UNIVERSITY of HOHENHEIM

FACULTY of AGRICULTURAL SCIENCES

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Disproportionate Growth in Farm Animals

Prerequisite for a Disturbed Health

Abstract # 23343

Based on : Resource allocation theory applied to farm animal production, Editor Rauw, W.M. (2008) CABI book; ISBN 9781845933944

Resource allocation

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Growth and production in farm animals depends on resources

Definition

Resource allocation = partitioning of available energy and materials into various vital activities or (body) structures (modified; Glazier, in Rauw et al. 2009)

Aristotle (384-322 B.C.): Idea of physiological limitation

Goethe (1749-1832): „the budget of nature is fixed but she is free to dispose of particular sums by any appropriation that may please her.

In order to spend on one side, she is forced to economize on the other side.

„The budget“ - Resource allocation

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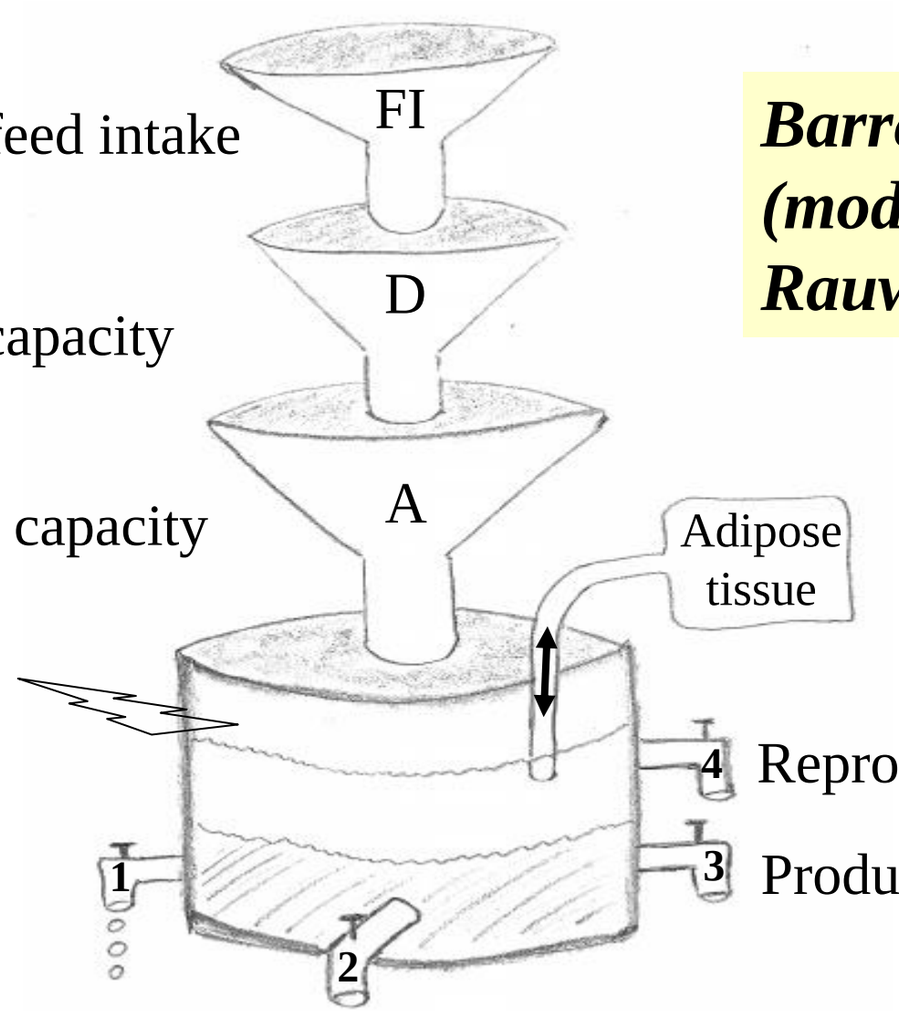

Barrel model (modified) Rauw et al. 2008

Resource allocation

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Management

-Feed quality
-Feeding frequency
-Supplements
-Keeping conditions
-Animal welfare

