Basic calculations for feeding animals

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Belo Horizonte 2019

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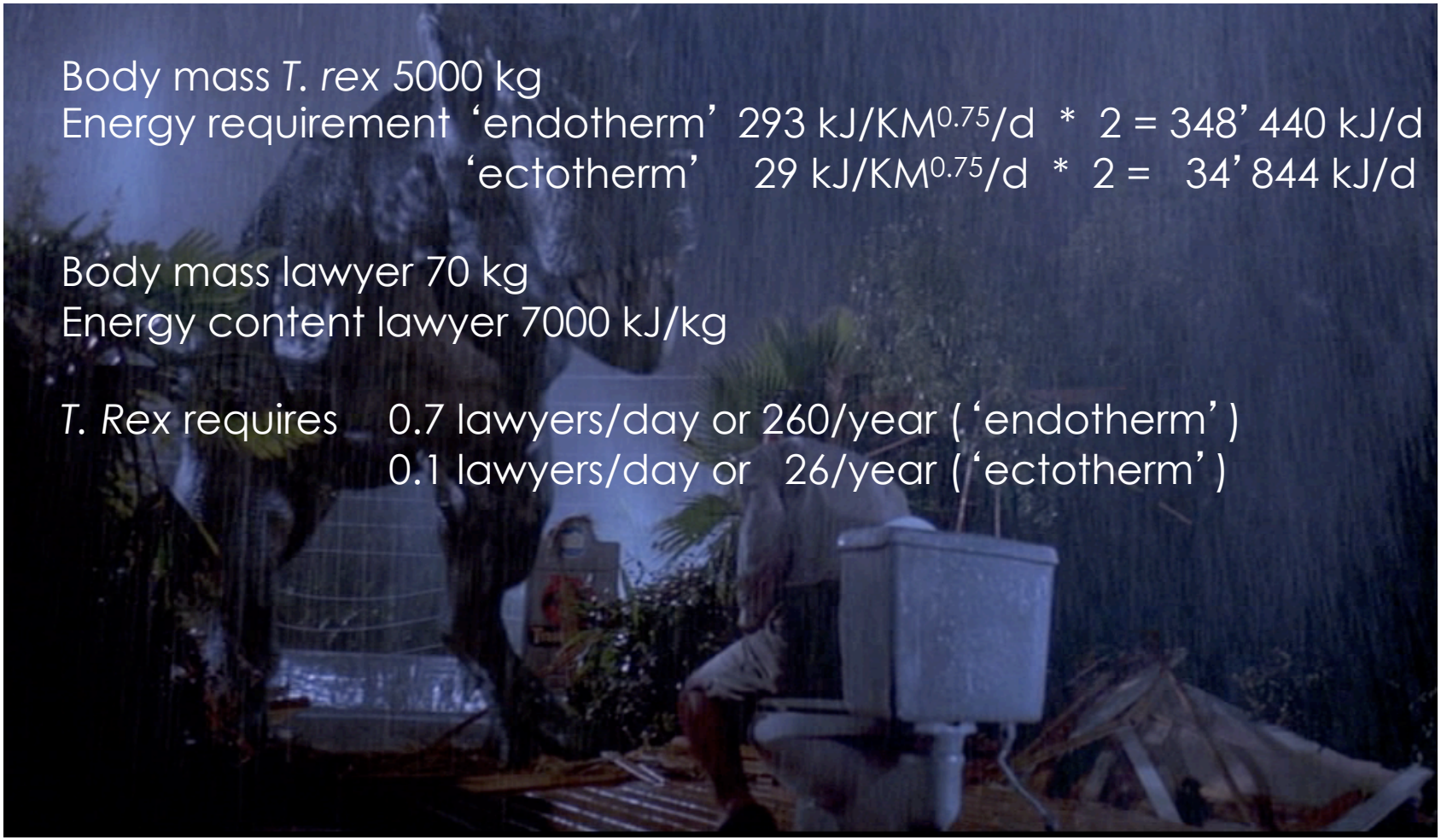
Clinic of Zoo Animals, Exotic Pets and Wildlife

How many lawyers does a T. rex need per year?



