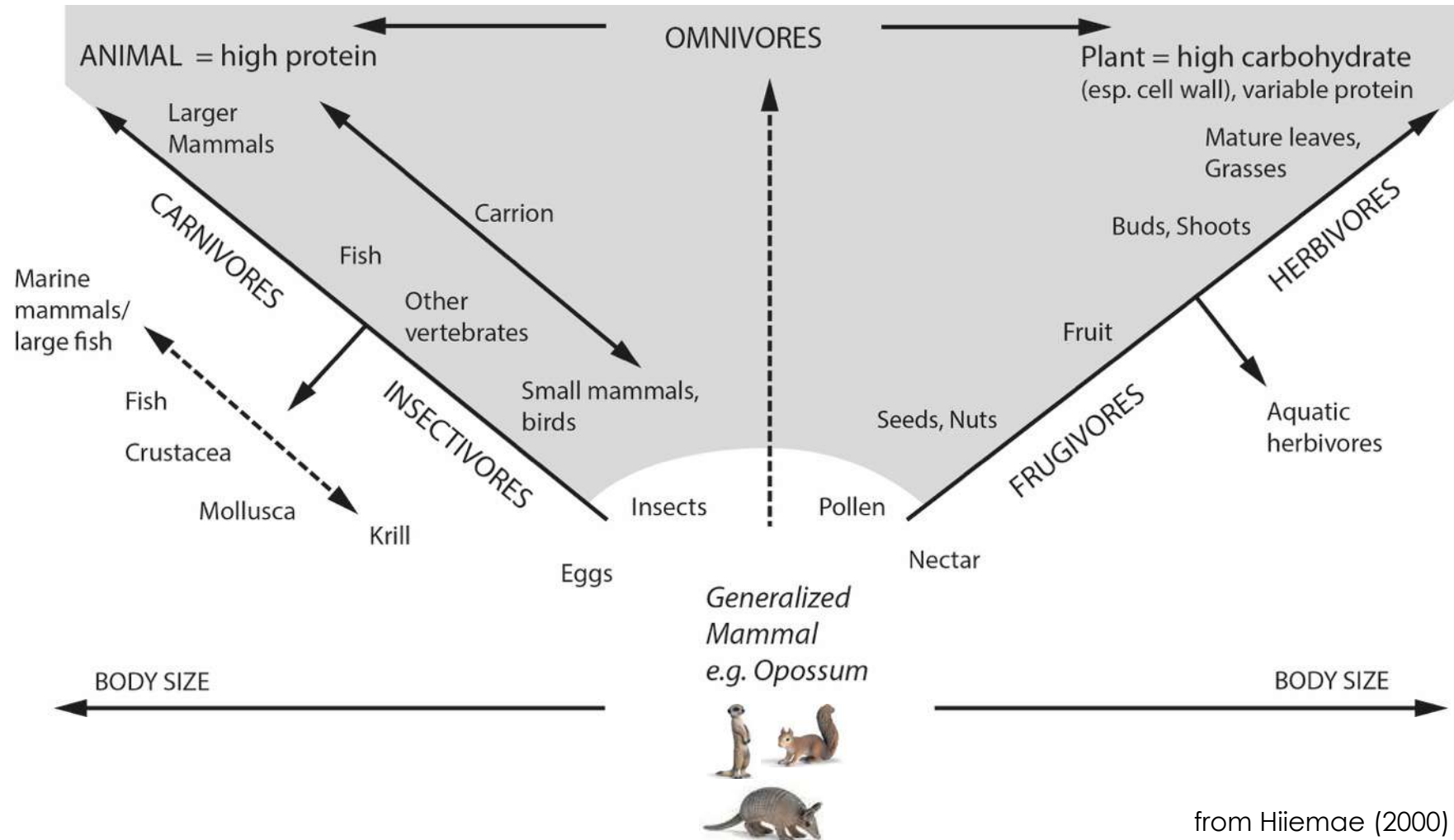
Sufficient amounts of available packages



from Hiimae (2000)

