Energy evaluation
Residency Class Vienna 2008

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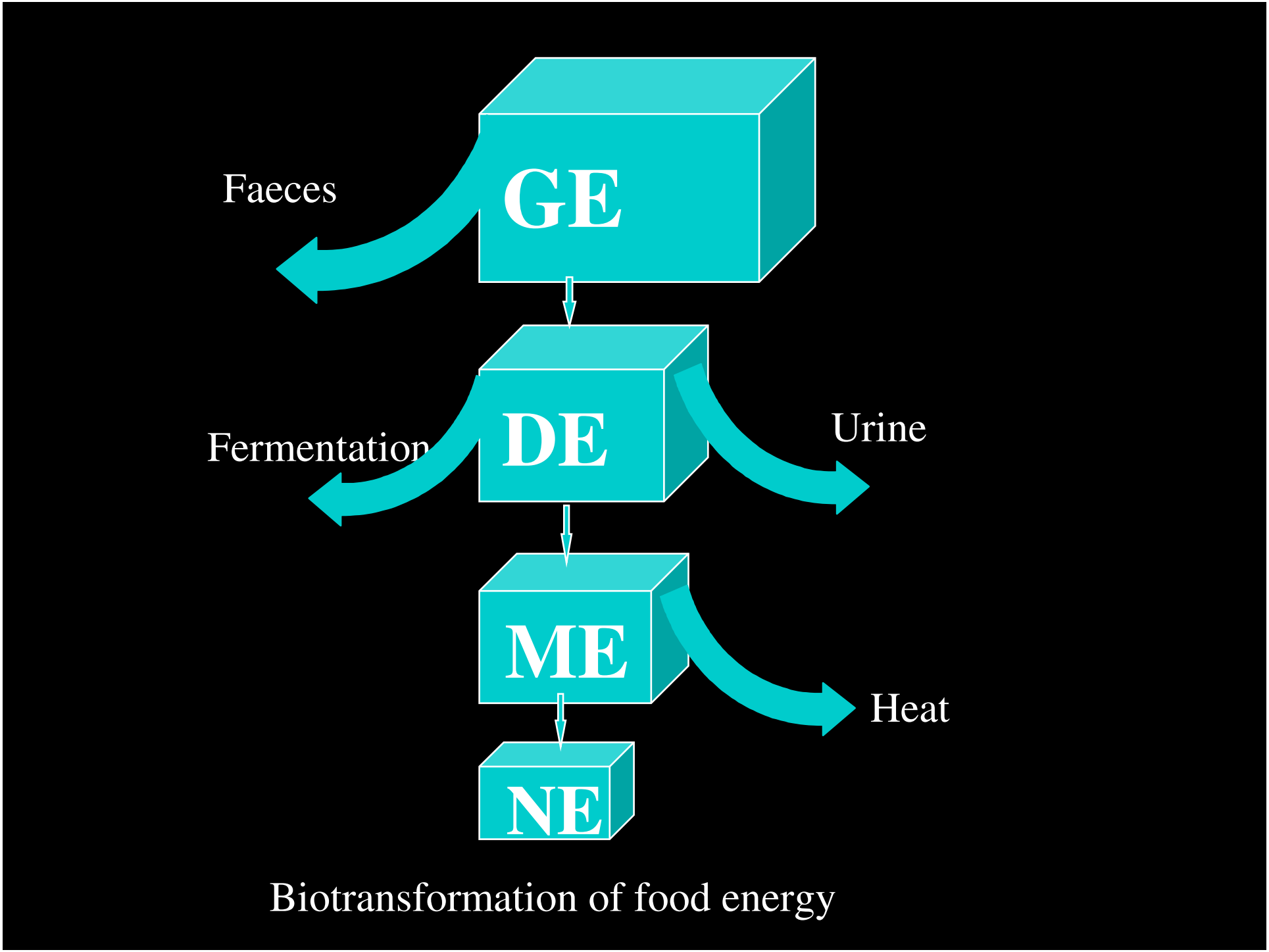