Body mass *T. rex* 5000 kg
Energy requirement 'endotherm' 293 kJ/KM$^{0.75}$/d * 2 = 348' 440 kJ/d
'ectotherm' 29 kJ/KM$^{0.75}$/d * 2 = 34' 844 kJ/d

Body mass lawyer 70 kg
Energy content lawyer 7000 kJ/kg

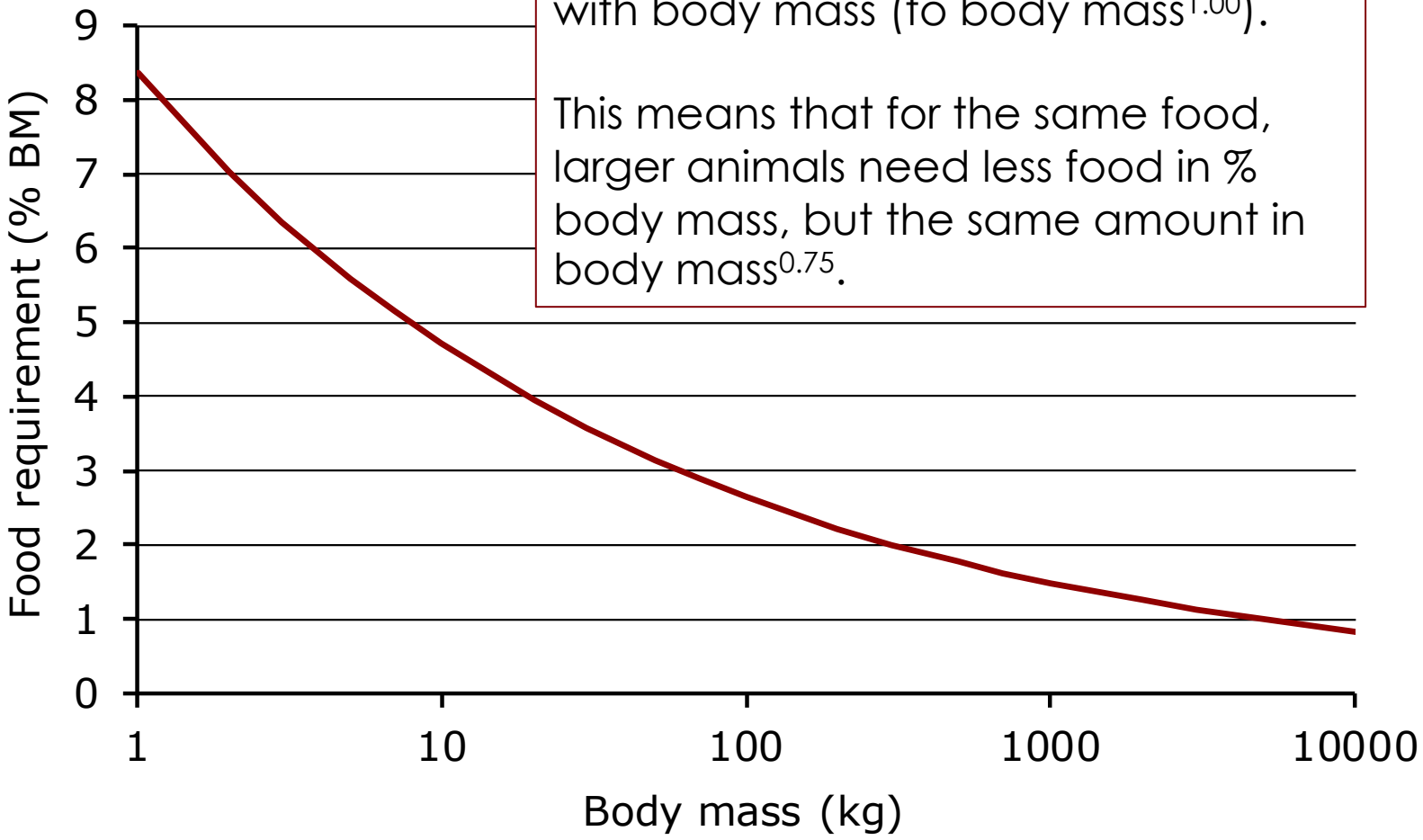
T. Rex requires 0.7 lawyers/day or 260/year ('endotherm')
0.1 lawyers/day or 26/year ('ectotherm')

from Spielberg et al. (1993)

Food requirements of … *anything*

Requirements do not scale linearly with body mass (to body mass$^{1.00}$).