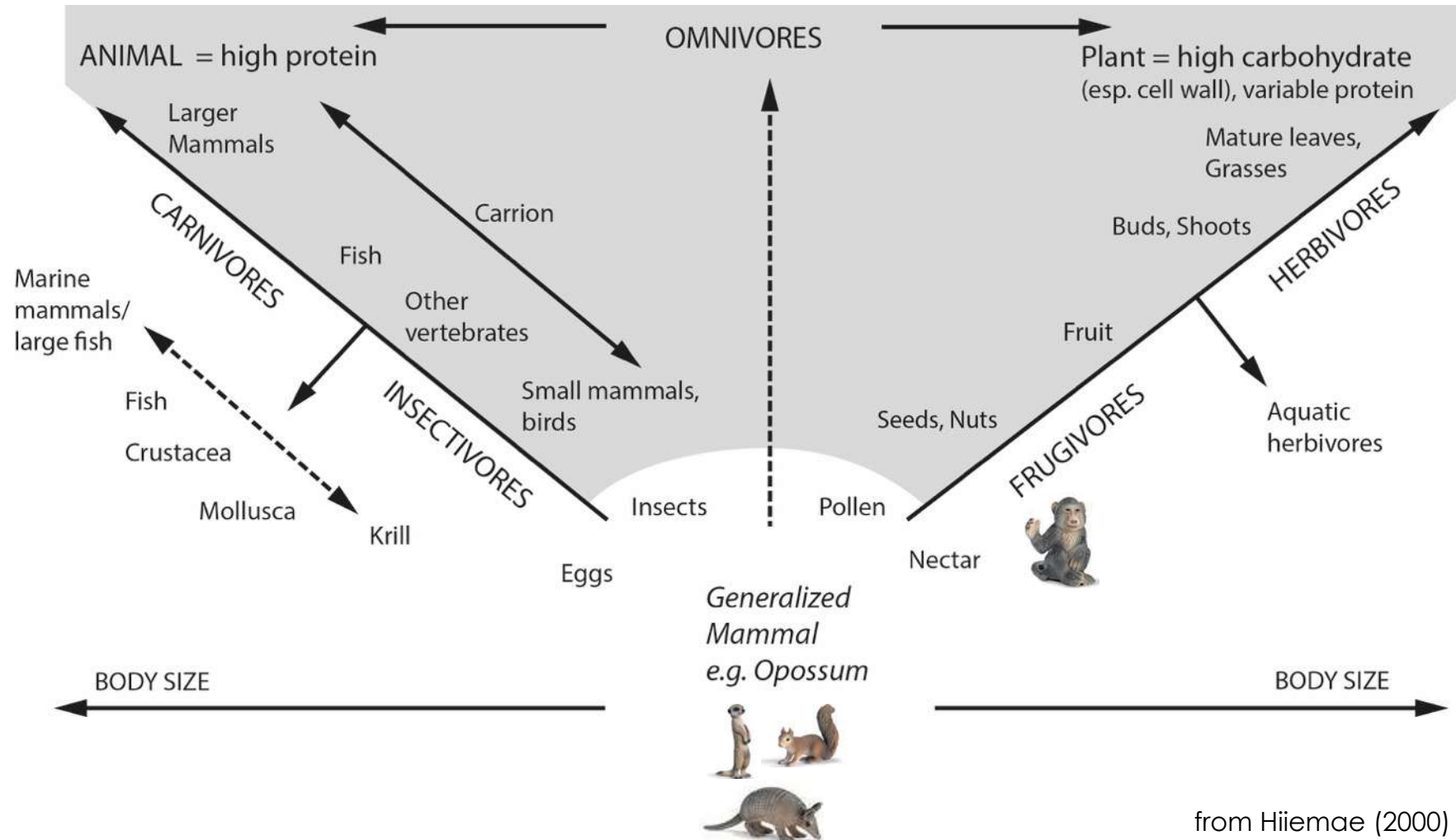


Sufficient amounts of available packages



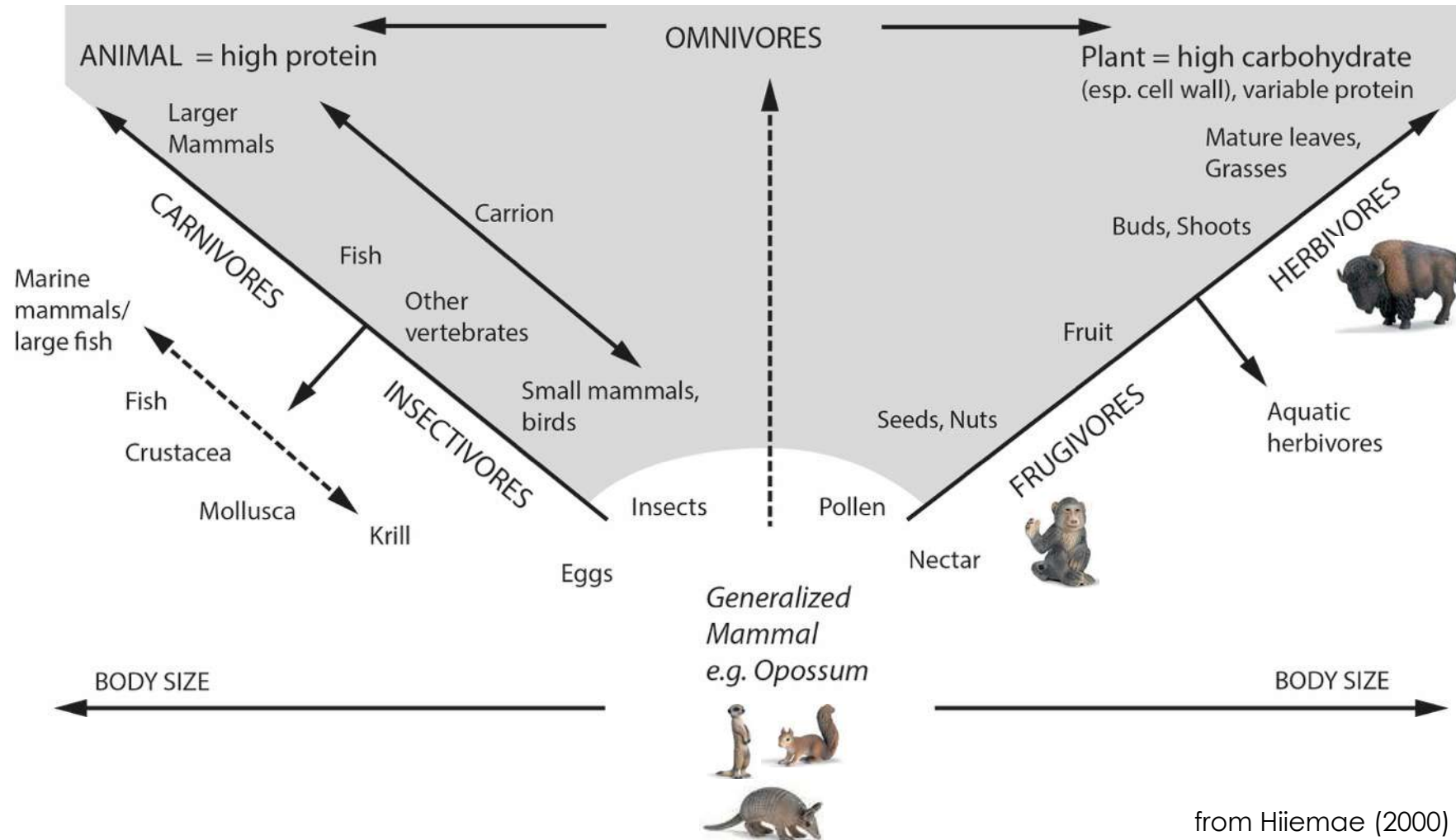


Sufficient amounts of available packages





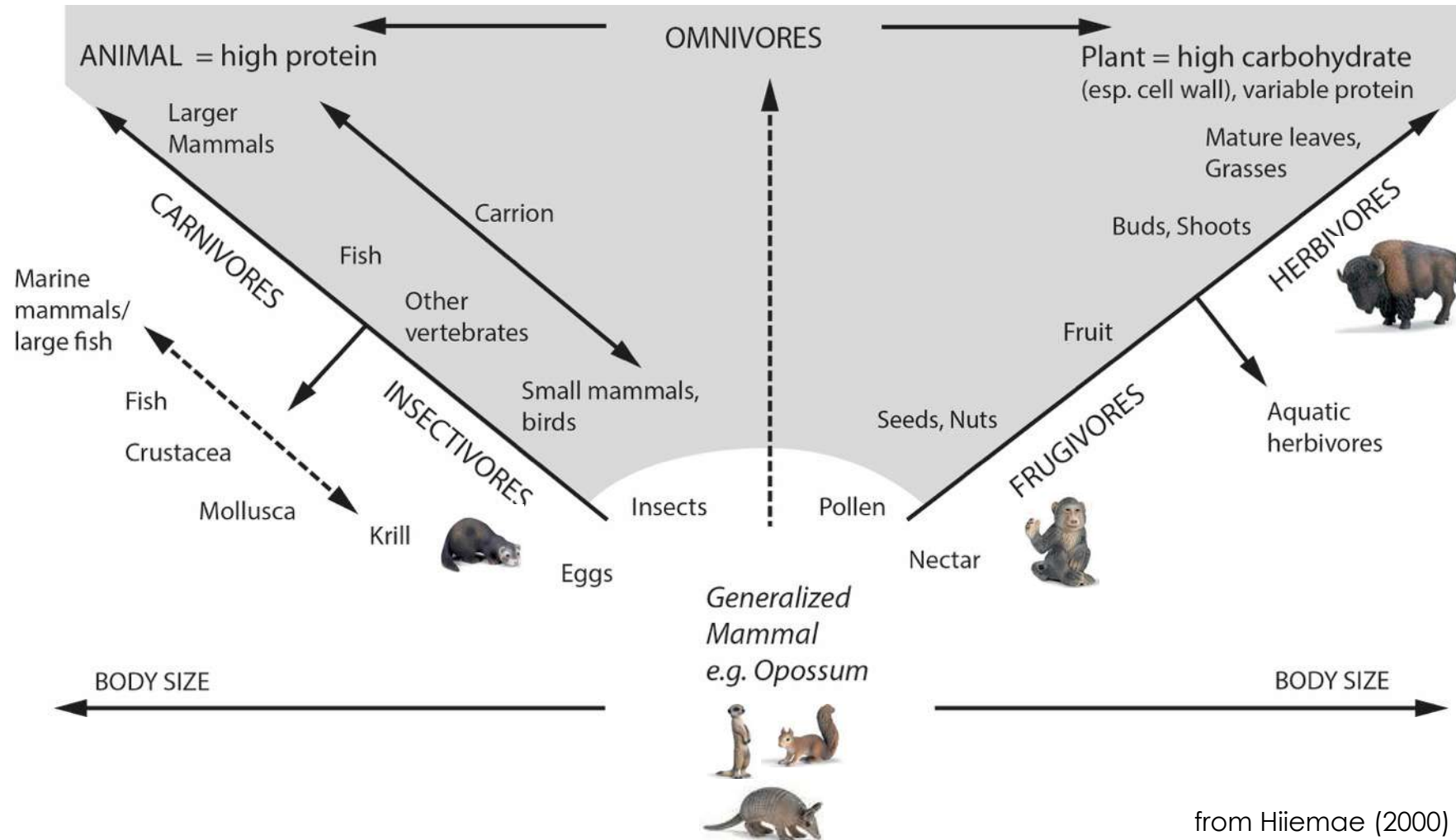
Sufficient amounts of available packages



from Hiimae (2000)

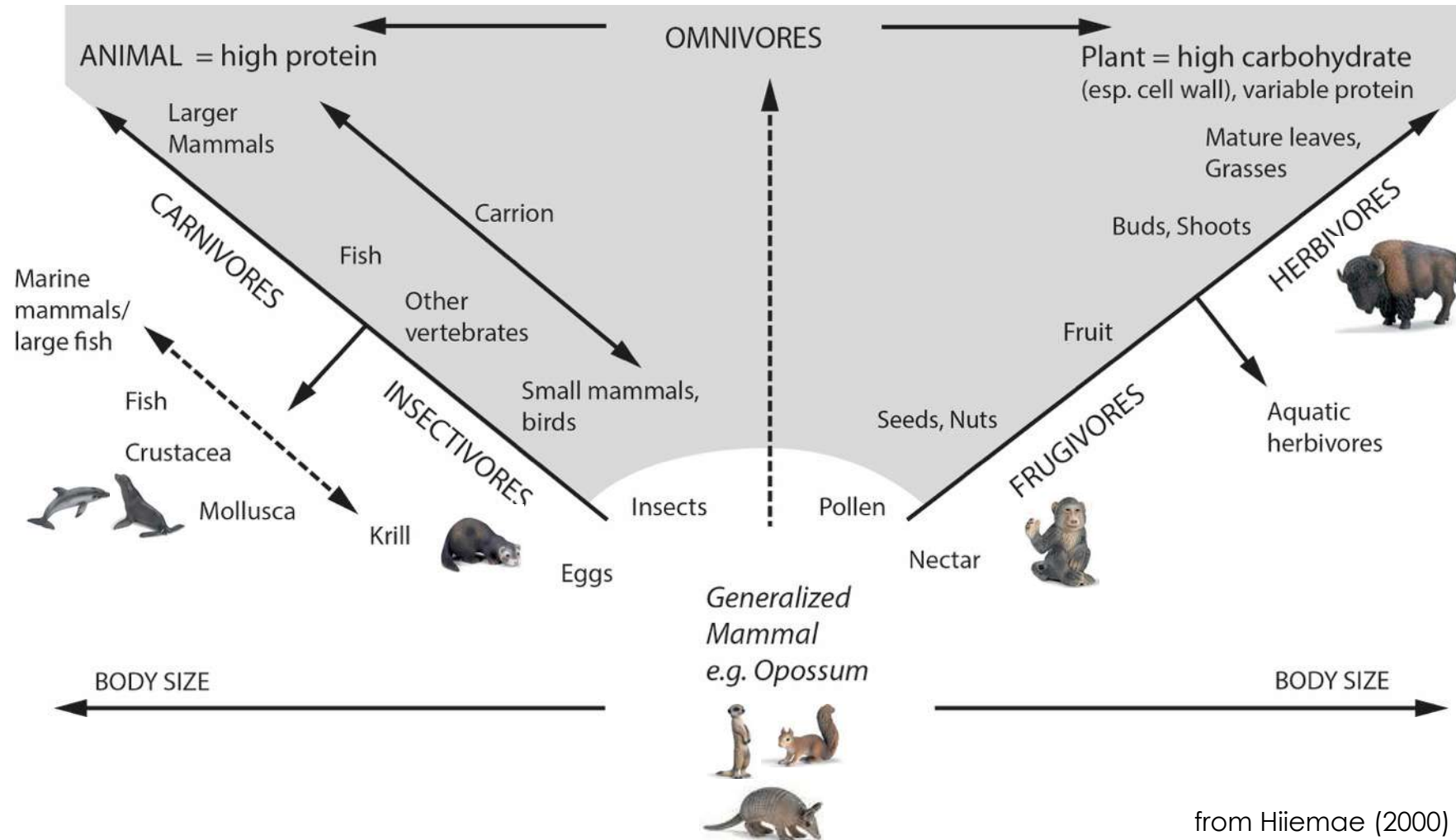


Sufficient amounts of available packages





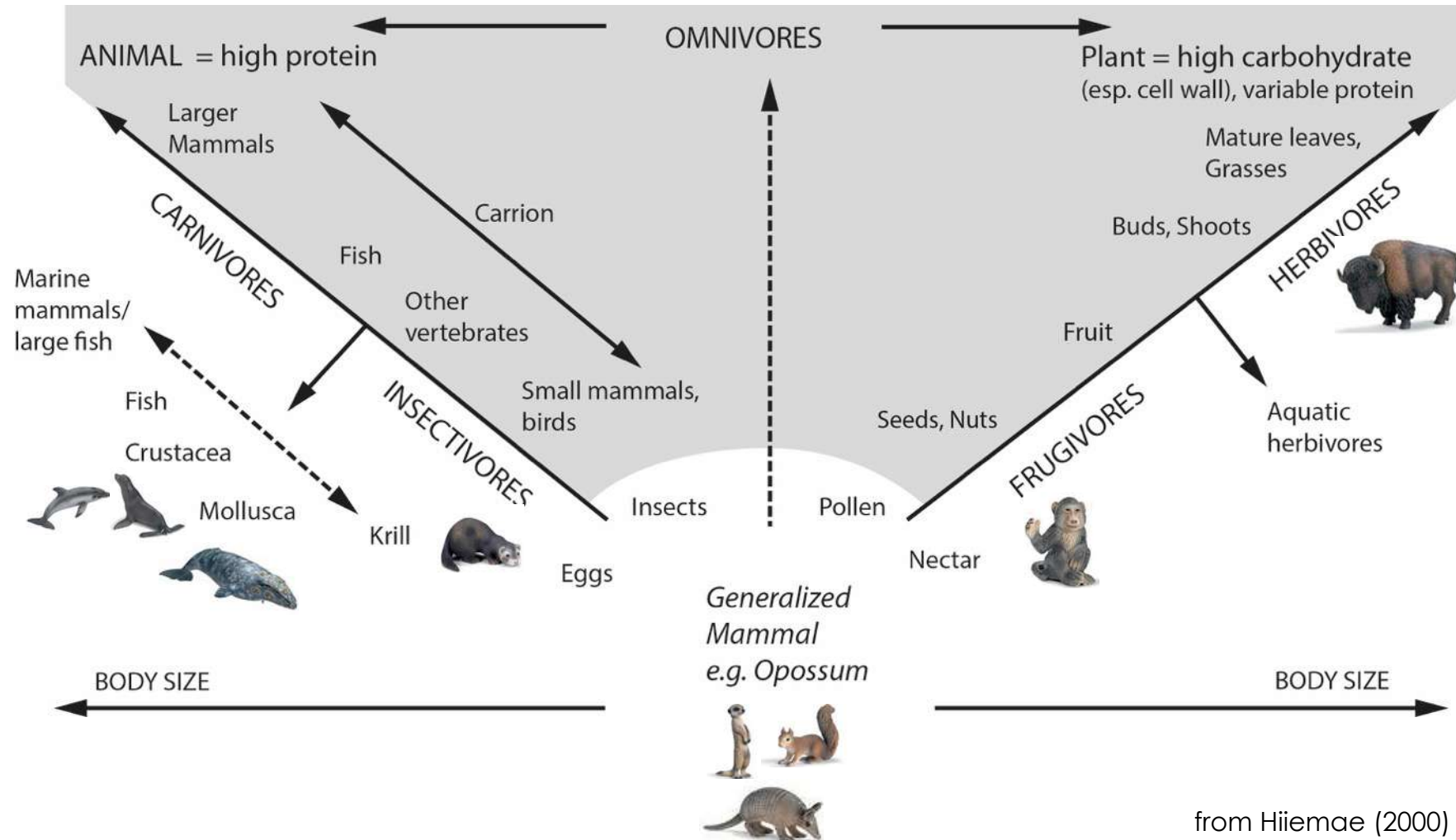
Sufficient amounts of available packages



from Hiimae (2000)