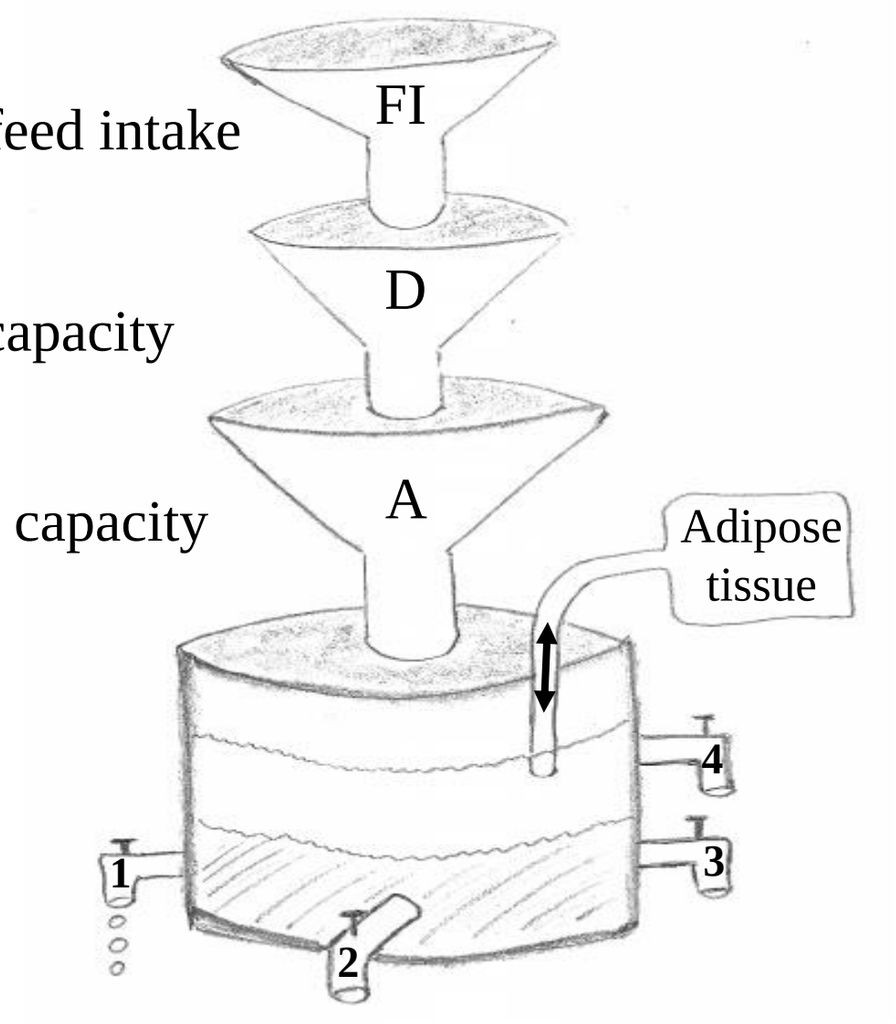
Voluntary feed intake

Digestive capacity

Absorptive capacity

Genetic background

-High VFI
-Size of gastrointestinal tract
-Efficacy of endogenous enzymes



Resource allocation

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Extended productive life span
Robustness - Fitness

Determined by:

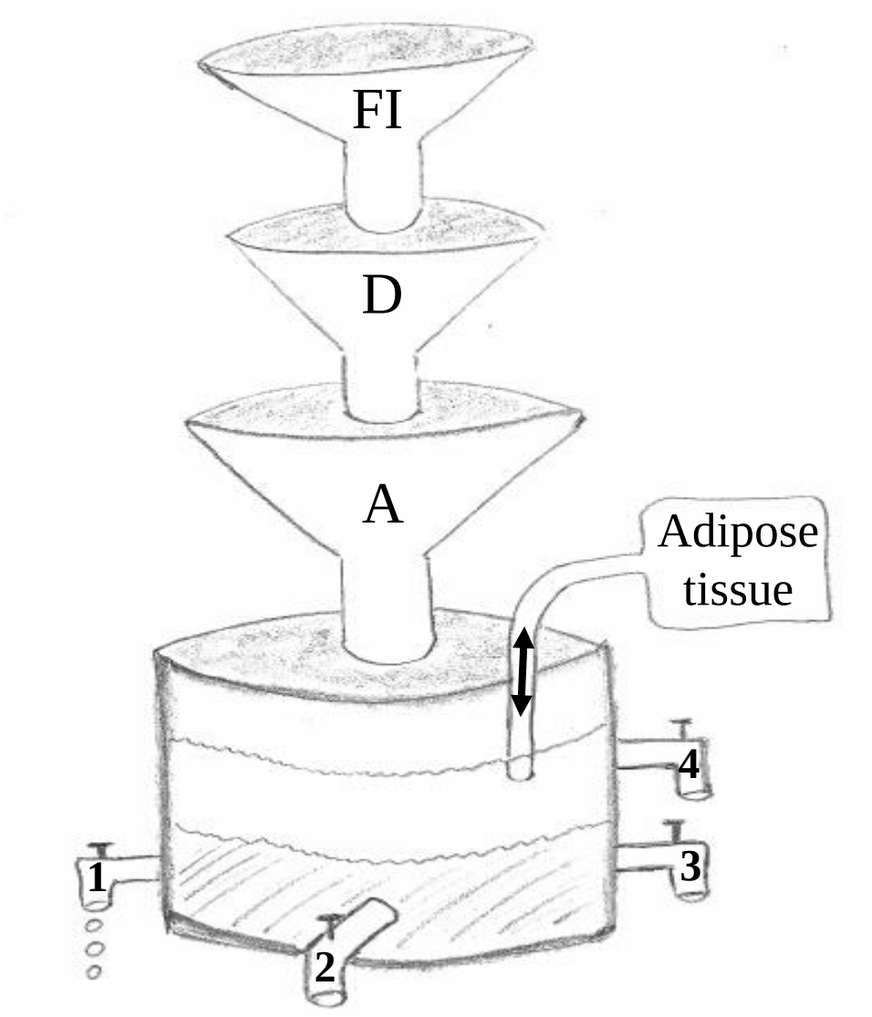
Genetic background
Resource allocation match
Sufficient time for repair
Adequate immune functions
Uncoupling capacity