This means that for the same food, larger animals need less food in % body mass, but the same amount in body mass$^{0.75}$.



Allometries

Morphological, physiological and life history variables scale with body mass.

Linear scaling: $y = a\ BM^{1.0}$ or $\log y = \log a + 1.0\ BM$

if this is correct, you can use "mg/kg" or "% of body mass"

in other words, if you use "mg/kg" or "% of body mass" you are implying that the scaling is linear

If scaling is not linear, you need "another measure" = allo-metry

Allometric scaling: $y = a\ BM^{b}$ or $\log y = \log a + b\ BM$

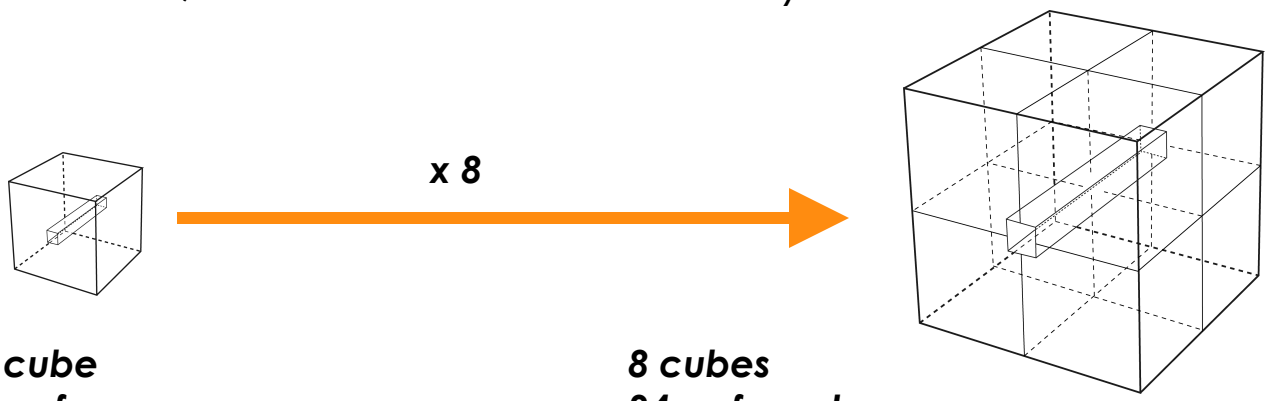
Allometries

Morphological, physiological and life history variables scale with body mass.