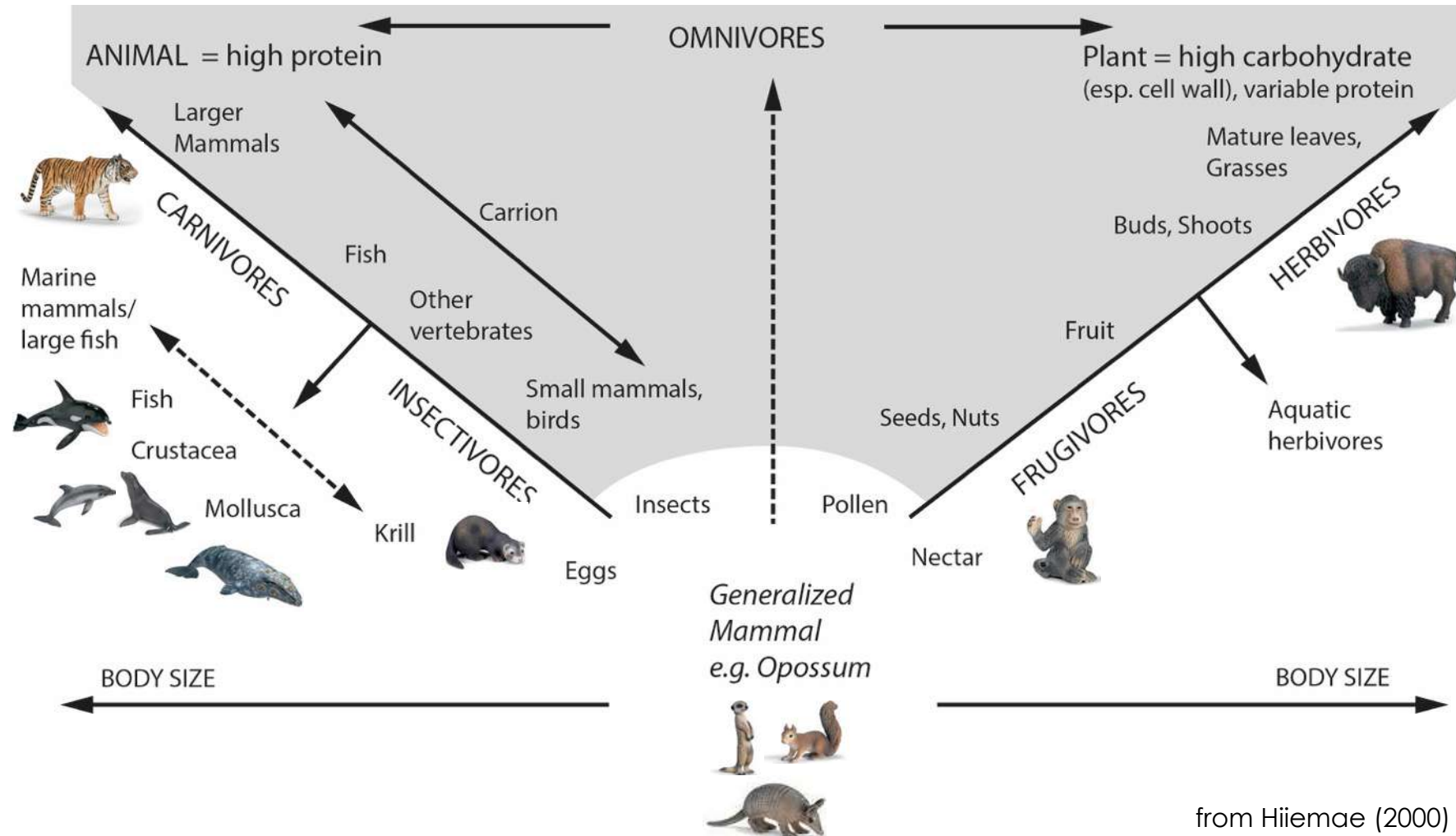


Sufficient amounts of available packages





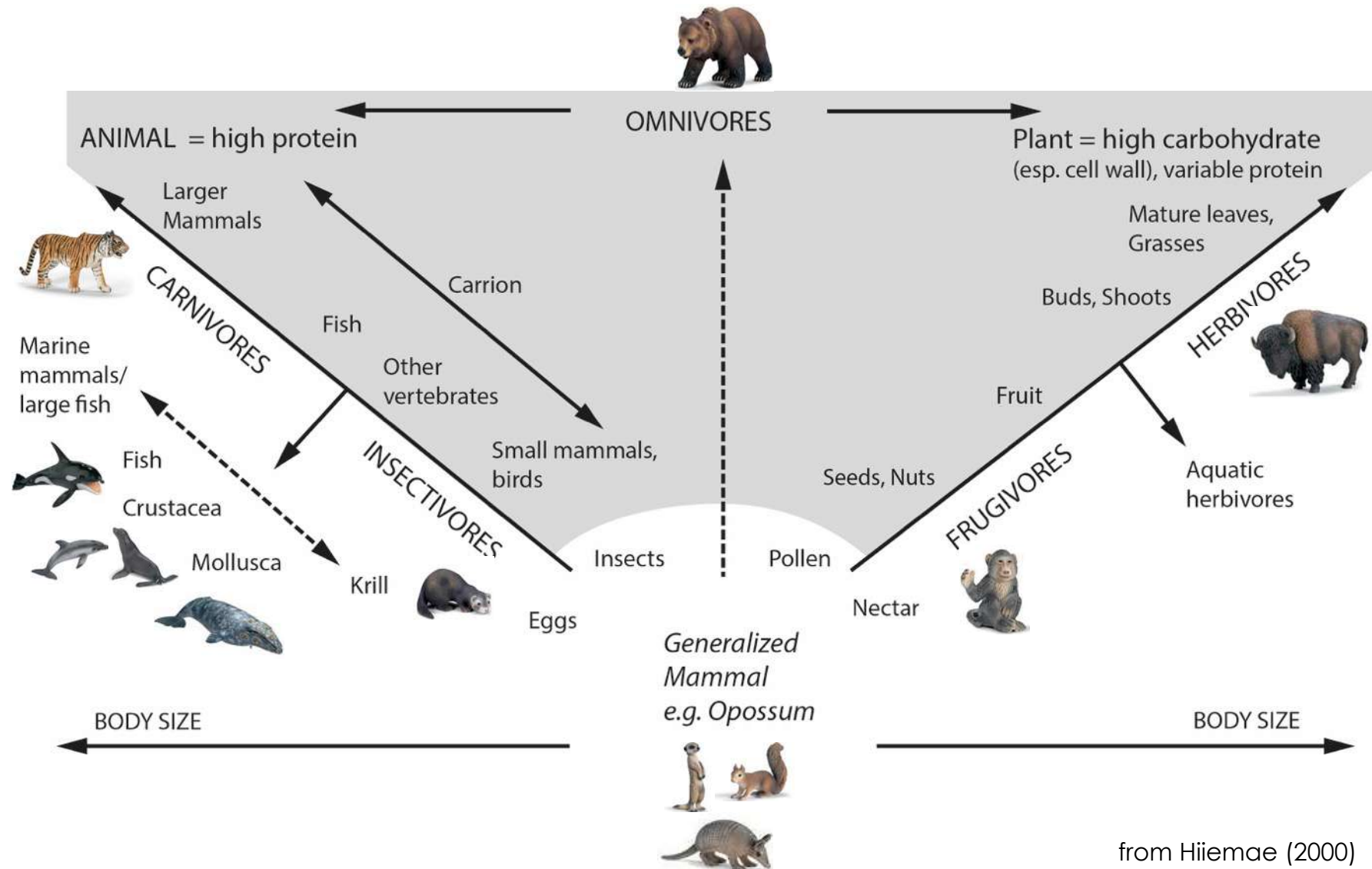
Sufficient amounts of available packages



from Hiimae (2000)

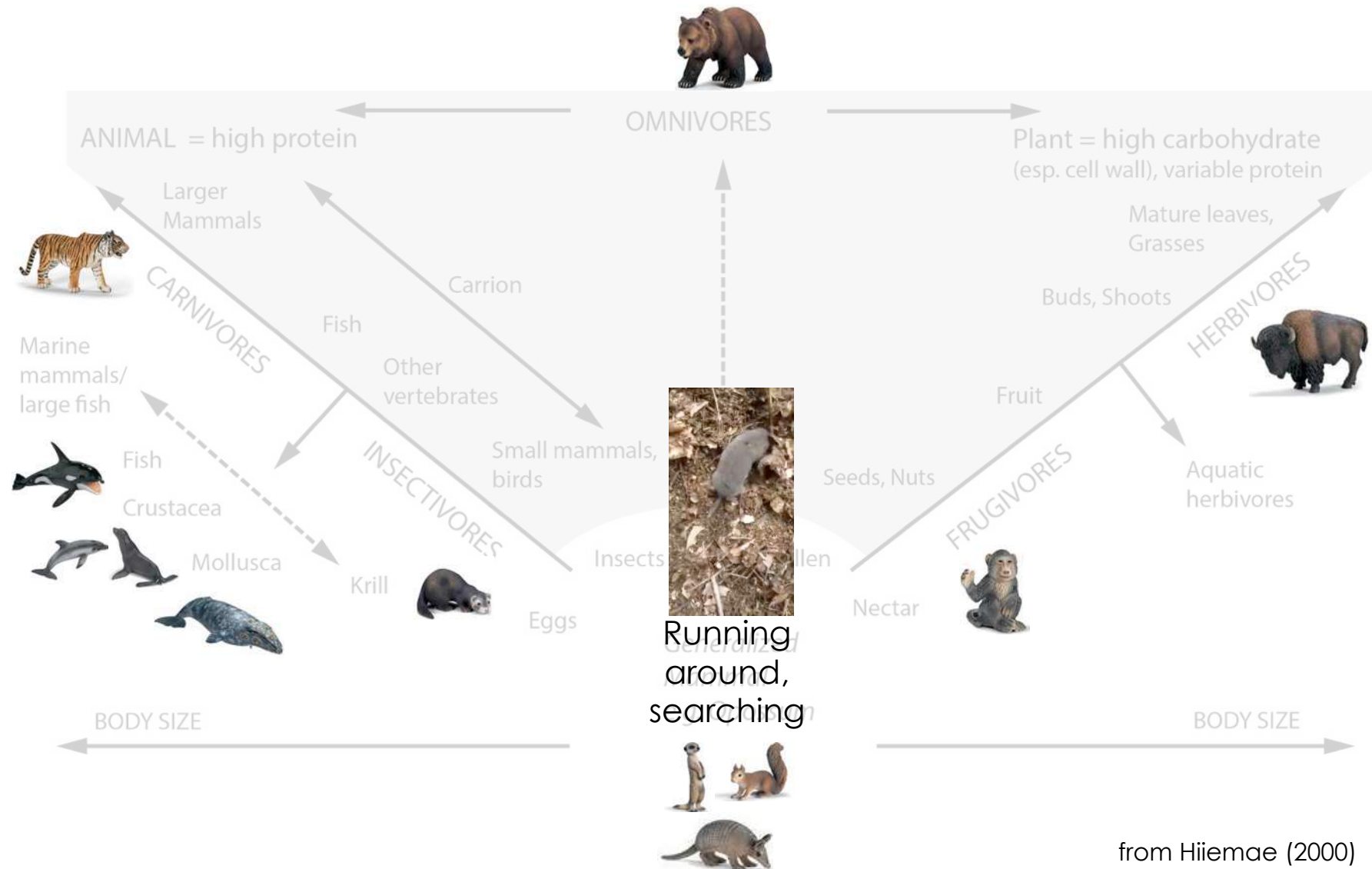


Sufficient amounts of available packages





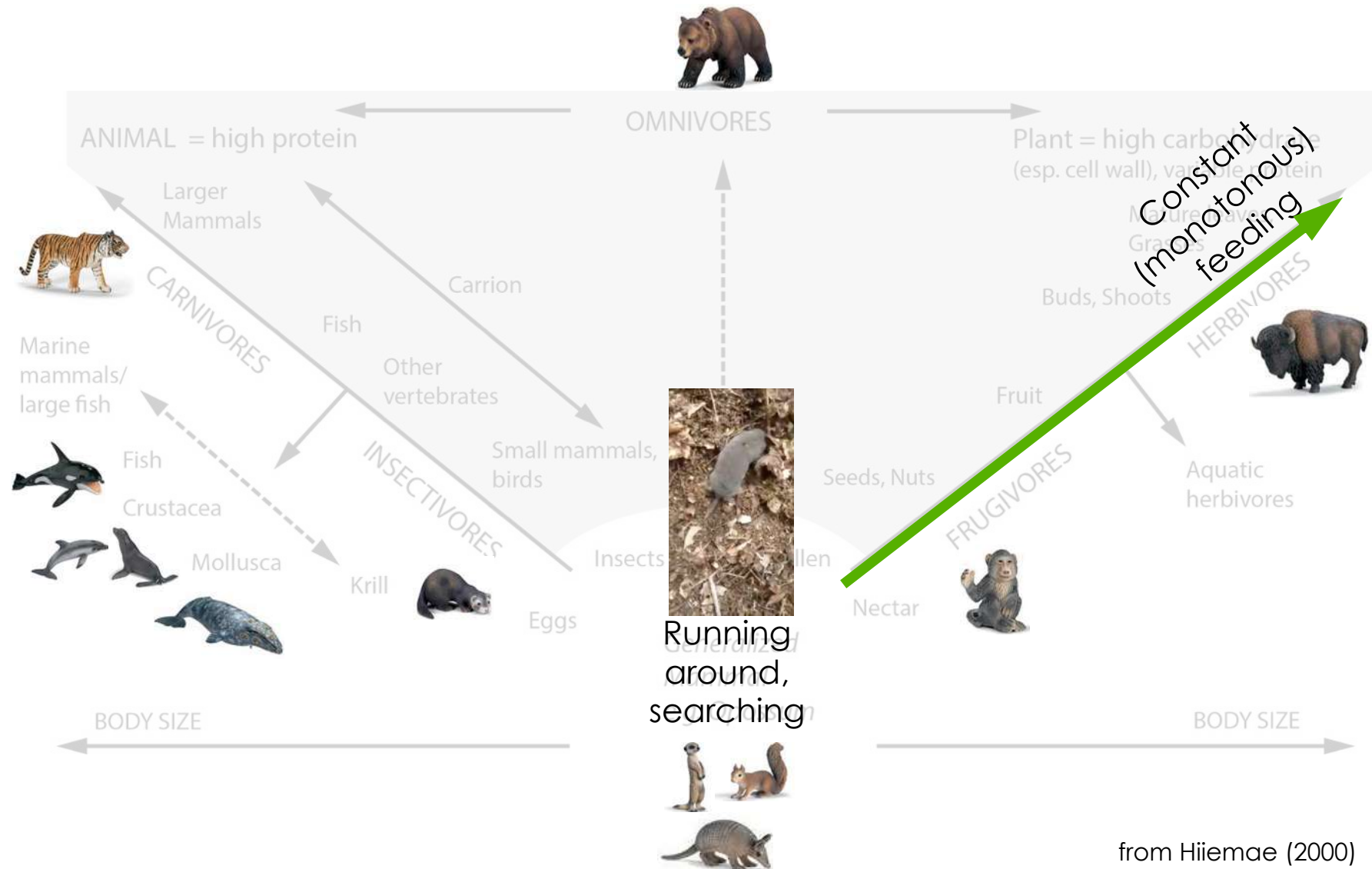
Foraging mode



from Hiimae (2000)