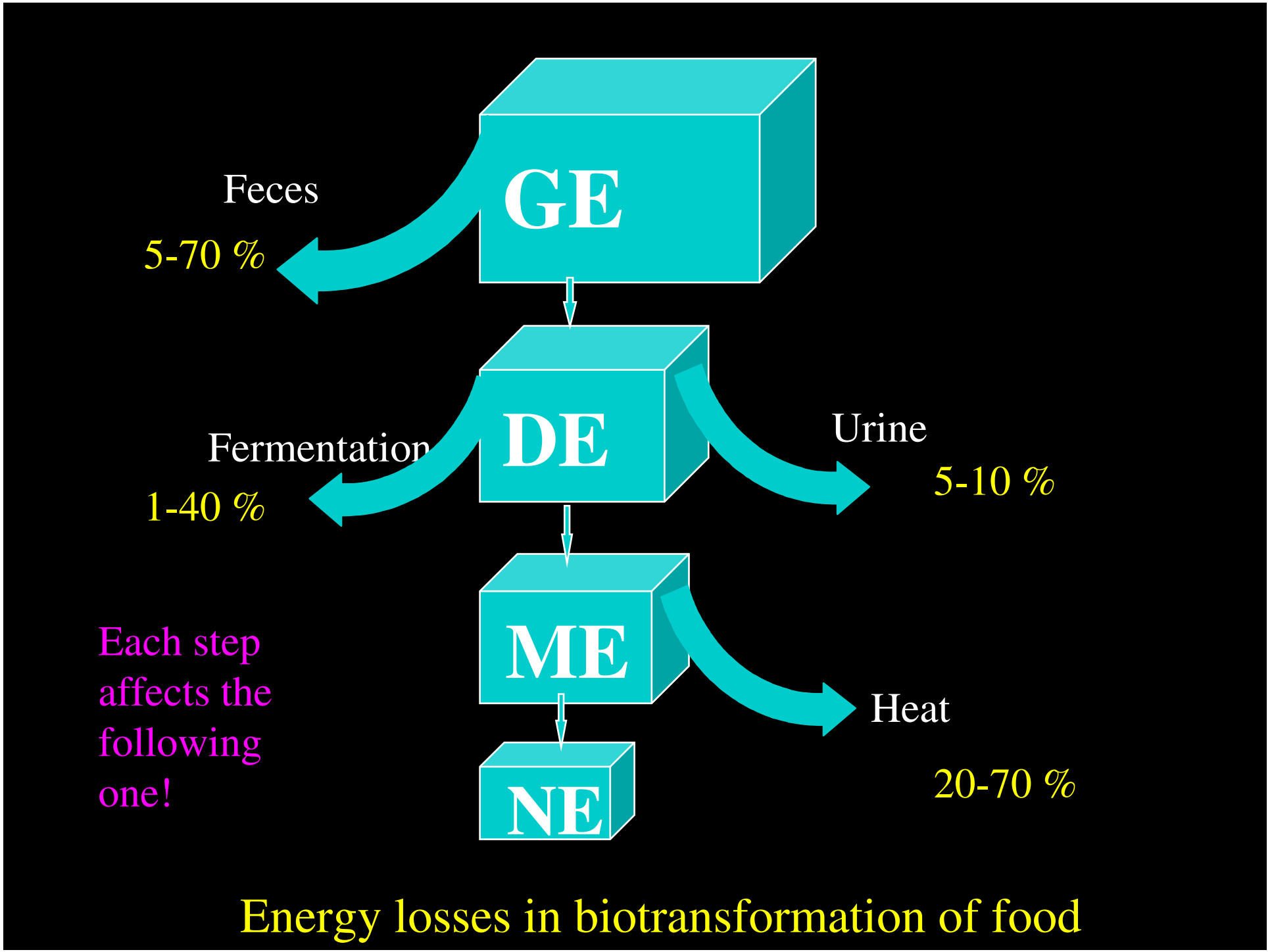