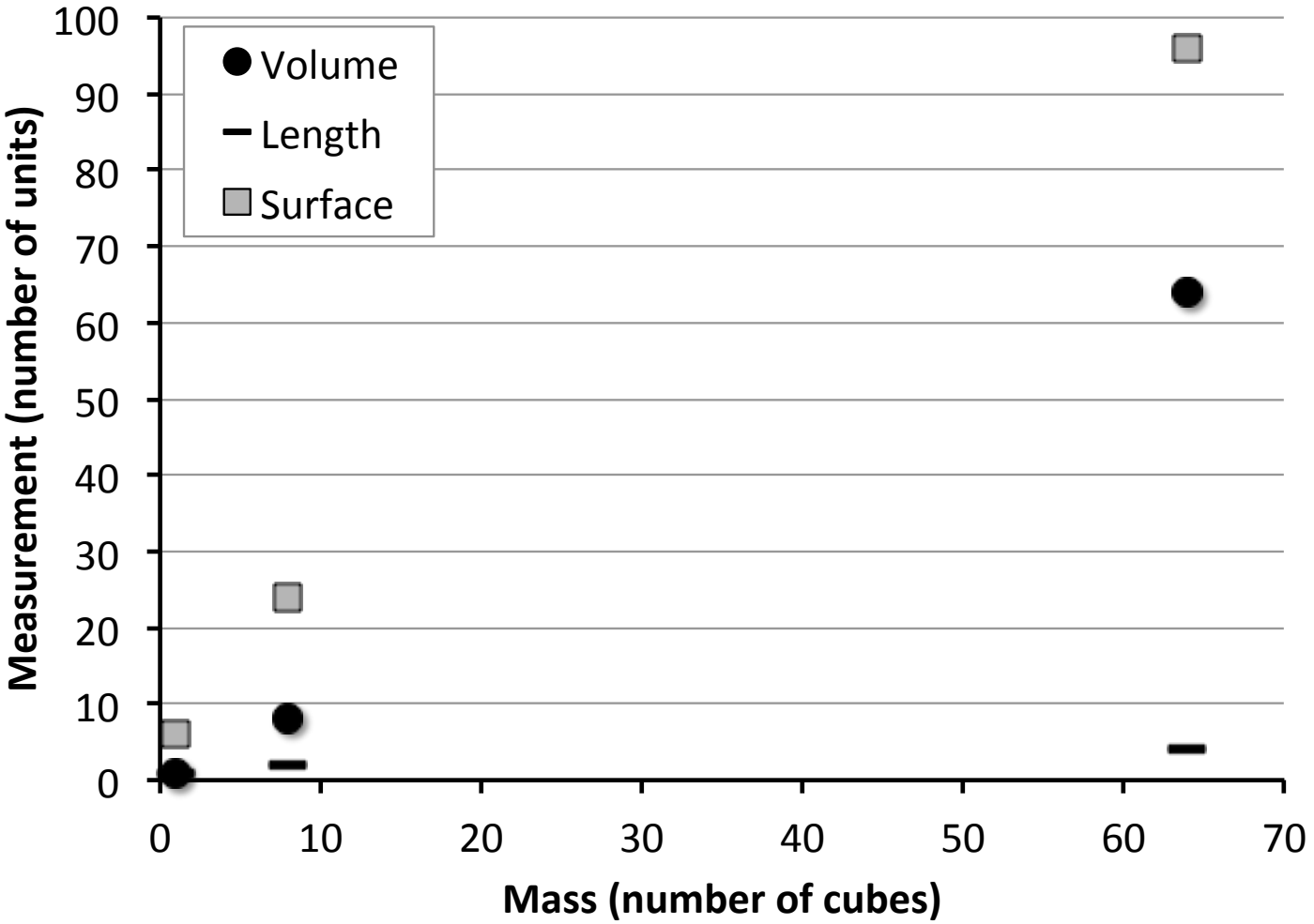
Linear scaling: $y = a\ BM^{1.0}$ *or* $\log y = \log a + 1.0\ BM$

Allometric scaling: $y = a\ BM^{b}$ *or* $\log y = \log a + b\ BM$

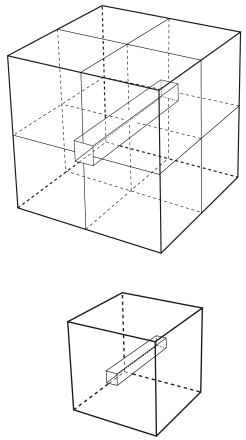
(allometric scaling mostly explained by geometry – e.g. surface-volume shifts, distribution networks etc.)