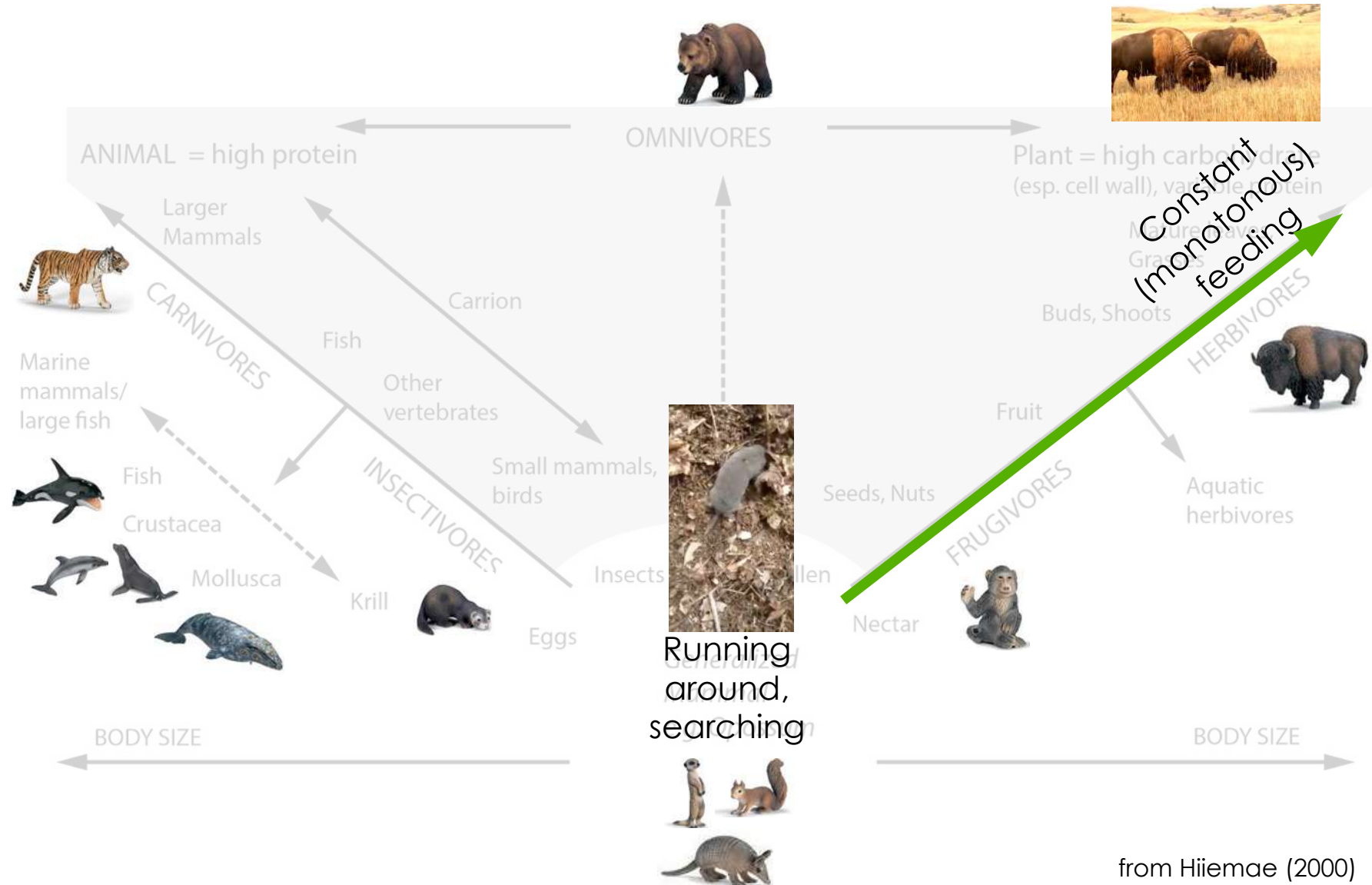


Foraging mode



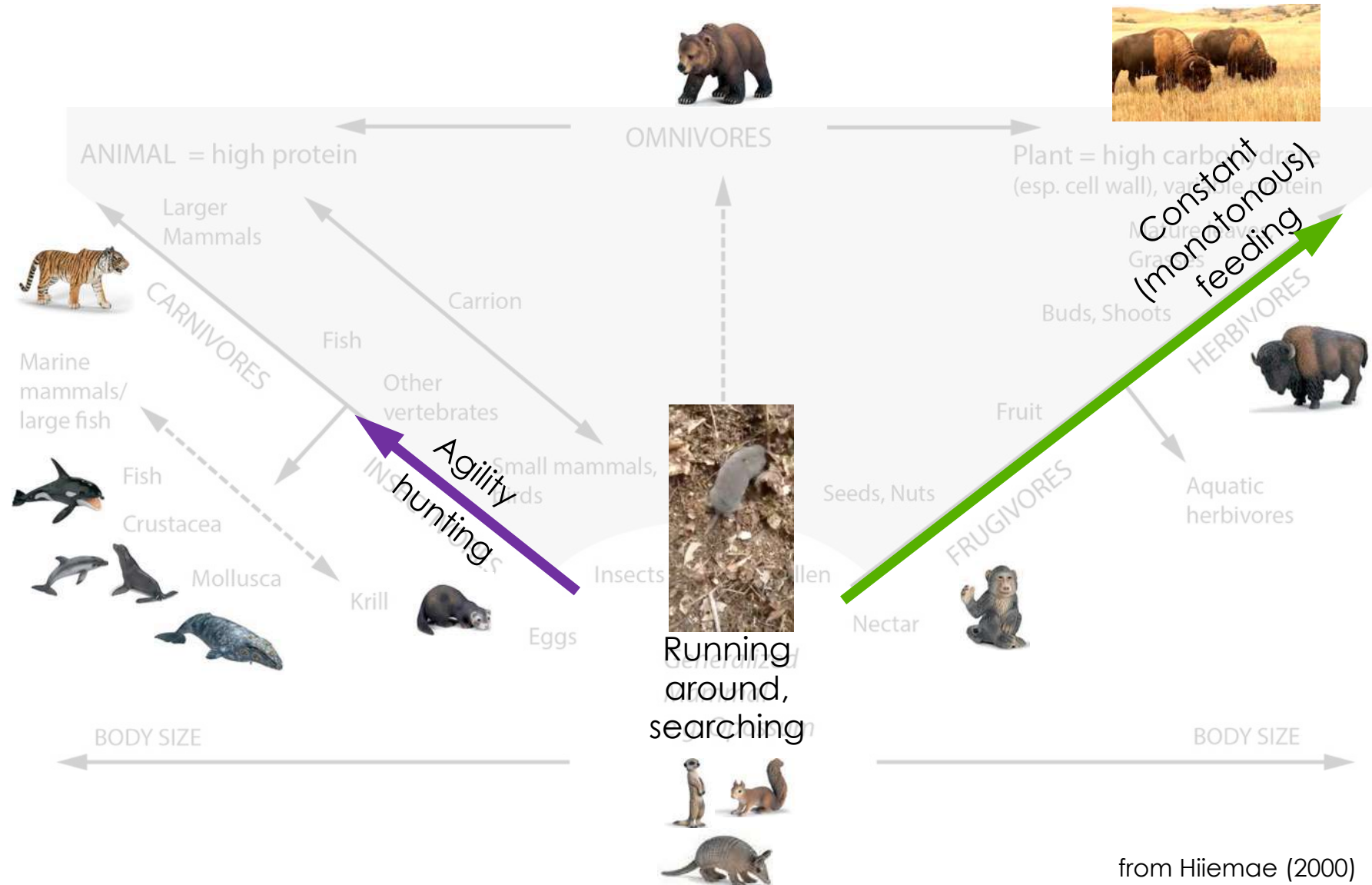


Foraging mode



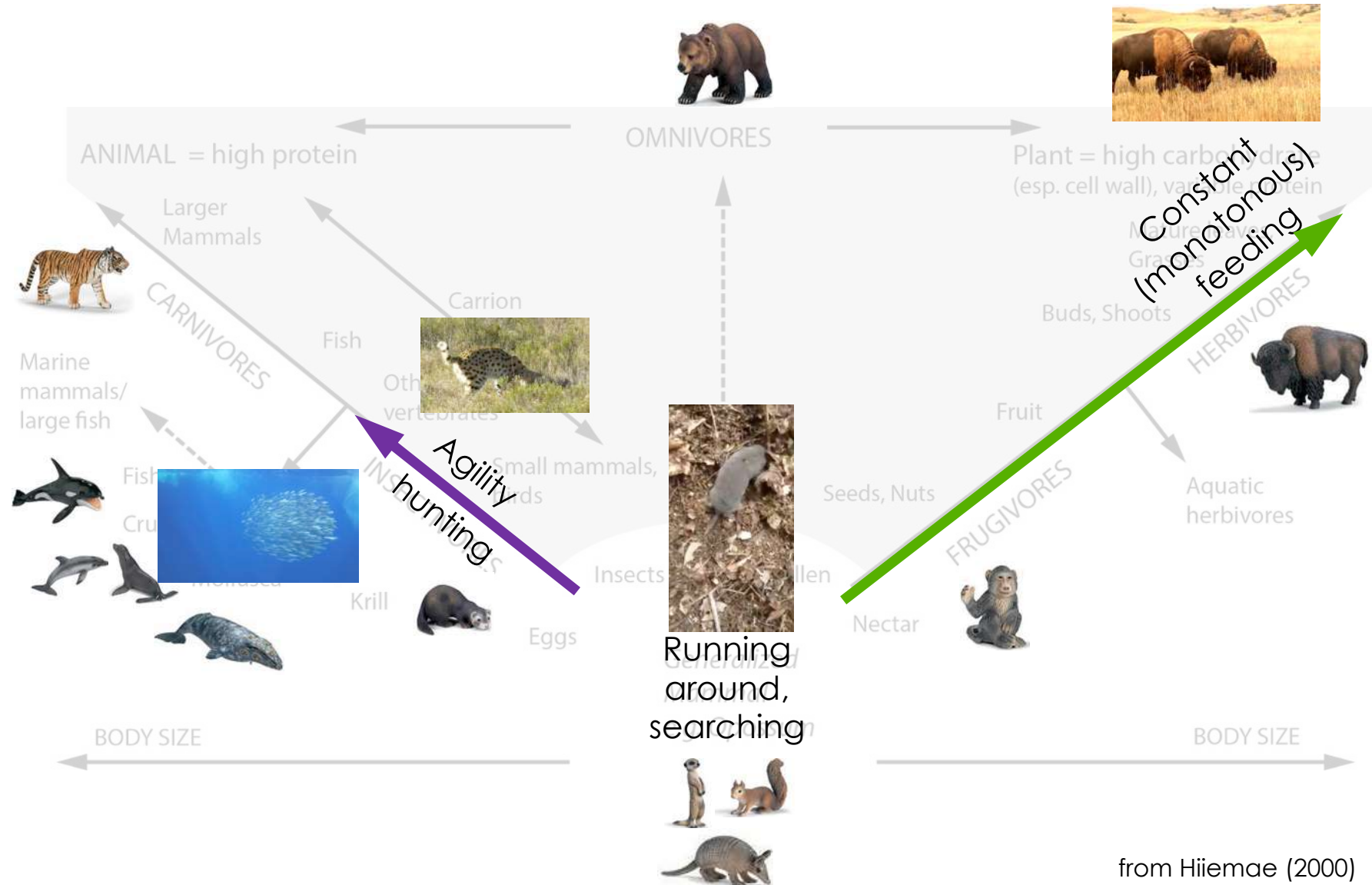


Foraging mode