Maintenance

Heat production

Immune response

Basal metabolic rate



Resource allocation

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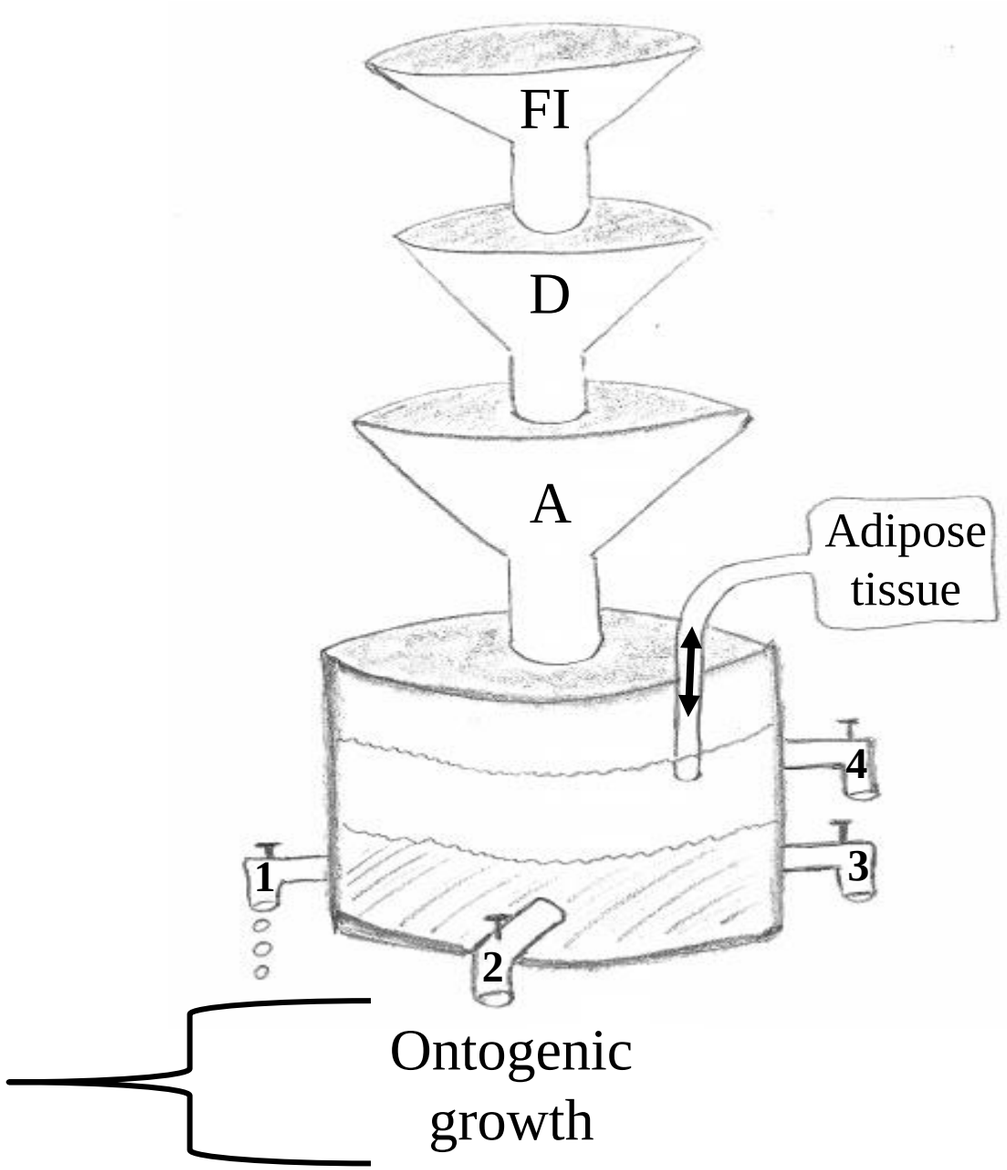
Extended productive life span
Robustness - Fitness

Determined by:
Genetic background
Resource allocation match
Adequate management
of mothers and offspring
(Prenatal „programming“)
Proper endocrine functions
Sufficient time for maturation



Resource allocation

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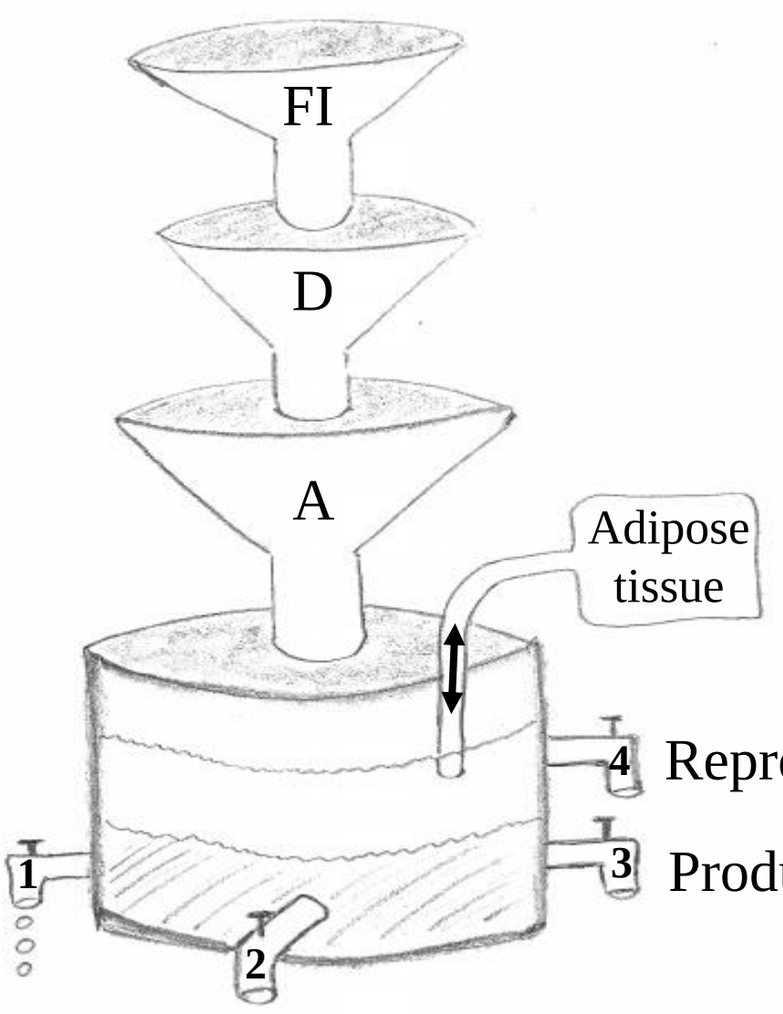