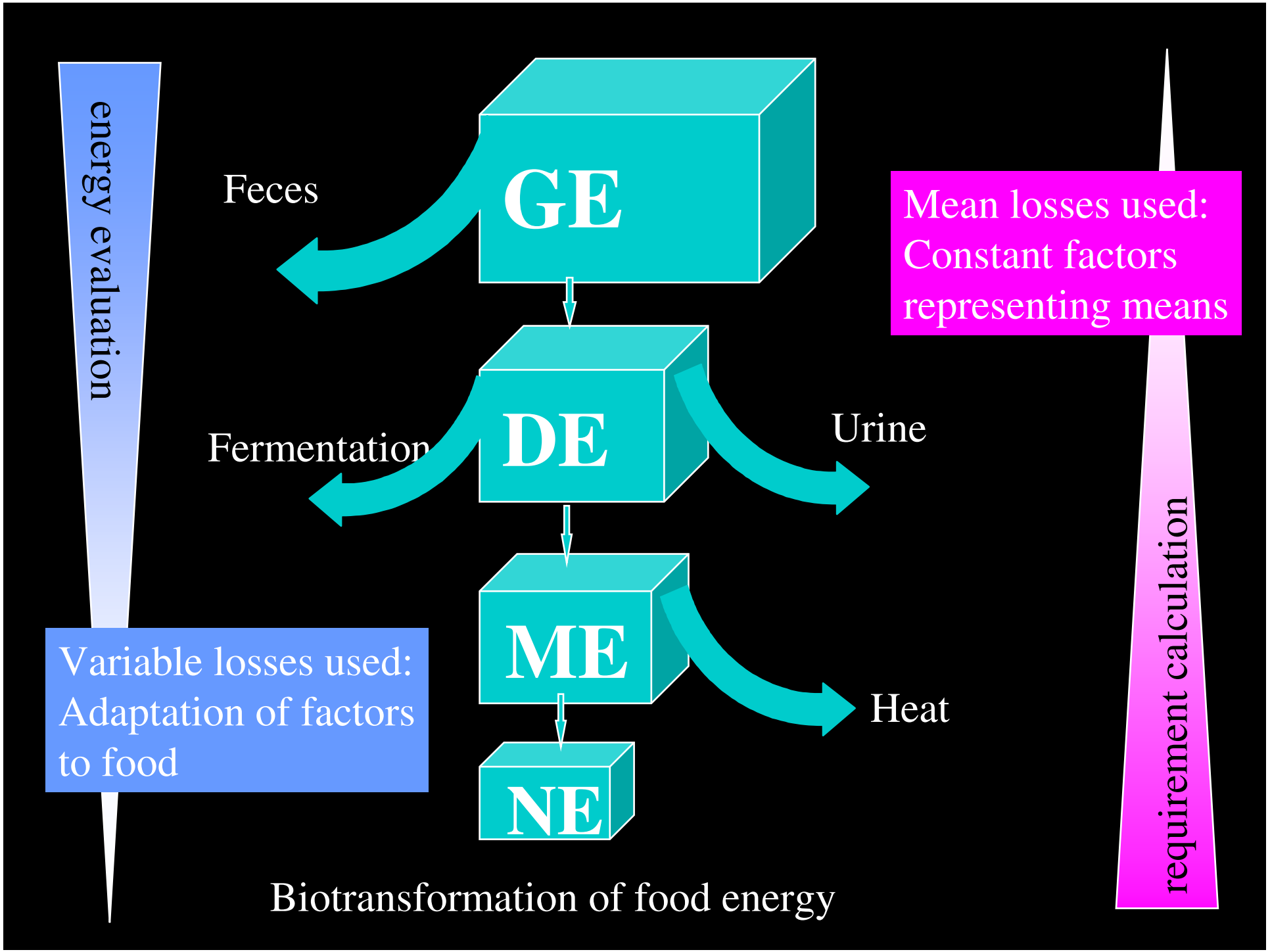
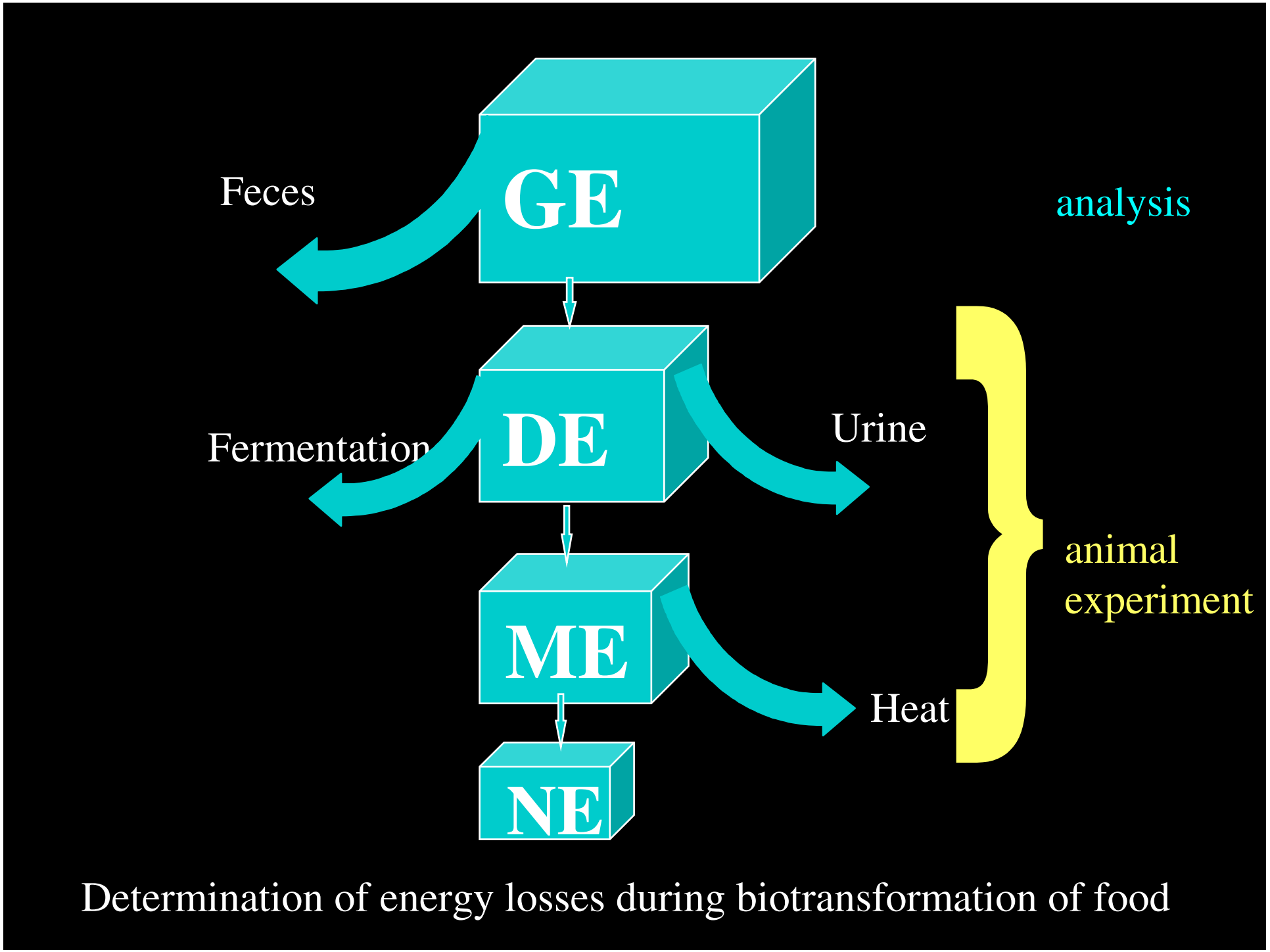