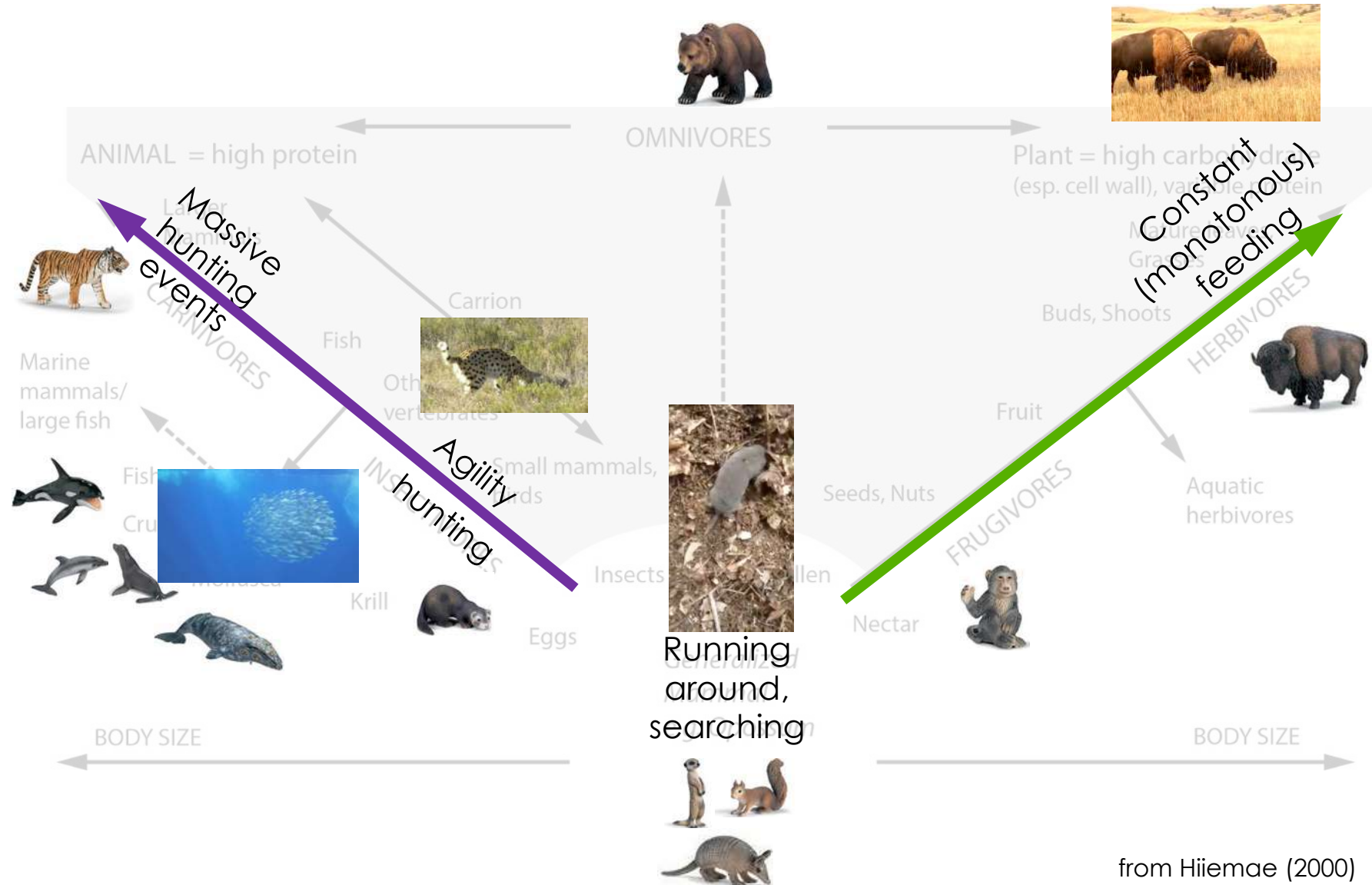


Foraging mode



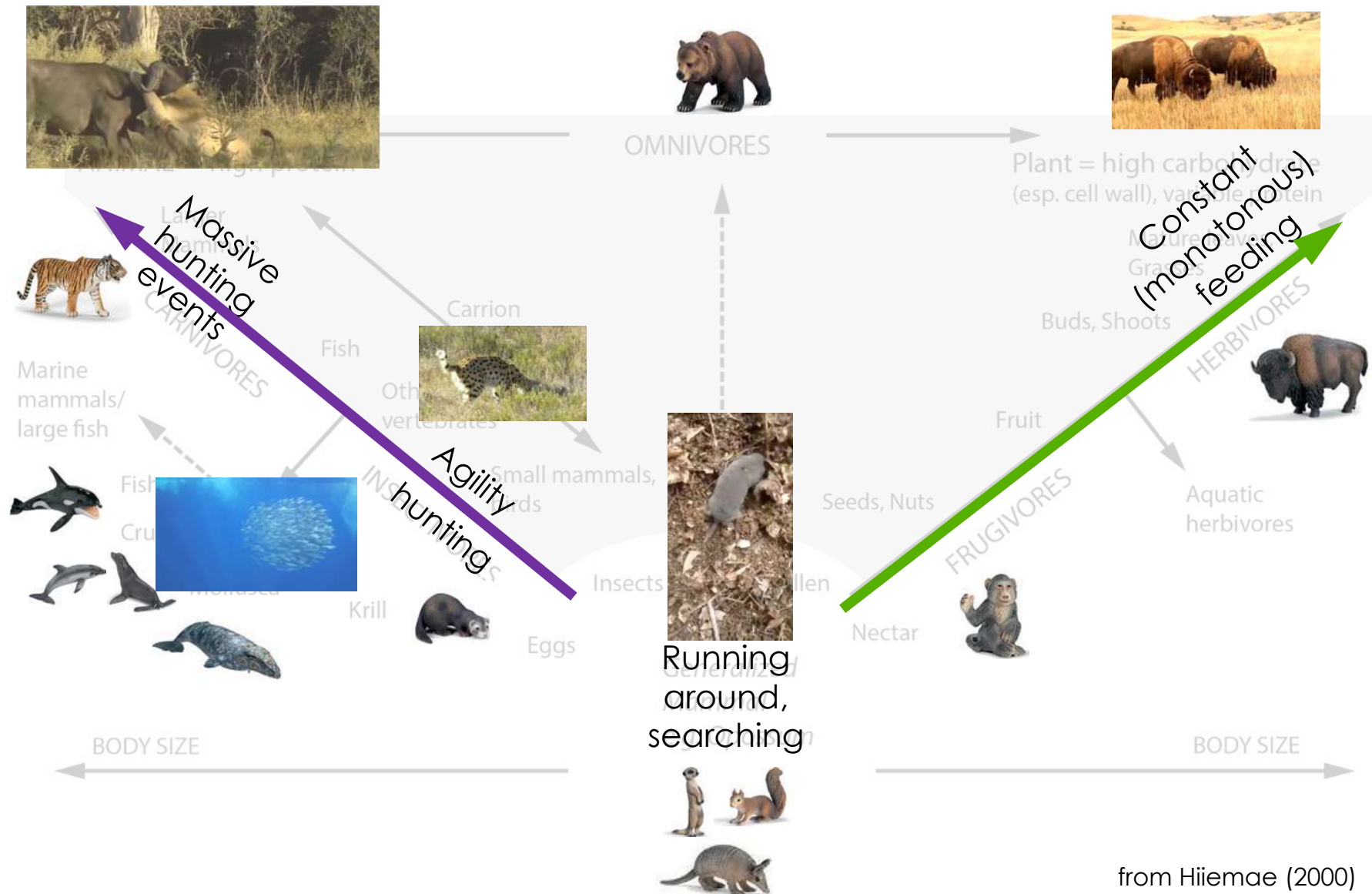


Foraging mode





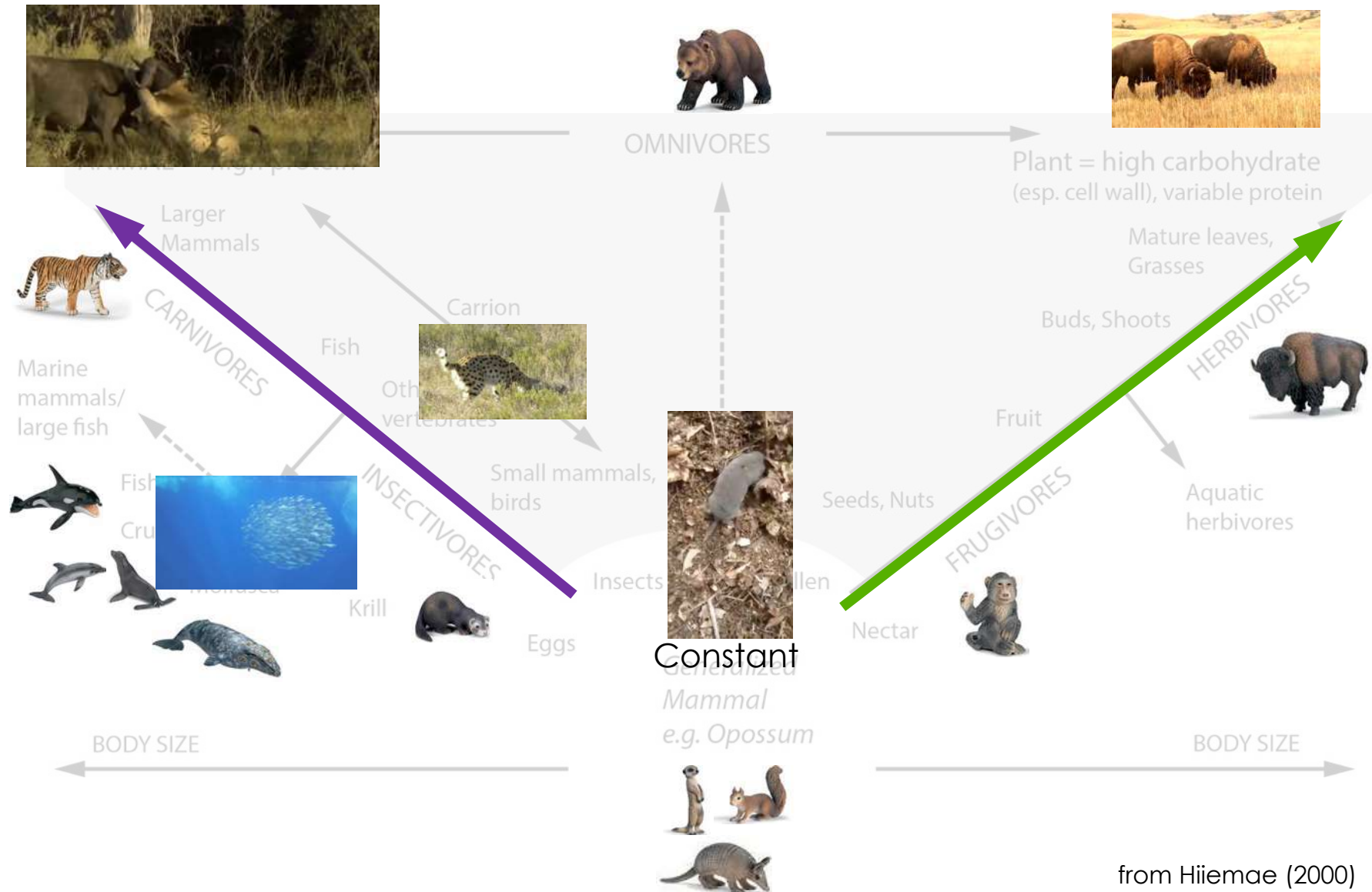
Foraging mode



from Hiimae (2000)