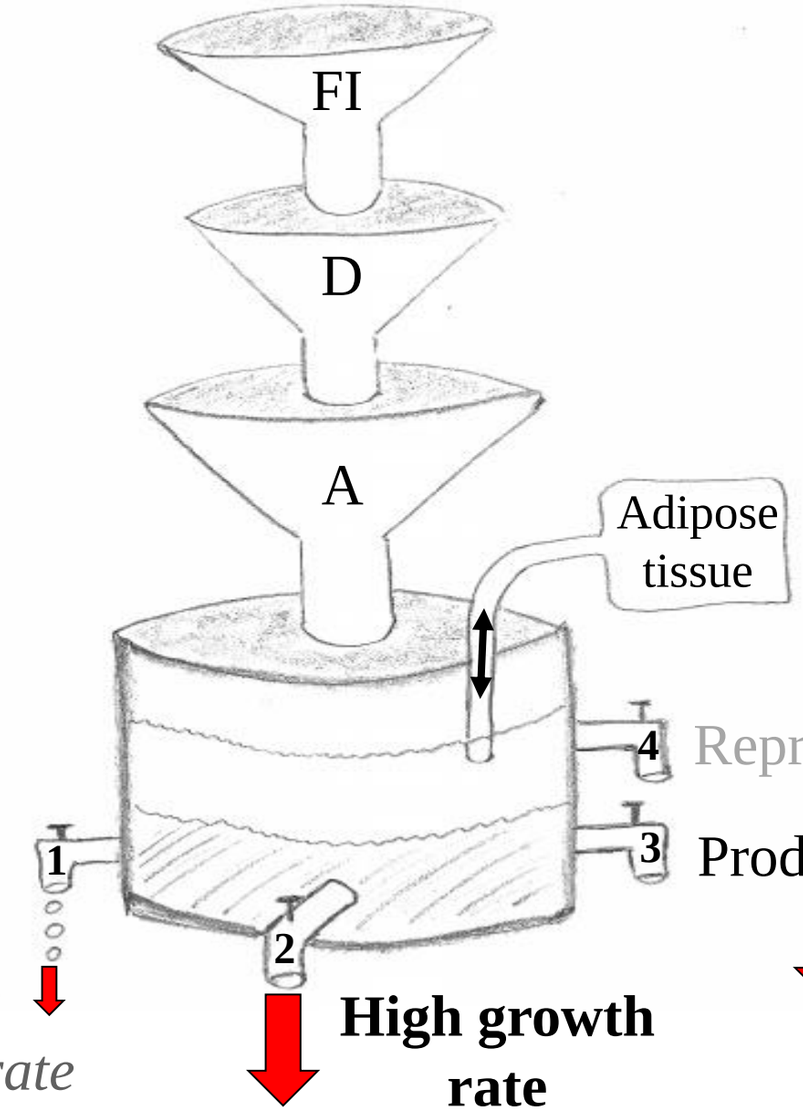
Determined by:

Genetic background with
selected single production traits
Resource allocation match
Adequate management
but
!negatively correlated to fertility
in high performance animals!

Animal proteins
Milk, Meat, Eggs

Young animals: Priority for 1+2, less for 3 + 4; adult 1 + 3 + 4, less 2

Limitations of resource allocation lead to disproportionate growth



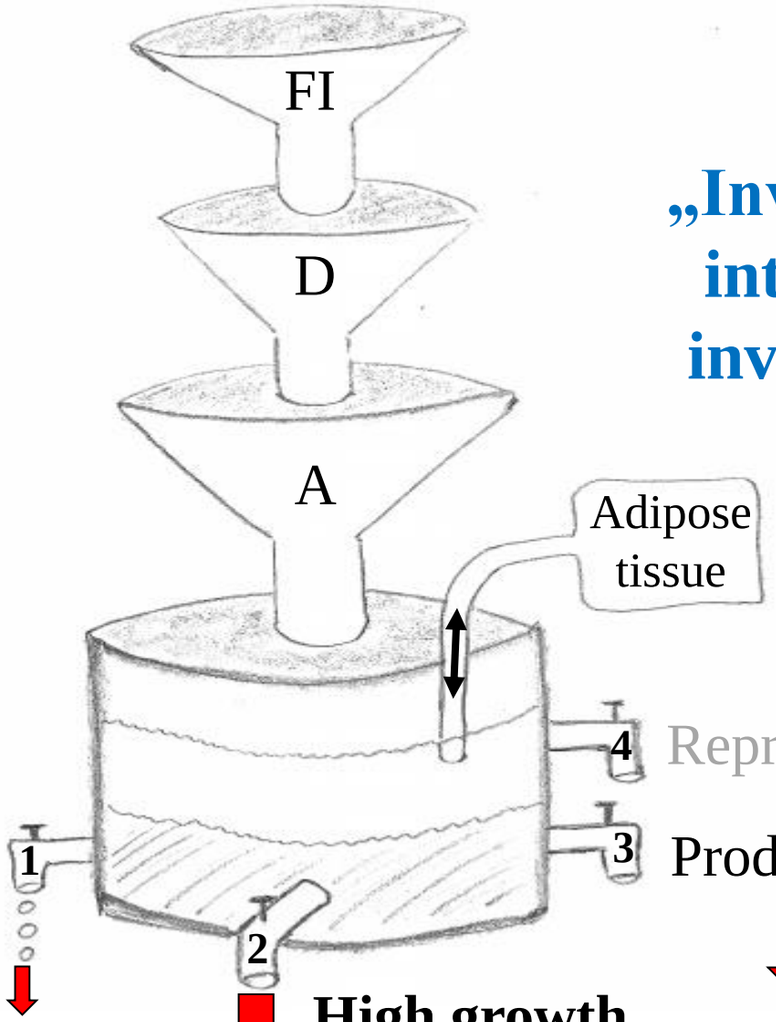
Priority for 1+2, less for 3 + 4

in young, rapidly growing meat-type animals

Resource allocation mismatch
Inadequate management

Morphological constraints
Functional conflicts

Limitations of resource allocation lead to disproportionate growth



„Investment (of resources and time) into production traded off against investment (of resources and time) into maintenance“