Biotransformation of food energy



Energy losses in biotransformation of food


energy evaluation
Feces
GE
Mean losses used:
Constant factors
representing means
DE
Fermentation
Urine
ME
Heat
NE
Variable losses used:
Adaptation of factors
to food
requirement calculation
Biotransformation of food energy



Determination of energy losses during biotransformation of food

There are two ways to get there for each step!

- Experimental determination
  - Scientific purposes
    - Development of
      - Evaluation systems
      - Predictive equations
  - Product development
- Estimation
  - Practical purposes – What‘s in the bag?
    - Ration and feed calculation
    - Product comparison

Gross energy GE

- Determination by bomb calorimetry
- Estimation by factors for proximates
  - Vary somewhat for different feed
  - For instance: fibre:
    - Polysaccharides 13-18 kJ/g organic matter
    - Lignin 17-27 kJ/g organic matter

    -> lignified fibre in feed for herbivores has higher GE than unlignified fibre in pet food

    -> „species differences“

  -> use factors appropriate to type of food

Determination of digestible energy

- Digestion trials
  - Bomb calorimetry of food and faeces
  - Cave: Estimates of energy in food and faeces using factors for proximates lead to systematic errors

Factors for proximates in faeces?

- Factors for proximates to calculate GE differ between faeces and food (higher lignin content, more NPN, more saturated fat in faeces than in food …..)
- -> faeces underestimated with food factors
  - up to 15 % difference, especially in herbivores
- -> digestibility overestimated with food factors
  - important when digestibility is low)
    - Error ~ 2 % when apparent digestibility is 85 %
    - Error ~ 8 % when apparent digestibility is 50 %

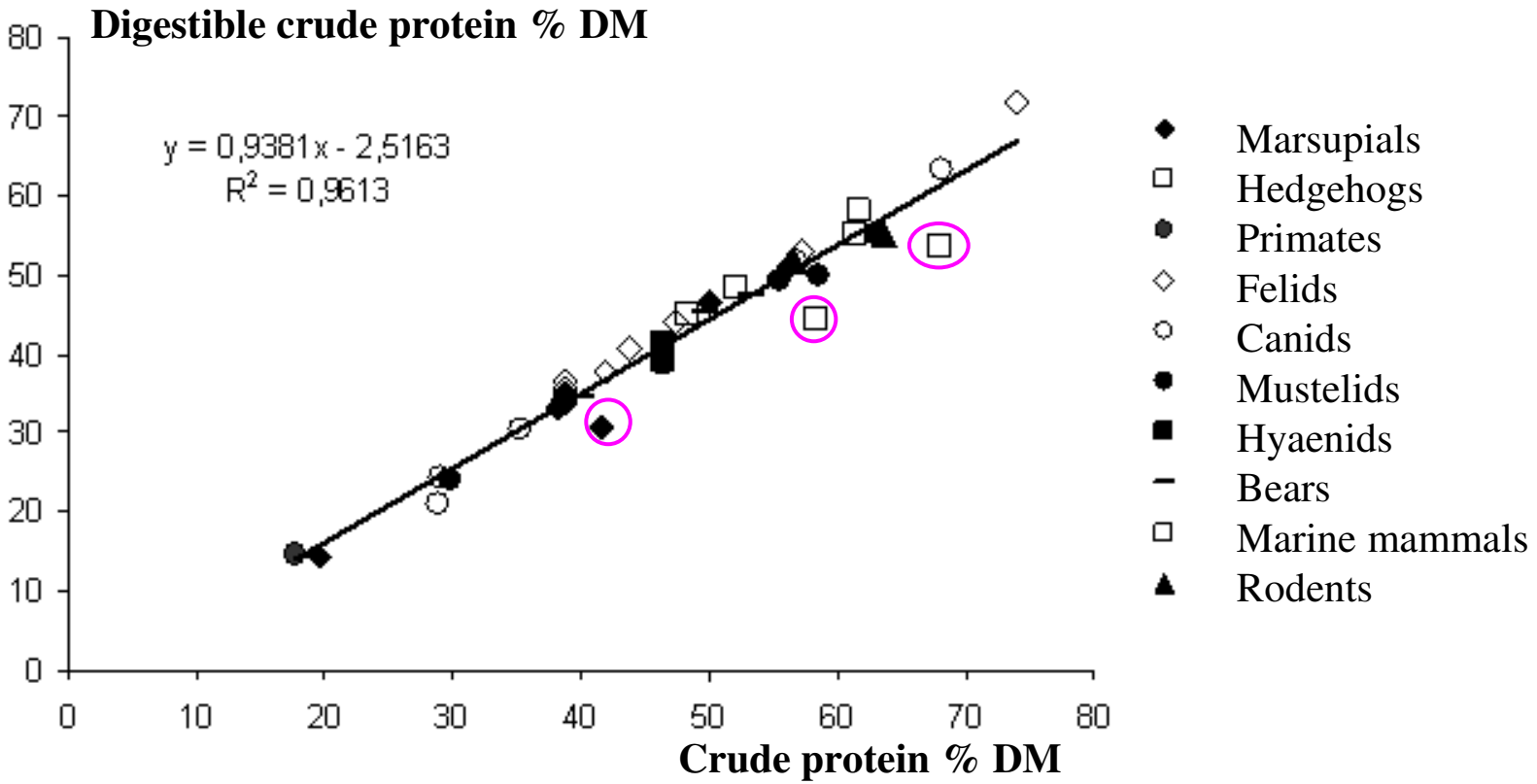
Alternative to bomb calorimetry in faeces: determine factors for faeces in respective species and for given type of feed

Estimation of digestible energy

- Predict digestibility
- For group of feed with uniform digestibility
  - Factors for proximates/nutrients
  - which include gross energy and mean digestibility of a nutrient