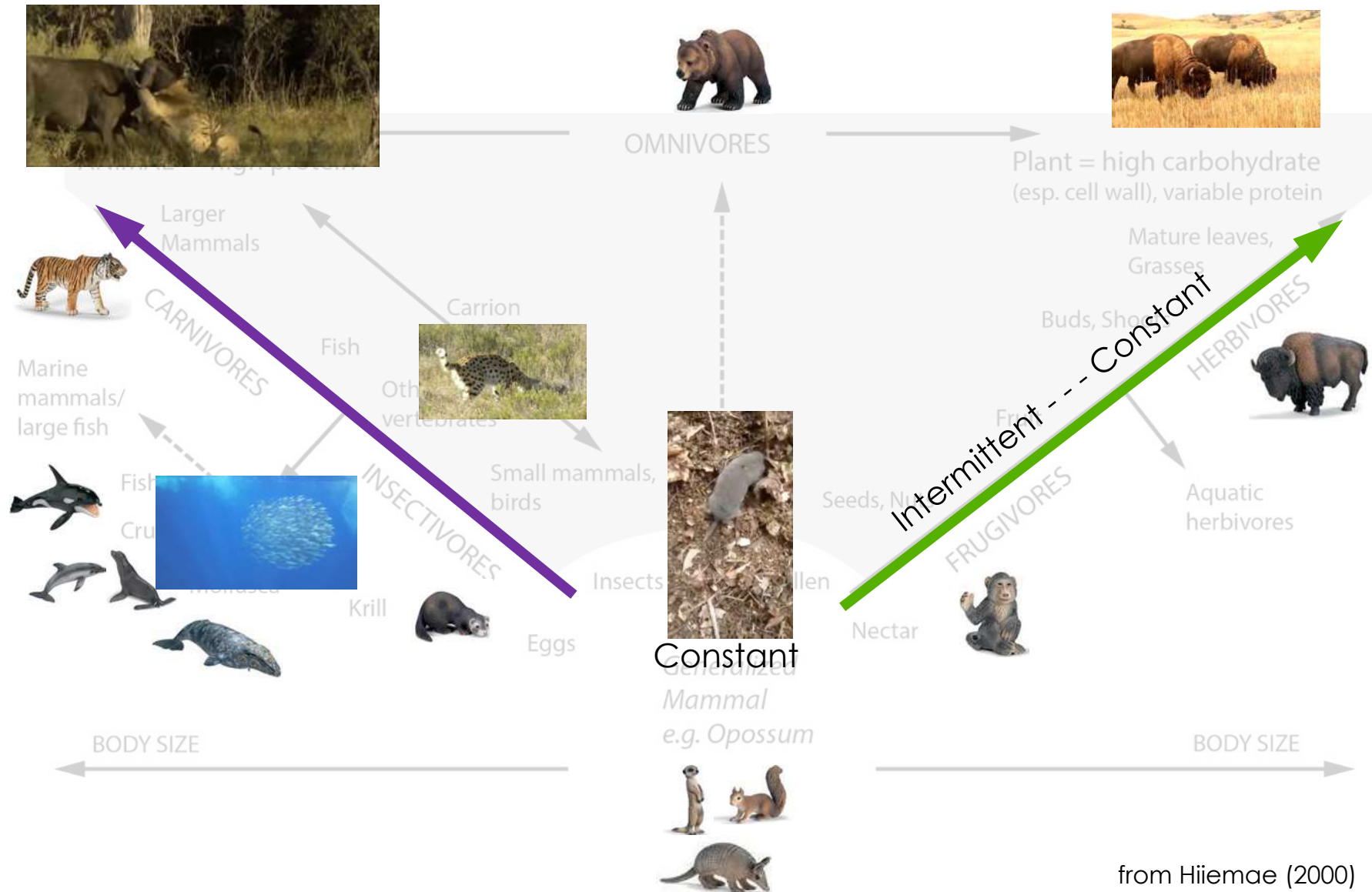


Feeding frequency





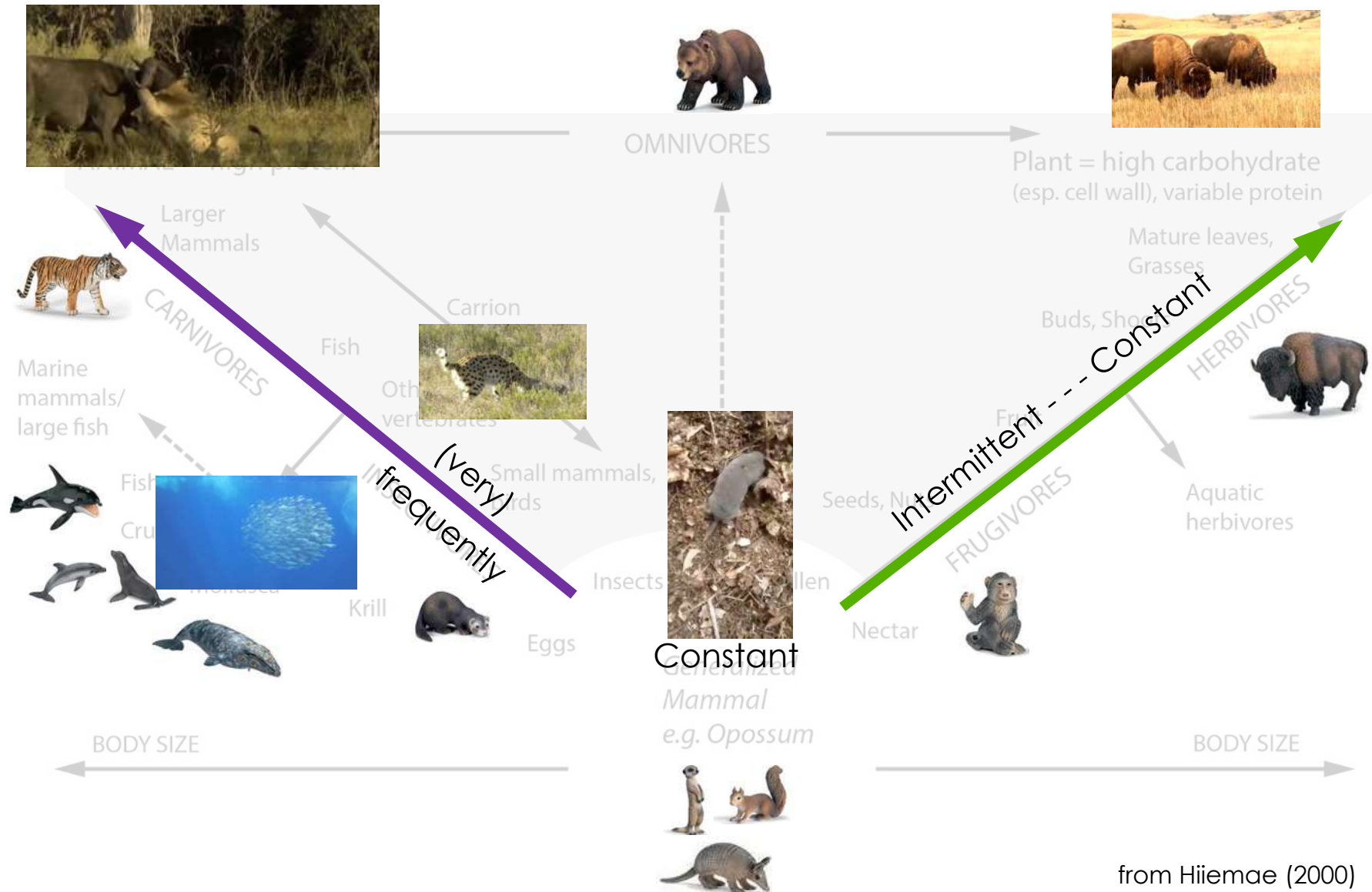
Feeding frequency



from Hiemae (2000)



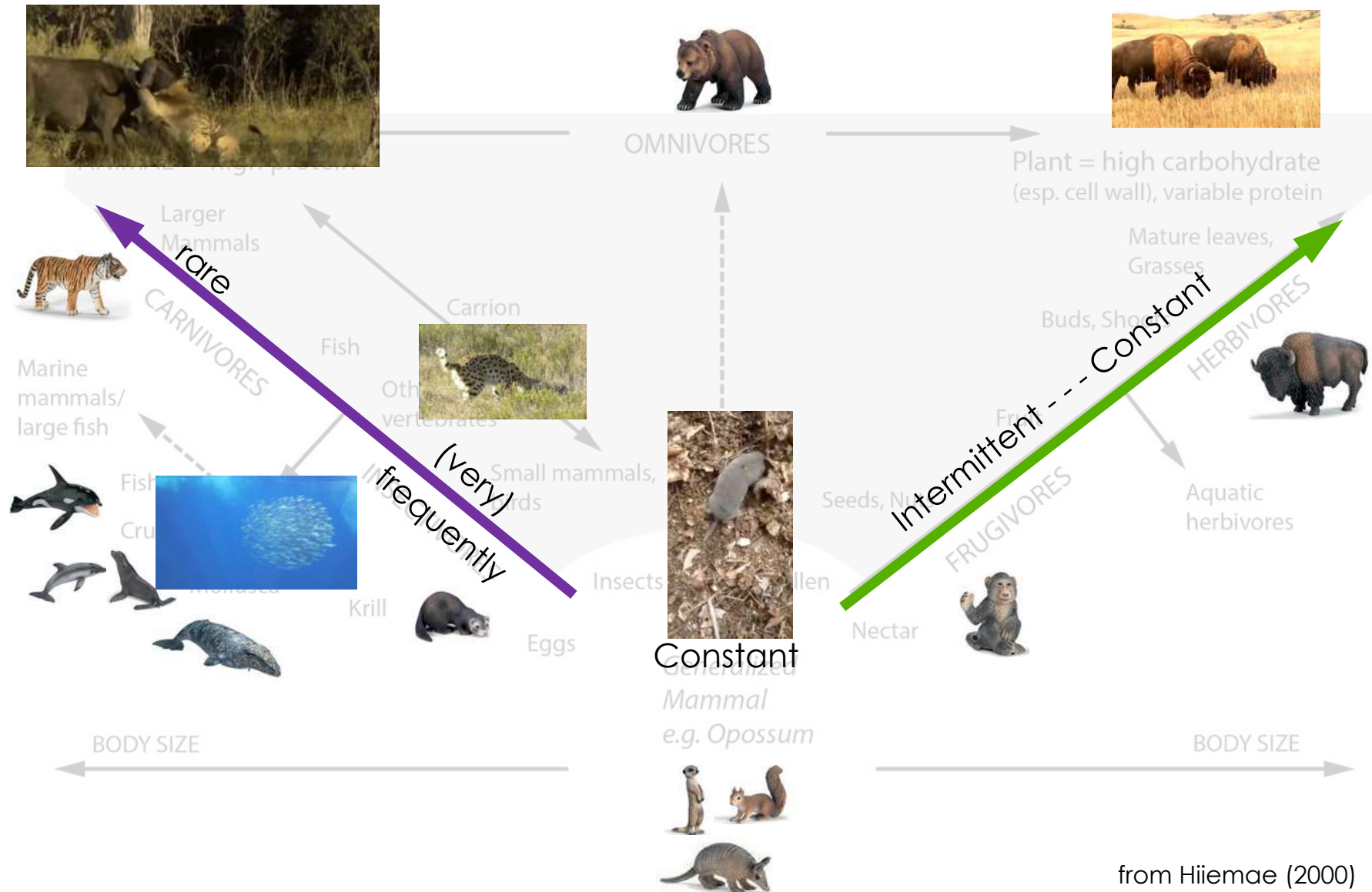
Feeding frequency



from Hiemae (2000)