(modified Knap, in Rauw 2008)

Maintenance

= immaturity of supportive cells, tissues and organs

High growth rate

= time of maturation decreases

Selective muscle growth

= resource allocation mismatch

Ascites syndrome in broilers

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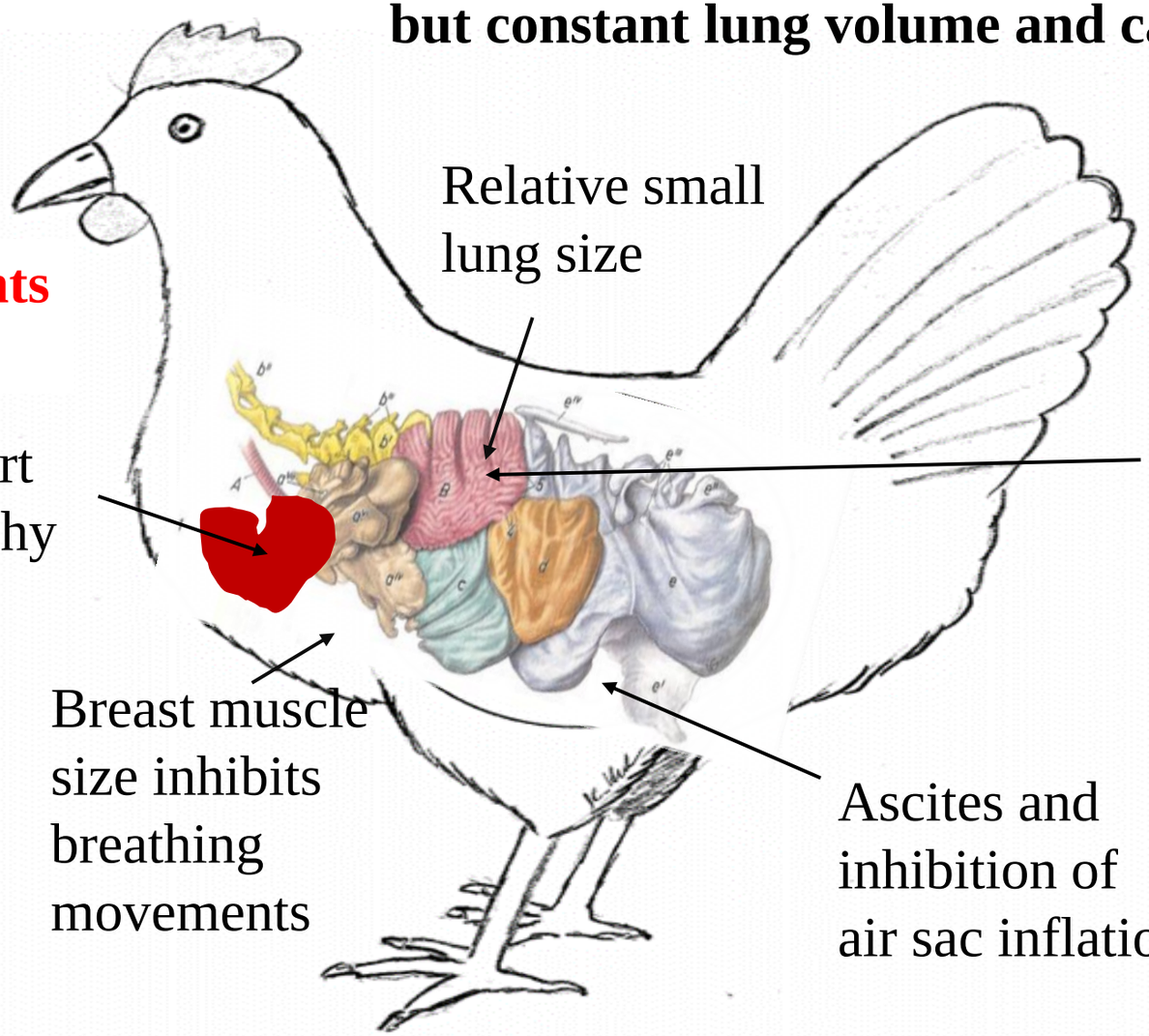
Accelerated growth rate **(40 g to 4000 g in 8 weeks)**
Cardiac output rate **(8 ml/min to 800 ml/min in 8 weeks)**
but constant lung volume and capillary capacity