Geometric scaling



64 cubes



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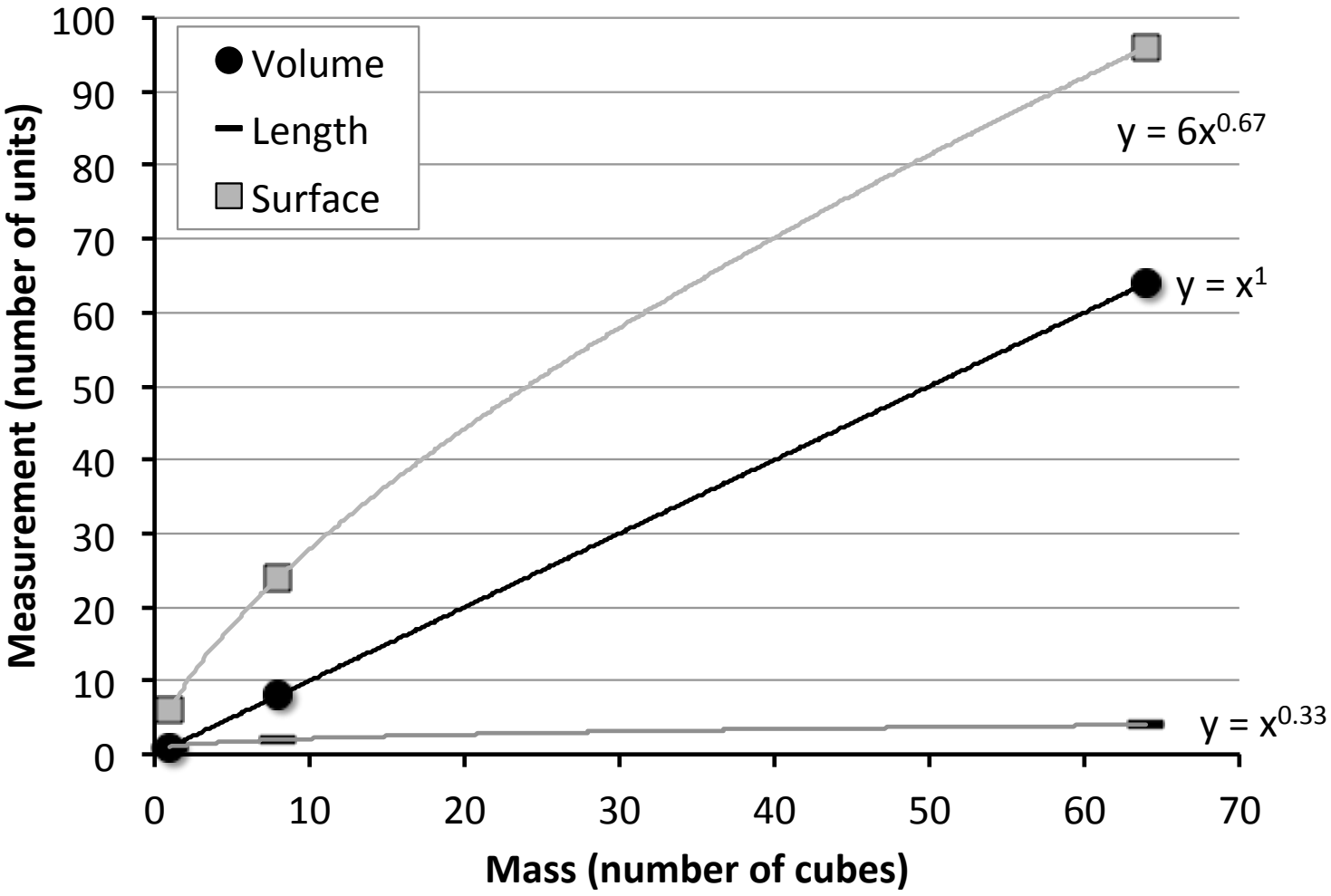

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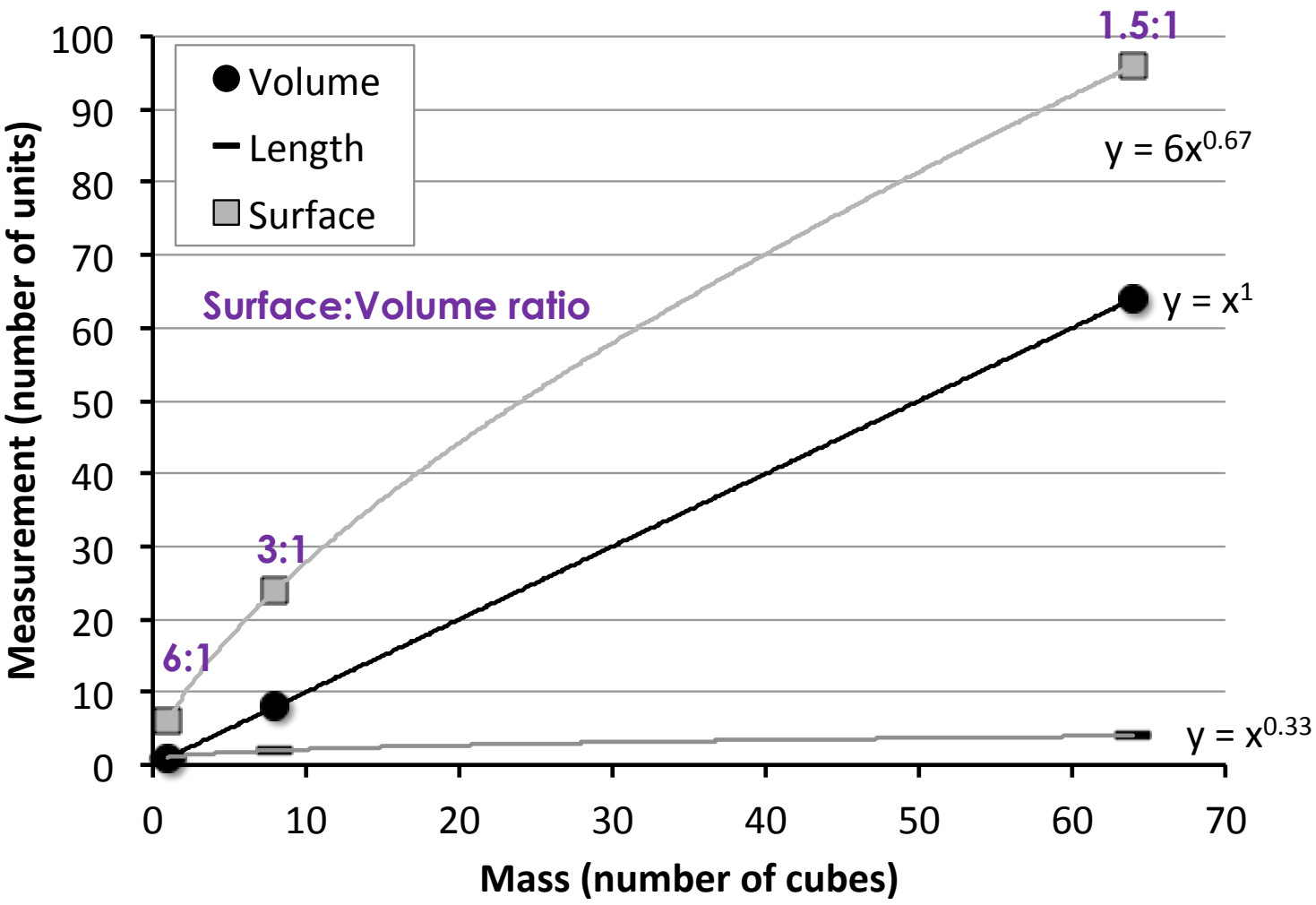