Feeding frequency

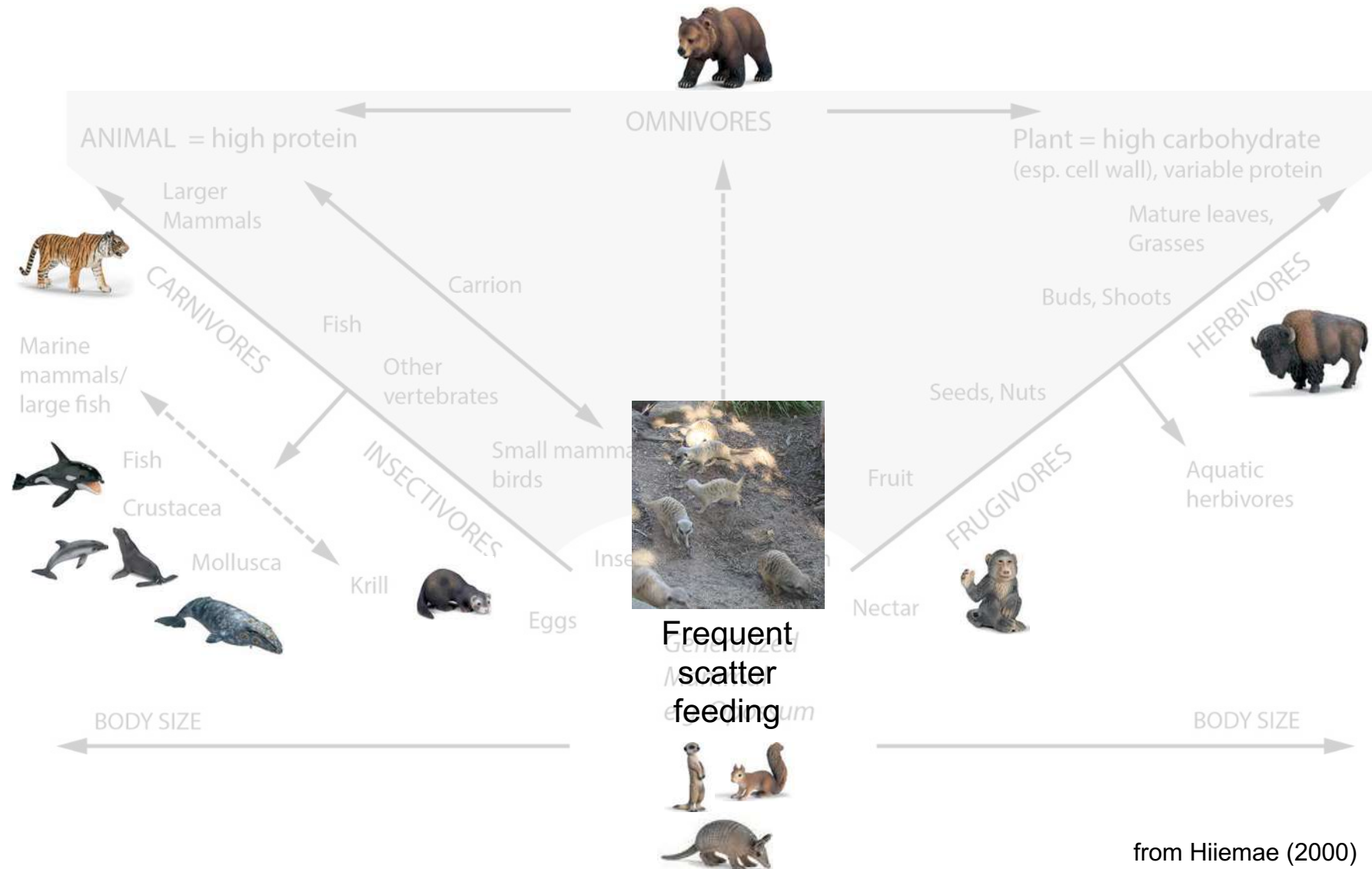




Feeding frequency in human care

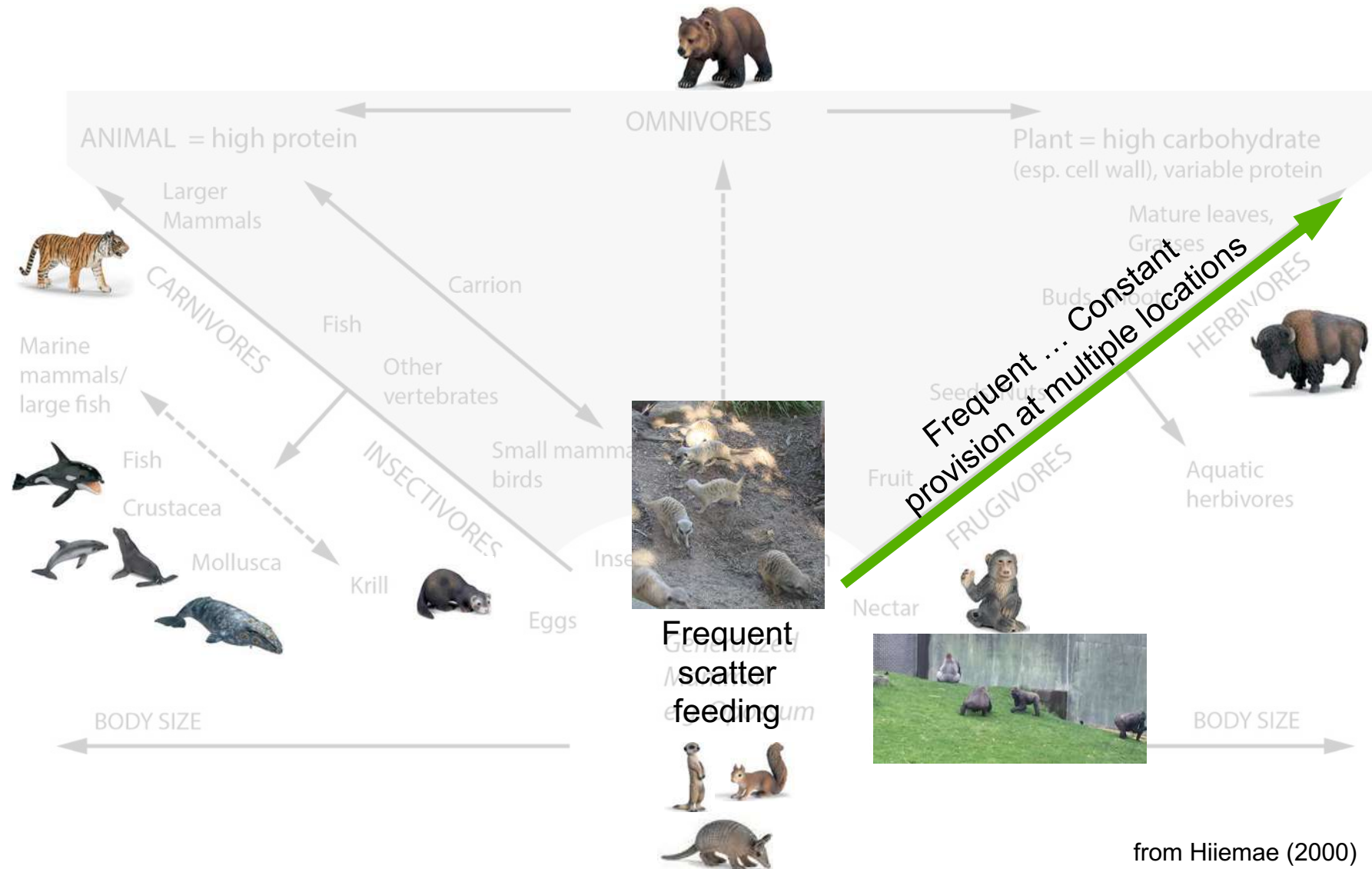


Zoo feeding frequency



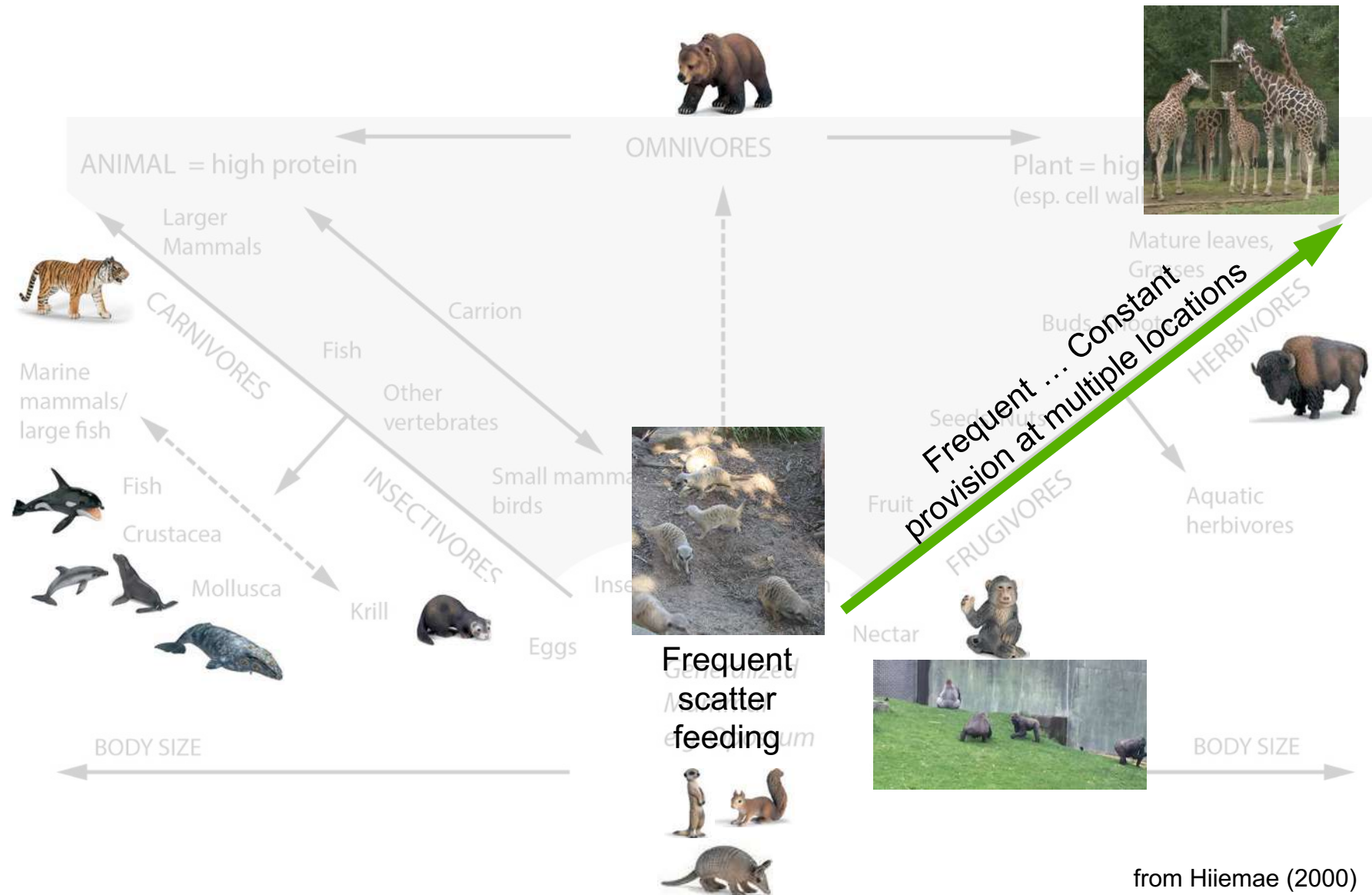


Zoo feeding frequency





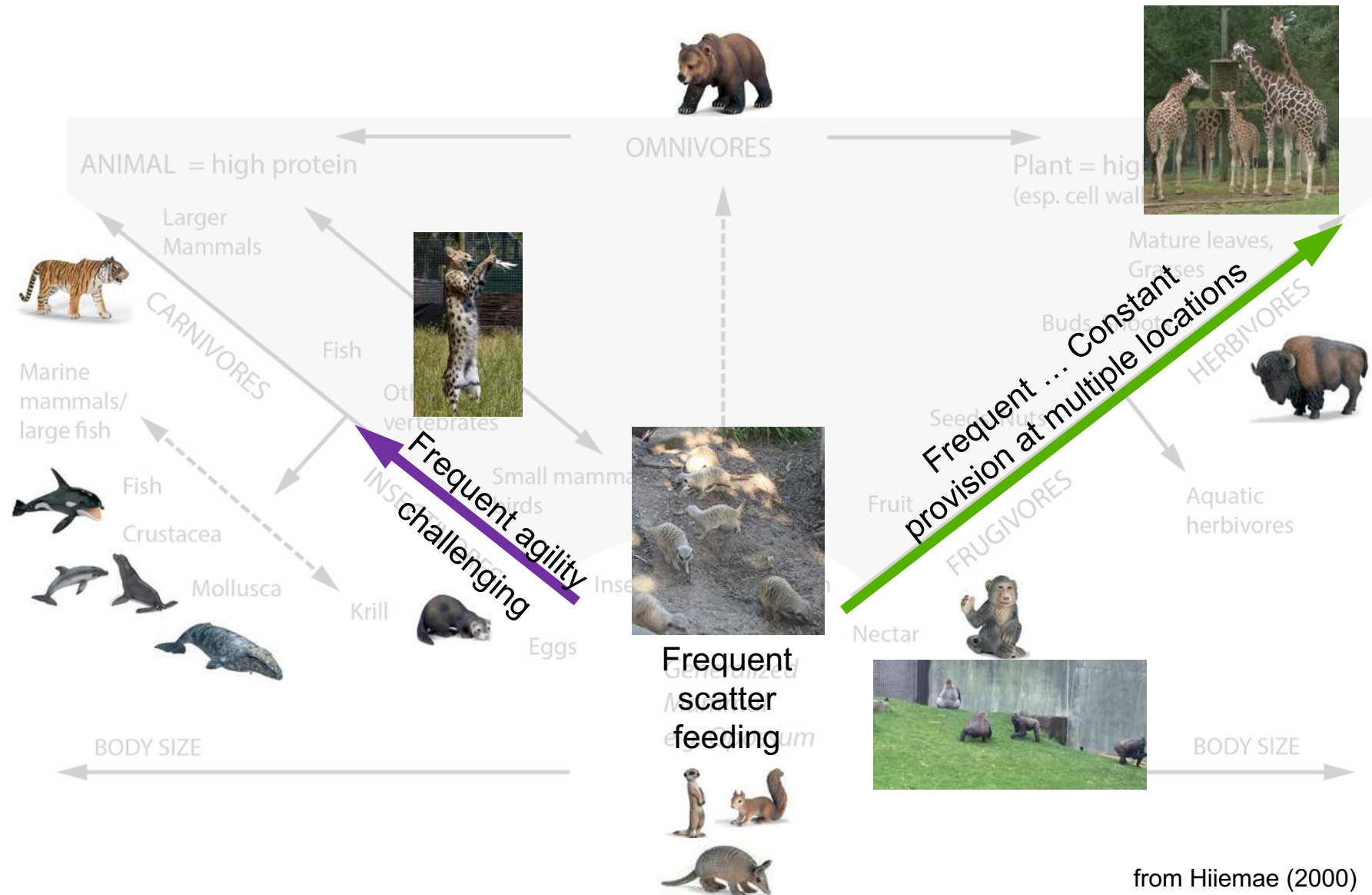
Zoo feeding frequency



from Hiimae (2000)



Zoo feeding frequency



from Hiemae (2000)



Semantics

words matter



Euphemisms

'Shellshock'



'Global warming'



'Pornography'



'Prison'





Euphemisms

'Shellshock'



'Combat fatigue'

'Global warming'



'Climate change'

'Pornography'



'Adult content'

'Prison'



'Correctional facility'



Euphemisms

'Shellshock'



'Combat fatigue'

'Global warming'



'Climate change'

'Pornography'



'Adult content'

'Prison'



'Correctional facility'

'Standard decency'





Euphemisms

'Shellshock'	↔	'Combat fatigue'
'Global warming'	↔	'Climate change'
'Pornography'	↔	'Adult content'
'Prison'	↔	'Correctional facility'
'Standard decency'	↔	'Enrichment'



Euphemisms

'Shellshock'	↔	'Combat fatigue'
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'Standard decency'	↔	'Enrichment'

Frequent scatter feeding is not 'enrichment'.





Euphemisms

'Shellshock'	↔	'Combat fatigue'
'Global warming'	↔	'Climate change'
'Pornography'	↔	'Adult content'
'Prison'	↔	'Correctional facility'
'Standard decency'	↔	'Enrichment'

Frequent scatter feeding is not 'enrichment'.
Lump feeding in 1-2 meals is pauperization.





Contingency plan ?

If you feed your tiger like this ...





Contingency plan ?

If you feed your tiger like this ...



*... you deprive it of 0.5-3 hours of hunt/ chase/ strain/ effort
every day.*



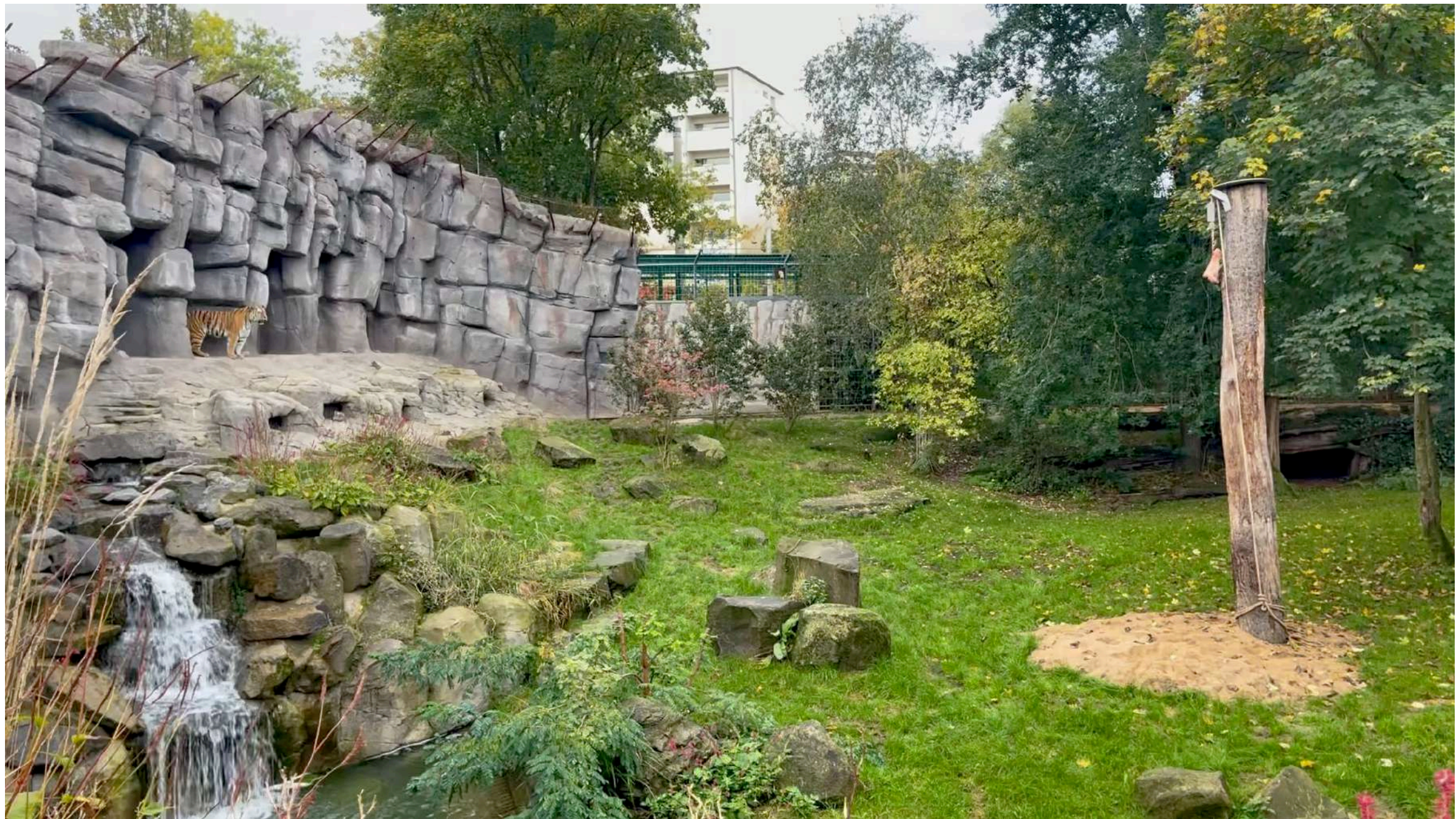
Contingency plan ?