Morphological constraints
Functional conflicts



Relative small lung size

Low compliance of lung and respiratory capillaries

Right heart hypertrophy

Breast muscle size inhibits breathing movements

Ascites and inhibition of air sac inflation

Wideman et al. 2013

Wideman et al. 2007

Nickel/Schummer/Seiferle
Anatomie der Vögel
Verlag Paul Parey

Muscle myopathy (wooden breast) in broilers

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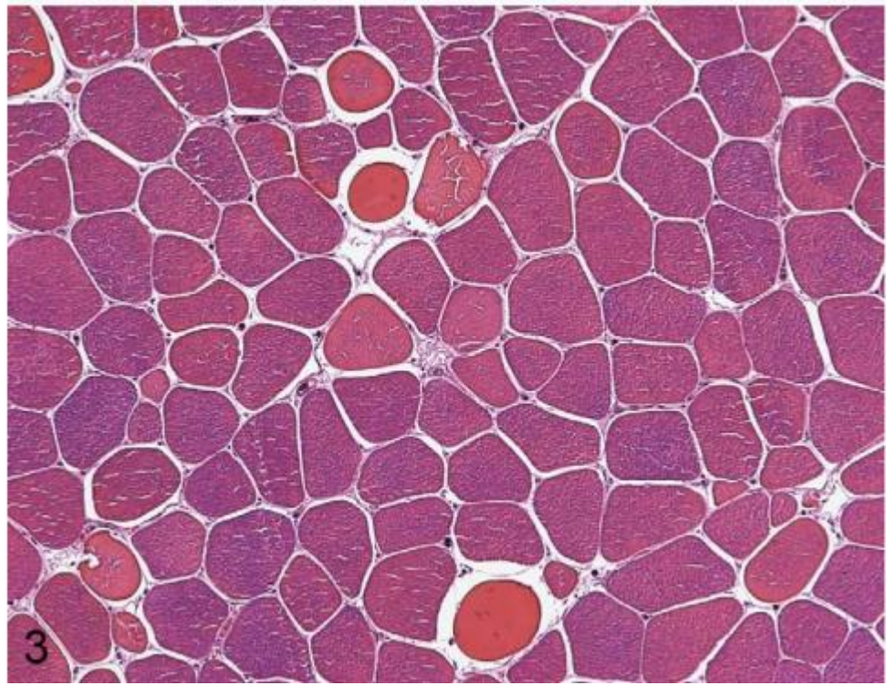

Healthy muscle

Wooden breast

Morphological constraints
Functional conflicts

Lack of vascularization
Myocyte necrosis
Inflammatory infiltration

Sihvo et al. 2014

Tibial dyschondroplasia in chicken

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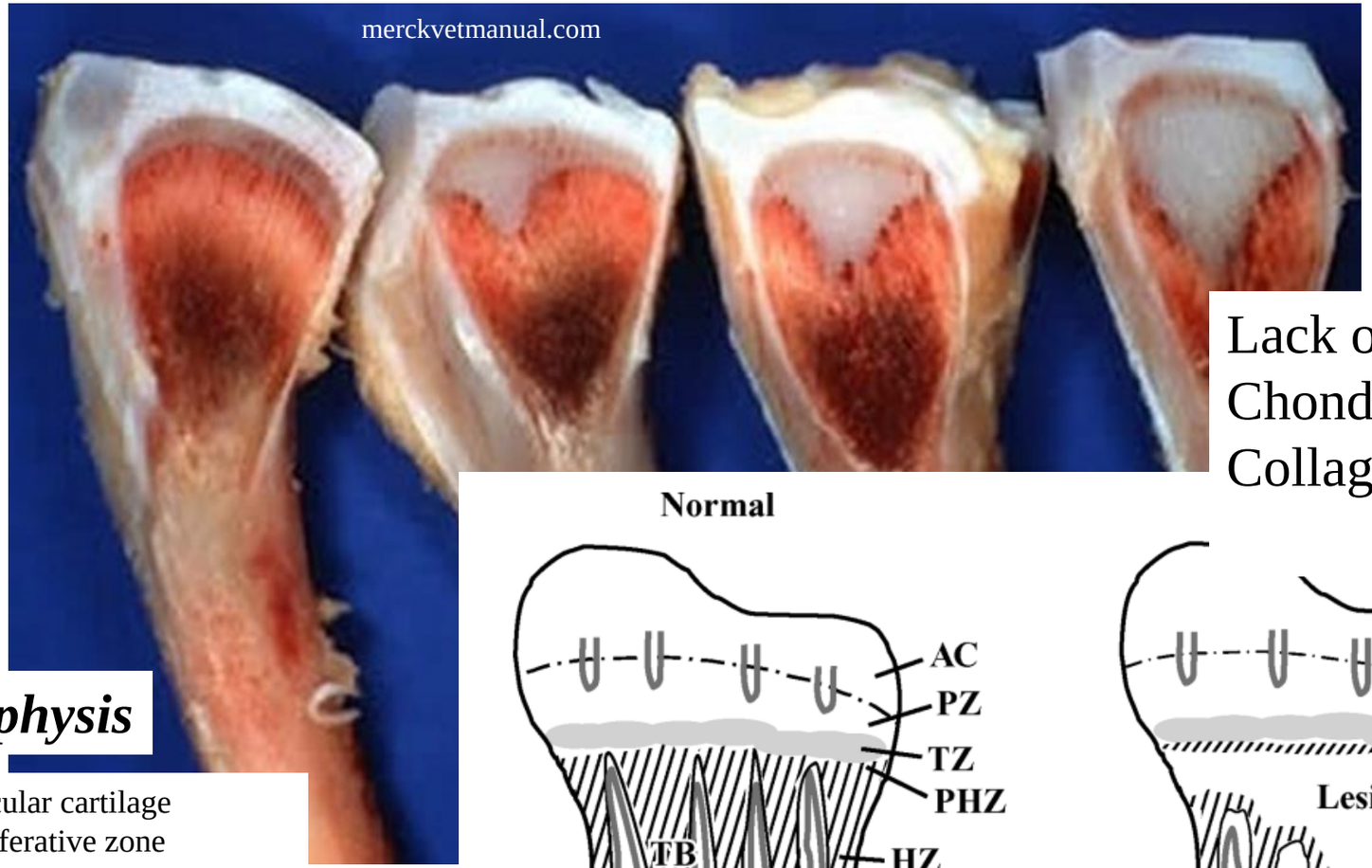
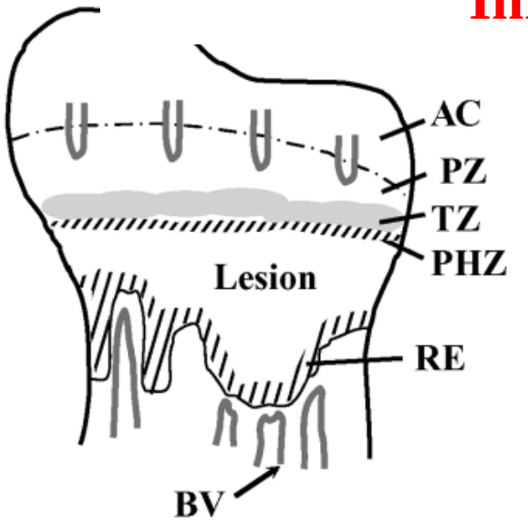