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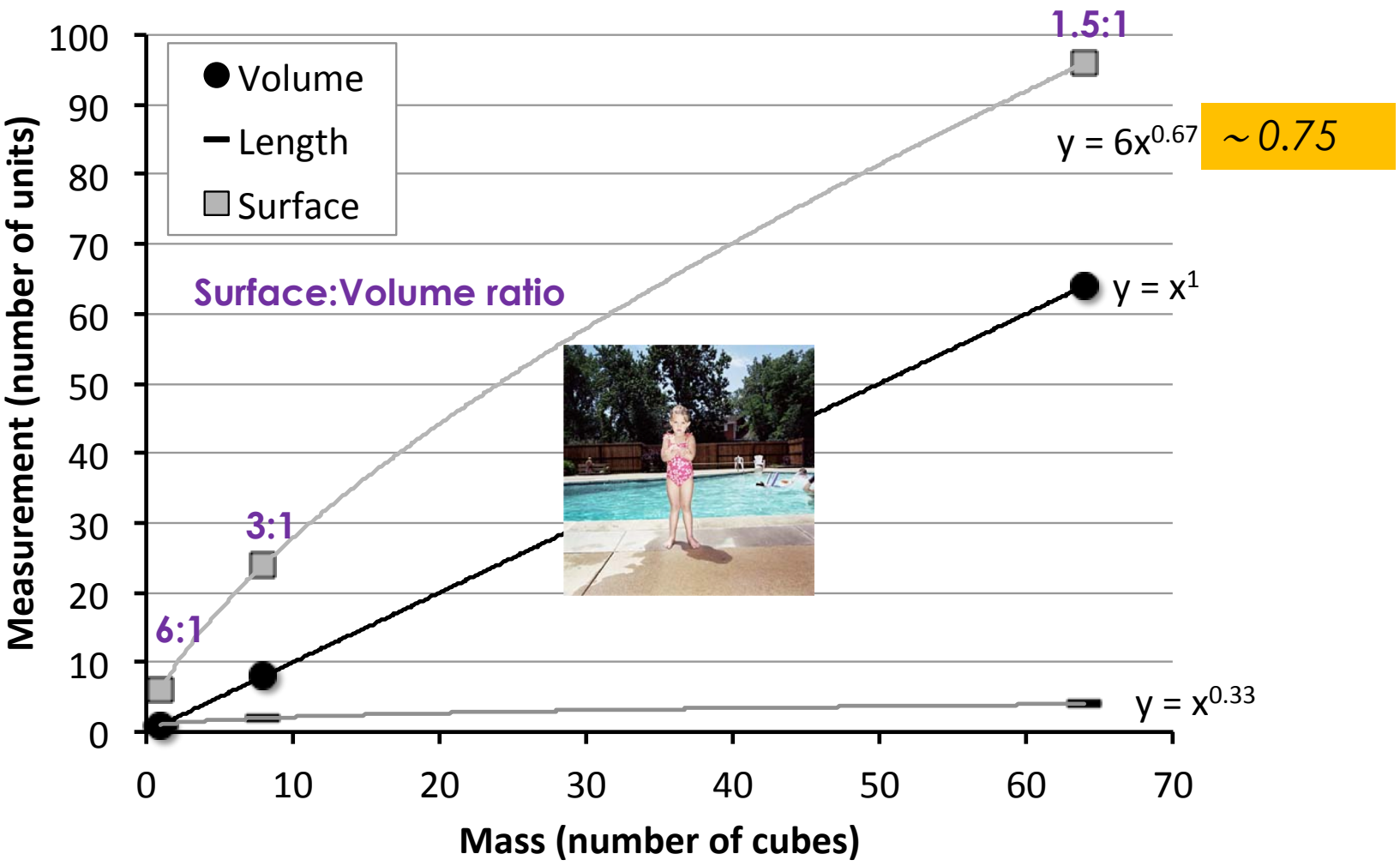