If you feed your tiger like this ...

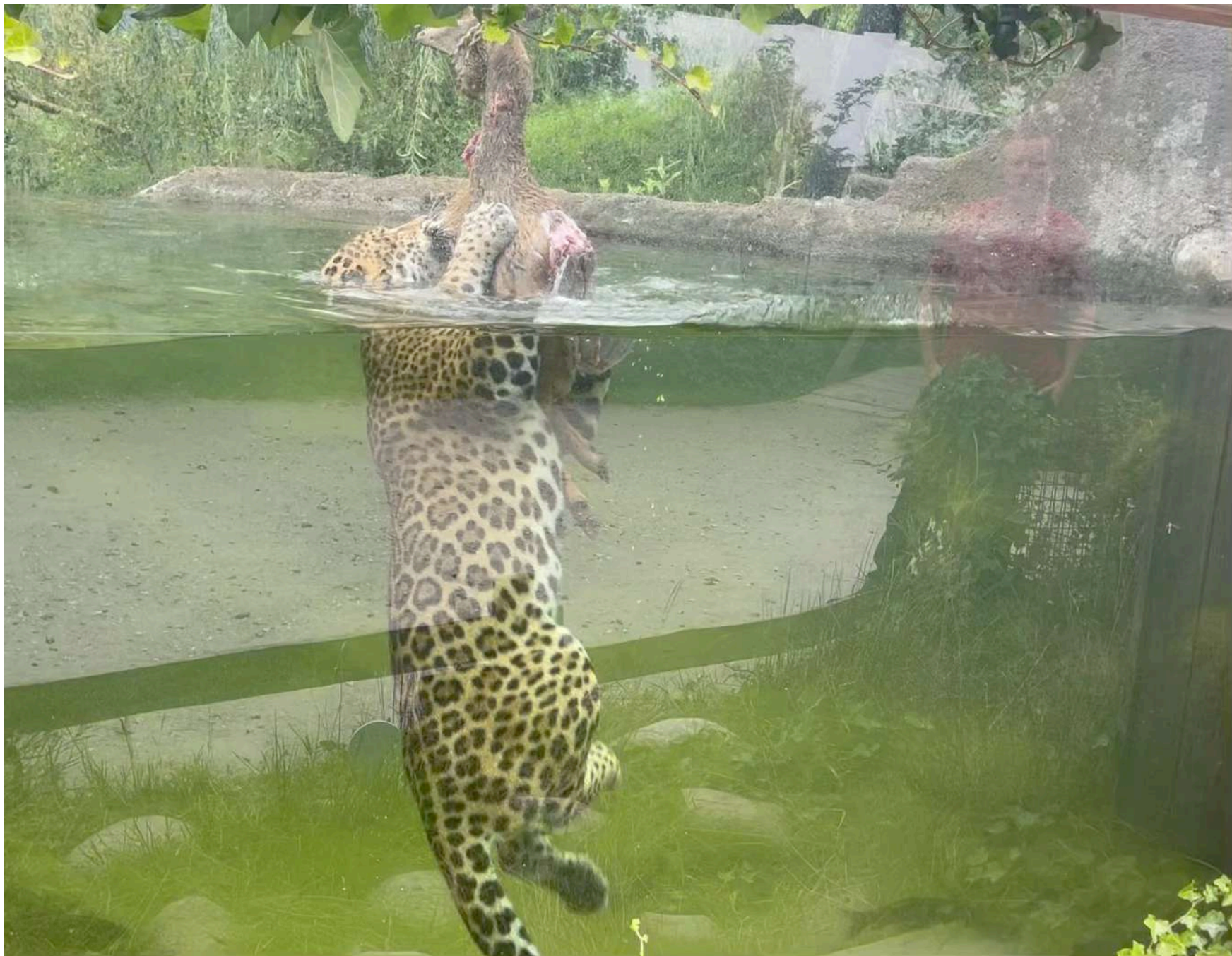


*... you deprive it of 0.5-3 hours of hunt/ chase/ strain/ effort
every day.*

What is your plan to compensate for that ?



Cellina Kleinlugtenbelt (2022)



Cellina Kleinlugtenbelt (2022)



Cellina Kleinlugtenbelt (2022)



Contingency plan ?

If you feed your meerkat like this ...



*... you deprive it of 3-4 hours of searching effort **every day**.*

What is your plan to compensate for that ?



Automated scatter feeding





Contingency plan ?

If you feed your herbivore like this ...



*... you deprive it of a lot of locomotion and searching effort
every day.*

What is your plan to compensate for that ?



Difficult access for herbivores



don't use fruits/carrots! just a grid example



Checklist

What is the natural food?





Checklist

What is the natural food?



What is the appropriate surrogate food?





Checklist

What is the natural food?
What are the (assumed) requirements?



Item	Quantity	Unit	Notes
Hay	10	kg	
Grain	5	kg	
Supplements	1	kg	
Water	10	litres	
Bedding	10	kg	
Stable equipment	1	set	
Transport	1	unit	
Veterinary services	1	unit	
Farrier services	1	unit	
Insurance	1	unit	
Stable management	1	unit	
Stable hygiene	1	unit	
Stable ventilation	1	unit	
Stable lighting	1	unit	
Stable heating	1	unit	
Stable cooling	1	unit	
Stable security	1	unit	
Stable safety	1	unit	
Stable maintenance	1	unit	
Stable repairs	1	unit	
Stable cleaning	1	unit	
Stable disinfection	1	unit	
Stable pest control	1	unit	
Stable fire safety	1	unit	
Stable first aid	1	unit	
Stable emergency procedures	1	unit	
Stable record keeping	1	unit	
Stable communication	1	unit	
Stable training	1	unit	
Stable management	1	unit	
Stable hygiene	1	unit	
Stable ventilation	1	unit	
Stable lighting	1	unit	
Stable heating	1	unit	
Stable cooling	1	unit	
Stable security	1	unit	
Stable safety	1	unit	
Stable maintenance	1	unit	
Stable repairs	1	unit	
Stable cleaning	1	unit	
Stable disinfection	1	unit	
Stable pest control	1	unit	
Stable fire safety	1	unit	
Stable first aid	1	unit	
Stable emergency procedures	1	unit	
Stable record keeping	1	unit	
Stable communication	1	unit	
Stable training	1	unit	

What is the appropriate surrogate food?





Checklist

What is the natural food?

What are the (assumed) requirements?

What is the natural foraging mode?

What is the appropriate surrogate food?

What safety feeds do I need?

What feeding behaviour should be evoked?



Species	Age	Sex	Weight	Height	Length	Width	Depth	Volume	Area	Perimeter	Surface	Volume	Area	Perimeter	Surface
Donkey	1	Male	100	120	150	100	100	1000	1000	1000	1000	1000	1000	1000	1000
Donkey	2	Female	120	140	180	120	120	1200	1200	1200	1200	1200	1200	1200	1200
Donkey	3	Male	150	180	220	150	150	1500	1500	1500	1500	1500	1500	1500	1500
Donkey	4	Female	180	220	280	180	180	1800	1800	1800	1800	1800	1800	1800	1800
Donkey	5	Male	220	280	350	220	220	2200	2200	2200	2200	2200	2200	2200	2200
Donkey	6	Female	280	350	450	280	280	2800	2800	2800	2800	2800	2800	2800	2800
Donkey	7	Male	350	450	550	350	350	3500	3500	3500	3500	3500	3500	3500	3500
Donkey	8	Female	450	550	700	450	450	4500	4500	4500	4500	4500	4500	4500	4500
Donkey	9	Male	550	700	850	550	550	5500	5500	5500	5500	5500	5500	5500	5500
Donkey	10	Female	700	850	1100	700	700	7000	7000	7000	7000	7000	7000	7000	7000
Donkey	11	Male	850	1100	1400	850	850	8500	8500	8500	8500	8500	8500	8500	8500
Donkey	12	Female	1100	1400	1800	1100	1100	11000	11000	11000	11000	11000	11000	11000	11000
Donkey	13	Male	1400	1800	2300	1400	1400	14000	14000	14000	14000	14000	14000	14000	14000
Donkey	14	Female	1800	2300	3000	1800	1800	18000	18000	18000	18000	18000	18000	18000	18000
Donkey	15	Male	2300	3000	3800	2300	2300	23000	23000	23000	23000	23000	23000	23000	23000
Donkey	16	Female	3000	3800	5000	3000	3000	30000	30000	30000	30000	30000	30000	30000	30000
Donkey	17	Male	3800	5000	6500	3800	3800	38000	38000	38000	38000	38000	38000	38000	38000
Donkey	18	Female	5000	6500	8500	5000	5000	50000	50000	50000	50000	50000	50000	50000	50000
Donkey	19	Male	6500	8500	11000	6500	6500	65000	65000	65000	65000	65000	65000	65000	65000
Donkey	20	Female	8500	11000	14000	8500	8500	85000	85000	85000	85000	85000	85000	85000	85000
Donkey	21	Male	11000	14000	18000	11000	11000	110000	110000	110000	110000	110000	110000	110000	110000
Donkey	22	Female	14000	18000	23000	14000	14000	140000	140000	140000	140000	140000	140000	140000	140000
Donkey	23	Male	18000	23000	30000	18000	18000	180000	180000	180000	180000	180000	180000	180000	180000
Donkey	24	Female	23000	30000	38000	23000	23000	230000	230000	230000	230000	230000	230000	230000	230000
Donkey	25	Male	30000	38000	50000	30000	30000	300000	300000	300000	300000	300000	300000	300000	300000
Donkey	26	Female	38000	50000	65000	38000	38000	380000	380000	380000	380000	380000	380000	380000	380000
Donkey	27	Male	50000	65000	85000	50000	50000	500000	500000	500000	500000	500000	500000	500000	500000
Donkey	28	Female	65000	85000	110000	65000	65000	650000	650000	650000	650000	650000	650000	650000	650000
Donkey	29	Male	85000	110000	140000	85000	85000	850000	850000	850000	850000	850000	850000	850000	850000
Donkey	30	Female	110000	140000	180000	110000	110000	1100000	1100000	1100000	1100000	1100000	1100000	1100000	1100000
Donkey	31	Male	140000	180000	230000	140000	140000	1400000	1400000	1400000	1400000	1400000	1400000	1400000	1400000
Donkey	32	Female	180000	230000	300000	180000	180000	1800000	1800000	1800000	1800000	1800000	1800000	1800000	1800000
Donkey	33	Male	230000	300000	380000	230000	230000	2300000	2300000	2300000	2300000	2300000	2300000	2300000	2300000
Donkey	34	Female	300000	380000	500000	300000	300000	3000000	3000000	3000000	3000000	3000000	3000000	3000000	3000000
Donkey	35	Male	380000	500000	650000	380000	380000	3800000	3800000	3800000	3800000	3800000	3800000	3800000	3800000
Donkey	36	Female	500000	650000	850000	500000	500000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000
Donkey	37	Male	650000	850000	1100000	650000	650000	6500000	6500000	6500000	6500000	6500000	6500000	6500000	6500000
Donkey	38	Female	850000	1100000	1400000	850000	850000	8500000	8500000	8500000	8500000	8500000	8500000	8500000	8500000
Donkey	39	Male	1100000	1400000	1800000	1100000	1100000	11000000	11000000	11000000	11000000	11000000	11000000	11000000	11000000
Donkey	40	Female	1400000	1800000	2300000	1400000	1400000	14000000	14000000	14000000	14000000	14000000	14000000	14000000	14000000
Donkey	41	Male	1800000	2300000	3000000	1800000	18								



Checklist

What is the natural food?

What are the (assumed) requirements?

What is the natural foraging mode?

What is the natural feeding frequency?

What is the appropriate surrogate food?

What safety feeds do I need?

What feeding behaviour should be evoked?



Item	Quantity	Frequency	Notes
Grass	10kg	Daily	
Hay	5kg	Daily	
Grain	2kg	Daily	
Minerals	10g	Daily	
Vitamins	10g	Daily	
Water	10L	Daily	
Exercise	1h	Daily	
Stimulation	1h	Daily	
Enrichment	1h	Daily	
Health	1h	Daily	
Behaviour	1h	Daily	
Training	1h	Daily	
Rest	1h	Daily	
Stress	1h	Daily	
Illness	1h	Daily	
Death	1h	Daily	





Thank you for your attention