Metaphysis

AC articular cartilage
PZ proliferative zone
TZ transition zone
PHZ prehypertrophic zone
HZ hypertrophic zone
BV metaphyseal blood vessels
TB trabecular bone
RE resorbing edge



Lack of vascularization
Chondrocyte necrosis
Collagen X dystrophy

Immaturity

Leach & Monsonego-Ornan 2007

Fatty liver hemorrhagic syndrome (FLHS) in chickens

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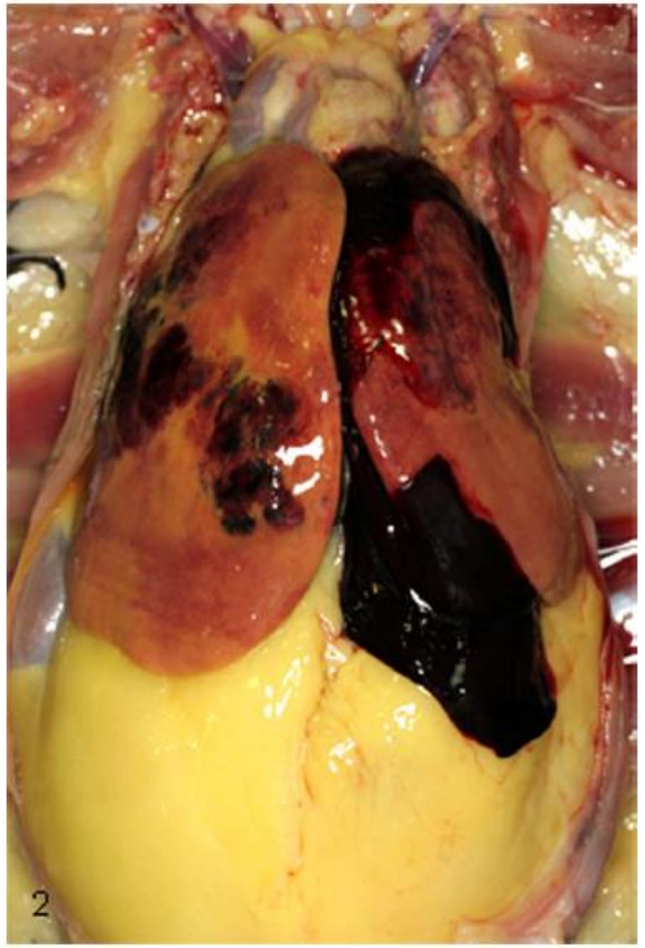
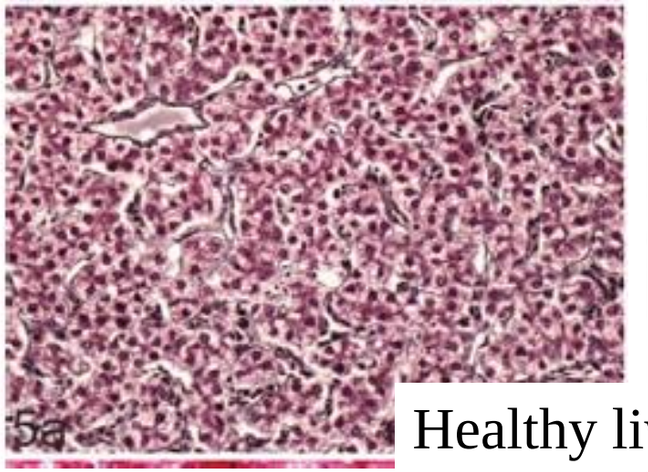
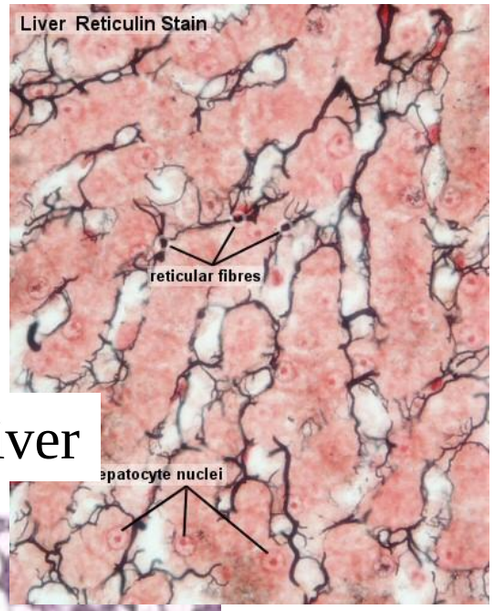