Nutrition of Captive and Free-Living Wild Animals

James K. Kirkwood

1. Requirement estimate
    - estimate (or weigh) body mass
    - estimate maintenance requirement (e.g., from Basal Metabolic Rate = BMR)

	Taxonomic group	Equation	Source
BMR	Reptiles (30°C)	$6.7\ W^{0.77}$	Bennett and Dawson, 1976
	Reptiles (20°C)	$2.5\ W^{0.80}$	Bennett and Dawson, 1976
	Birds	$80\ W^{0.67}$	Bennett and Harvey, 1987
	Eutherian mammals	$70\ W^{0.75}$	Kleiber, 1961
	Marsupial mammals	$48\ W^{0.74}$	Dawson and Hulbert, 1970

Table 23.1: Allometric equations describing basal metabolic rate (BMR), maintenance energy requirements (MER), and free-living average daily (ADMR) metabolic rates (kcal/day) for a variety of taxonomic groups in relation to body weight (W, kg).

1kcal = 4.184kJ.

BMR = 293 (kJ ME) * W (kg) $^{0.75}$

Maintenance ≈ 2 * 293 (kJ ME) * W (kg) $^{0.75}$

Remember: BMR is a requirement in ME (metabolizable energy). Not GE (gross energy)! Not DE (digestible energy)!

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2. Estimate metabolizable energy content in food
   - from tables, using various equations (e.g., dog & cat NRC)

Food	Carnivore	Omnivore	Herbivore
lean meat	1.5	1.5	-
fat	9	9	9
whole animals	1.5	1.5	-
grass	-	0.5	0.5
hay	-	-	1.8
cereals/grains	-	3.5	3.0
green vegetables	-	0.2	0.3
roots	-	0.4	0.4
fresh fruit	-	0.4	0.4

Table 23.3: Approximate metabolisable energy densities of some foods

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Table 23.3: Approximate metabolisable energy densities of some foods (kcal/g fresh weight). (1kcal = 4.184kJ.)

!

dry matter of hay: 90% of fresh weight
dry matter of grass: 25% of fresh weight

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3. Calculate the required (estimated) amount
   - Requirement (kJ/d)/ ME concentration (kJ/kg ***fresh matter or dry matter***) = Amount (kg ***fresh matter or dry matter***)

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4. Monitor and adjust continuously !

But what about diets with several components ?


all items must be part of the calculation & weighing/counting



if animals must be fed as a group, the least-preferred item should be given first, when all are hungry and will eat it, before more preferred items are offered

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if one item cannot be weighed practically (like forages), they are offered ad libitum, assuming the animals will eat enough of them (adjust forage as necessary)

But what about diets with several components ?

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no problem if you really monitor and adjust continuously

animals must be fed as a group, the least-preferred item must be given first, when all are hungry and will eat it, before more preferred items are offered

if one item cannot be weighed practically (like forages), they are offered ad libitum, assuming the animals will eat enough of them (adjust forage as necessary)