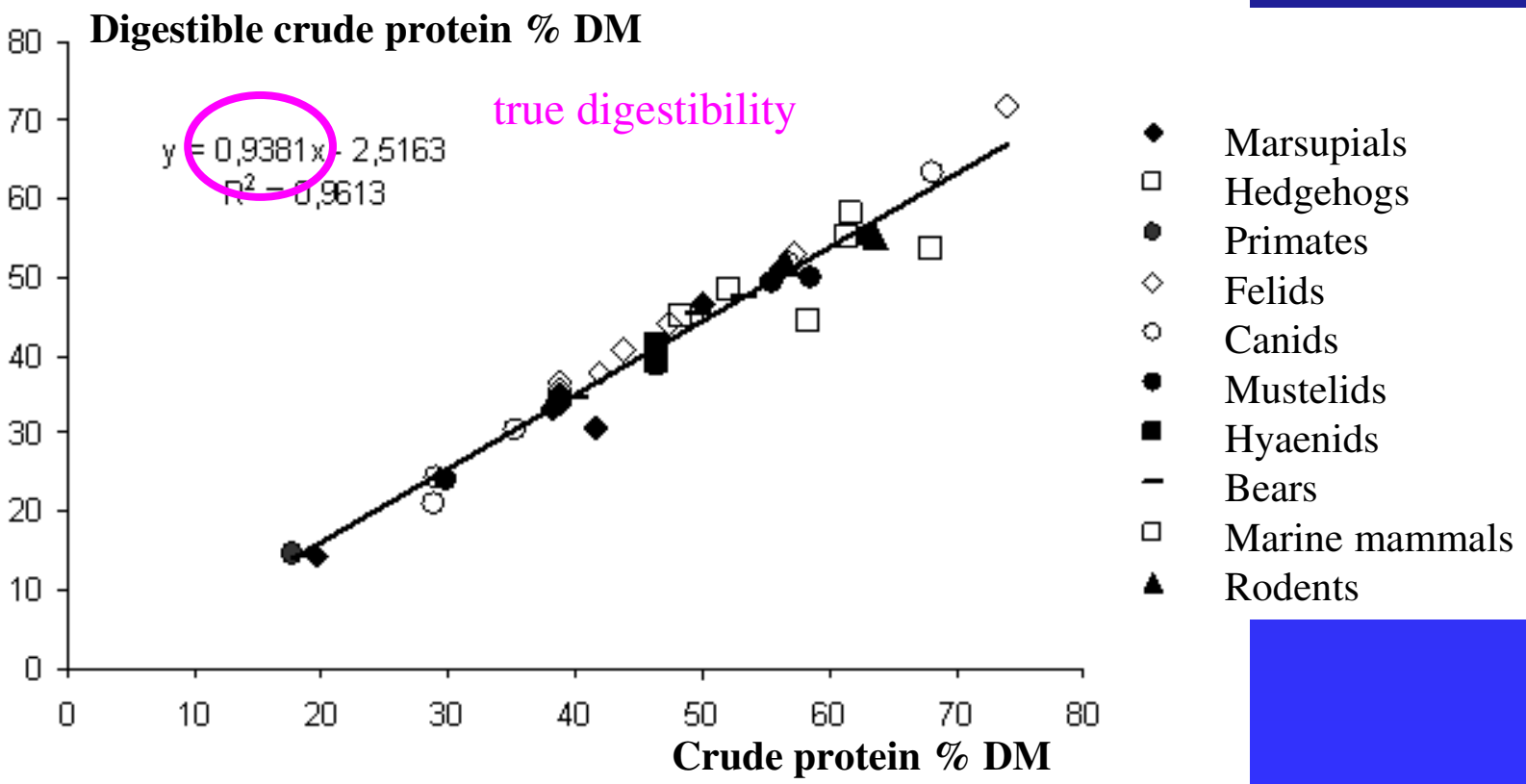
Estimation of digestible energy

- Testing for uniformity -> Lukastest
  - Home made diets for various zoo animals
  - Factor for protein possible