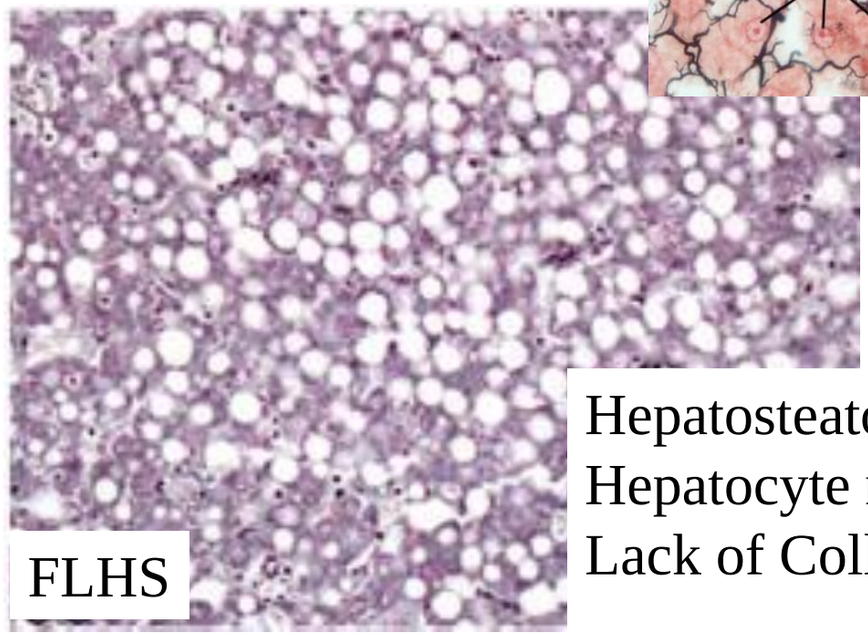
Figure 2. Coelomic cavity; chicken. Multifocal to coalescing subcapsular hepatic hemorrhages with diffuse hepatic pallor, intracoelomic blood clots, and abundant intracoelomic fat.

Trott et al. 2014



Healthy liver





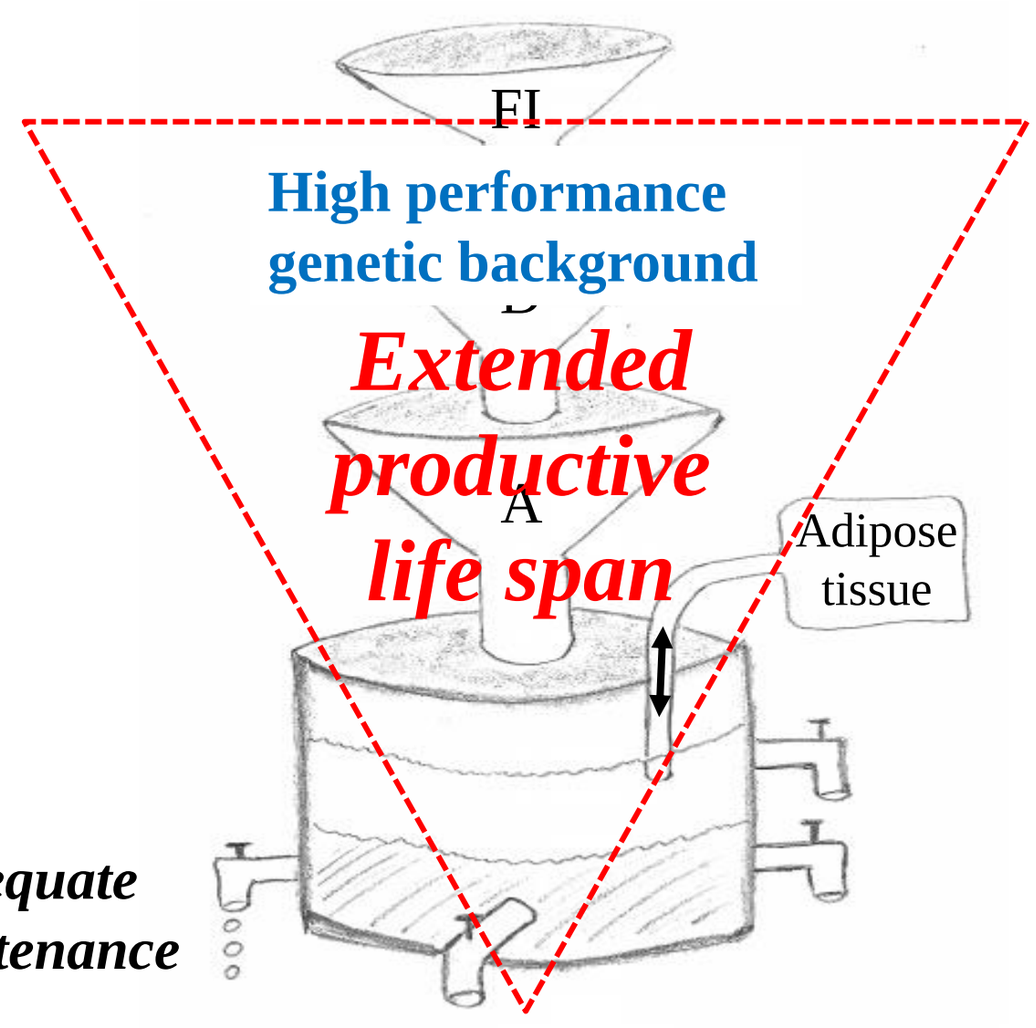
FLHS

Hepatosteatosis
Hepatocyte necrosis
Lack of Collagen type III
Immaturity

Conclusion

Adequate Management

Resource allocation match



Adequate maintenance

Time for maturation

Program

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Developmental programming and disproportionate growth

1. **Opsomer, Van Eetvelde, Kamal**
Evidence for metabolic programming in dairy cattle

2. **Canario, Pere, Quesnel, Billon, Hebrard, Riquet, Mormede, Liaubet**
Delayed development in Large White Purebreds than Crossbreds with Meishan born in the same litter

30 min coffee break

3. **Madsen, Bee**
Impact of dietary L-arginine supply during early gestation on myofibre development in newborn pigs

Hastened postnatal development and disproportionate growth

4. **Ormon, Bourgon, Munro, Macdonald, Lam, Miller, Montanholi**
Microstructure and function of the thyroid gland may relate to feed efficiency in the bovine

5. **McCoard, Silvestre, Molenaar, Muir, Koolaard, Burggraaf, Wards, Pacheco**
Impact of pre-weaning nutritional regimes on mammary gland development in heifer calves

and Poster session 11

Thank you very much for your attention