Estimation of digestible energy

- Developing Factors for proximates or

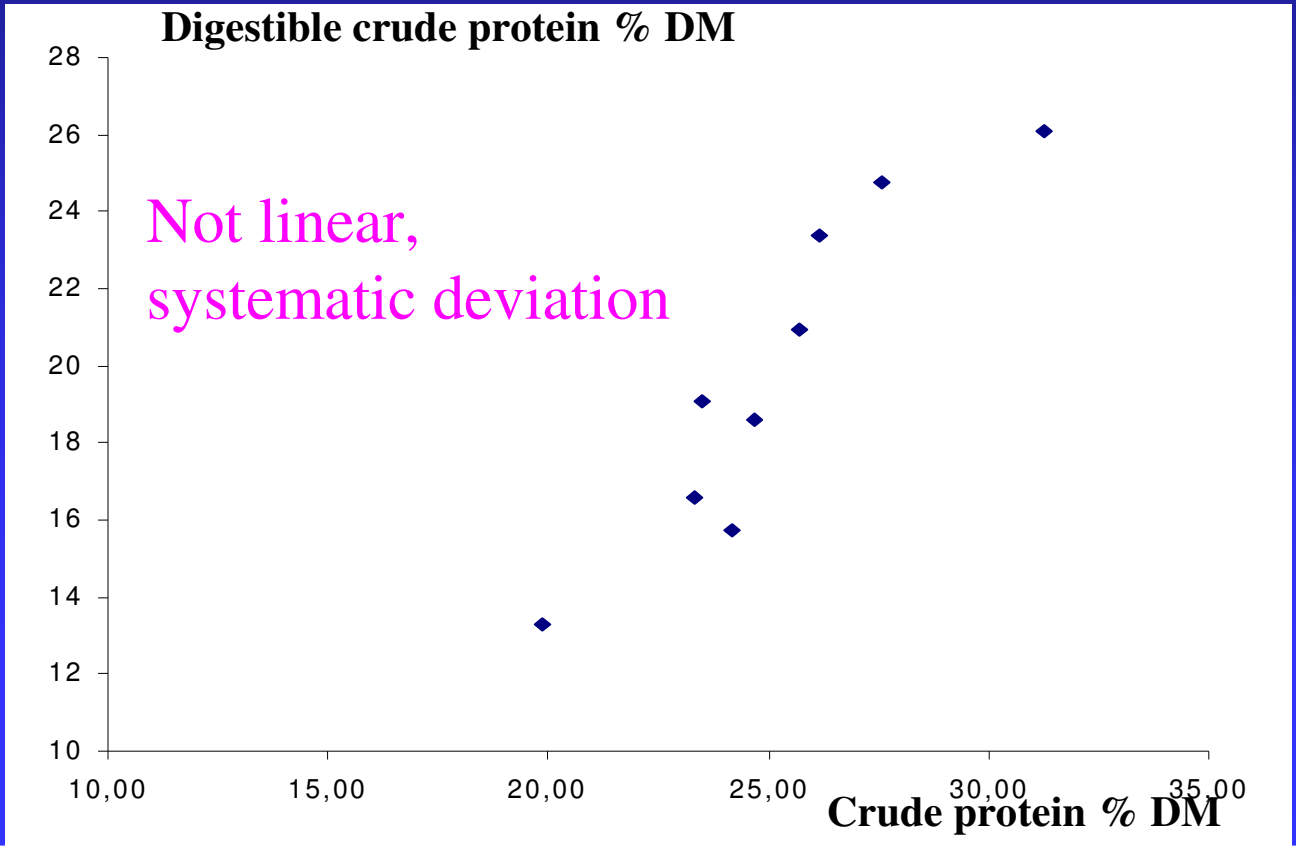


Estimation of digestible energy

- Developing Factors for proximates or nutrients by multiple regression analysis
  - Cave: Co-correlations between nutrients and/or energy (such as high fat -> low fibre…)
    - Factors may deviate from logical figures, may be even higher than for gross energy
    - Estimates may have systematic errors when the composition of the evaluated food deviates somewhat from the test population, even if the digestibility does NOT differ
    - Such statistical artefacts may even affect composition of feed when factorial ration calculation is used

Estimation of digestible energy

- Testing for uniformity -> Lukastest
  - Semi-purified high fibre/high carbohydrate diets for dogs
  - not uniform, not linear, common factors cannot be found

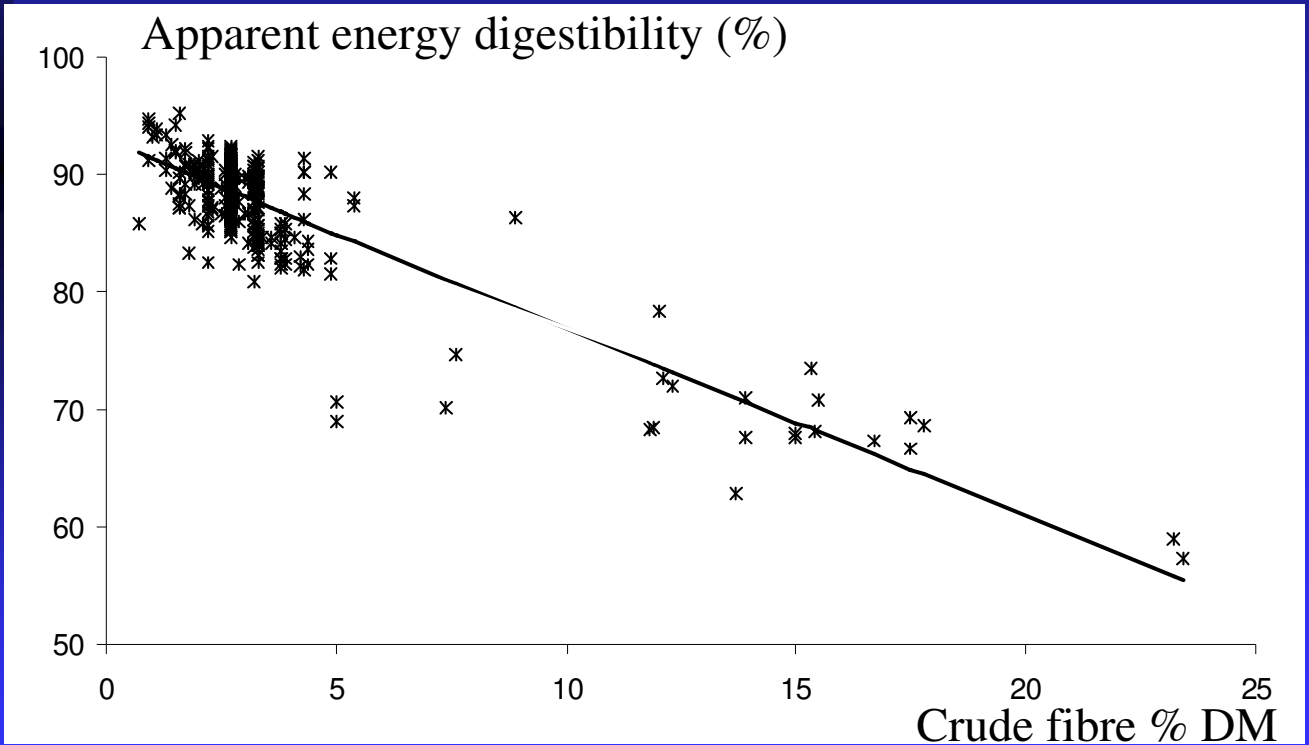


Estimation of digestible energy

- Predict digestibility
- For group of feed with varying digestibility
  - A) Subdivide into more uniform groups
    - such as roughage versus concentrates, grass silages first cut versus second cut ….
  - B) find parameters which predict digestibility of nutrients or energy
    - Such as fibre content, gross energy content, fat content, starch content….

Estimation of digestible energy

- Prediction of digestibility of energy by fibre in dogs



Relationship between CF in dry matter and energy digestibility in 495 dog foods
energy digestibility = 92.9 –1.60 x CF (% DM); r=0.87

Estimation of digestible energy

- Prediction of digestibility of energy by fibre in dogs
  - Calculate gross energy with factors for proximates
  - Calculate digestibility of energy by fibre
  - Calculate digestible energy by multiplying digestibility with gross energy and divding by 100

Determination of metabolizable energy (ME)

- Calorimetry
- Short-cut in carnivores:
  - Balance trials with collection of faeces and urine during energy equlilibrium
  - Neglecting gas losses from fermentation

Estimation of renal energy losses

- Prediction from digestible protein content in feed in N-equilibrium
- 160 mg N excretion per g digestible protein
- Per mg of N 2.1 mg of urea are excreted
- Per g digestible protein 342 mg urea are produced
- Heat of combustion of urea ~ 11 kJ/g
- Energy losses per g digestible protein 3.8 kJ

„protein correction“

Estimation of renal energy losses

- Species differences:
- Energy losses per g digestible protein not entirely identical for all mammal species
- Other NPN-compounds in urine
  - Ammonia, allantoin, uric acid, hippuric acid…
- Experimental errors….
  - N retention in exerimental animals (growth!)…

Estimation of metabolizable energy in carnivores

- From experimentally determined DE
  - N-correction using experimentally determined protein digestibility
  - ~ experimentally determined ME
- From estimated DE
  - N-correction using mean factor for protein digestibility

Herbivores are different

Do not neglect gas production in ruminants…