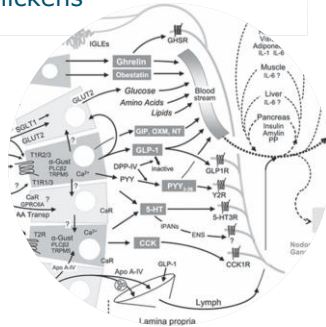


The endocrine control of energy homeostasis in chickens

Prof Eddy Decuypere

Division of Livestock-
Nutrition-Quality

KU Leuven



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For quality of life

The endocrine control of energy homeostasis in chickens

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Introduction: energy balance

- ♦ Energy balance = energy intake
minus
energy expenditure

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1. Energy intake

- ♦ Control and regulation of feed intake is very complex
 - peripheral ↔ central mechanisms
 - physical factors ↔ chemical factors
 - endocrine ↔ neural
 - long term ↔ short term

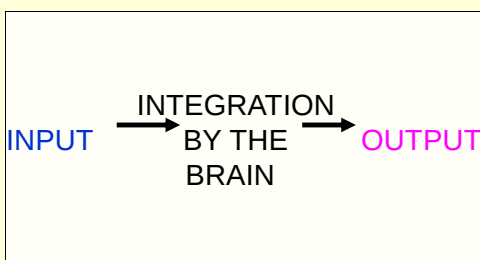
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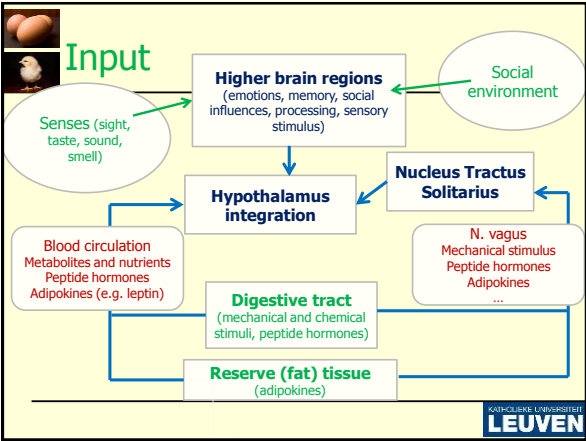
- ♦ short-term: meal-to-meal
 - visual – sensory – olfactory
 - cognitive/experience
 - hunger and satiety hormones: gut-derived
 - gut mechanoreceptors
 - gut osmoreceptors
 - metabolic cues: diet-induced thermogenesis
 - ...

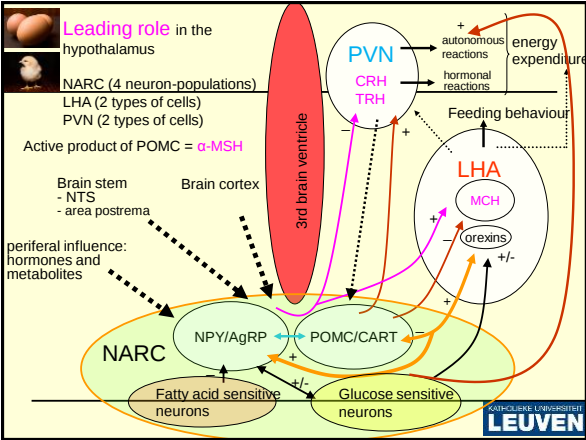
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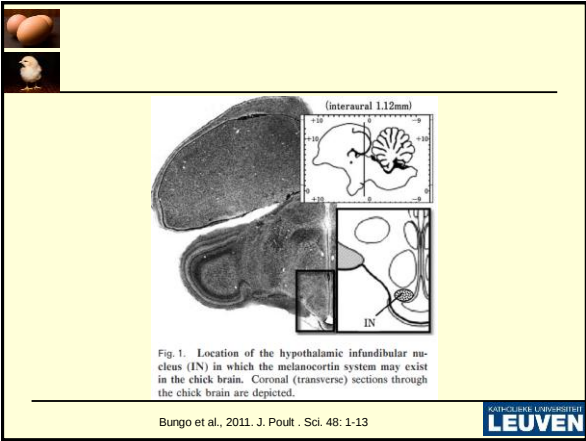
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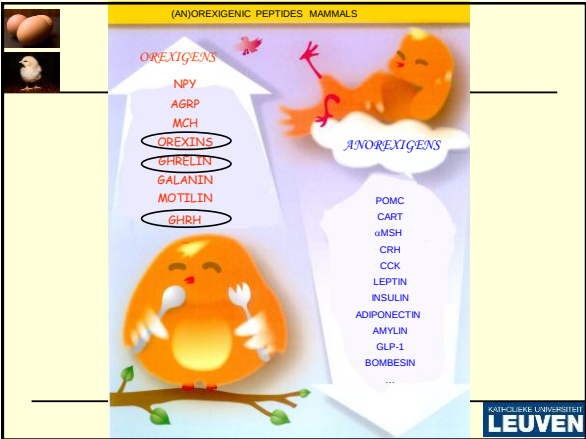


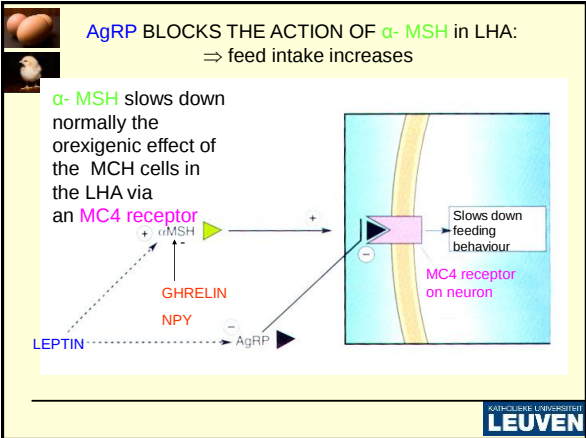
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Effect of feed deprivation on **avian** hypothalamic neuropeptide gene expression

NPY	↑
AgRP	↑
POMC	↓
CART	≡
MC4R	↑
MCH	↑
Orexins	↑
CRH	↓
TRH	↓

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Effect of central or peripheral administration of compounds on feed intake

compound	site	response
Ghrelin	icv iv	↓
Obestatin	iv ip	no
α-MSH	icv	↓
CRF	icv	↓
urocortin	icv	↓
NPY	icv	↑
AgRP	icv	↑
GHRH	icv	↓
MC3/4R agonists	iv icv	↓

Red font: opposed to mammals





Effect of central or peripheral administration of compounds on feed intake (Con'd)

compound	site	response
CART	icv	↓
μ-opioid agonists	icv	↑
bombesin	icv	↓
leptin ?	icv iv	↓
insulin	icv	↓
peptide YY	icv	↑
pancreatic polypeptide	icv	↑
Orexins-A/B	icv	≡
GLP-1	icv	↓

Red font: opposed to mammals

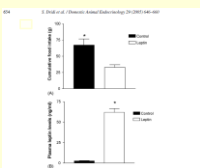




- ◆ Source: chicken ↔ mammalian
- ◆ Fragment length
- ◆ Broiler ↔ layer
- ◆ Age
- ◆ Dose
- ◆ Direct effect or via locomotor behavior?
- ◆ Ad libitum or pre-fasted



LEPTIN: still controversial in avian species?



The Chicken Leptin Gene: Has It Been Cloned?
M. Friedman-Einat,^{1,2} T. Boswell,^{1,2} G. Horev,² G. Girishvarma,¹ L. C. Dunn,¹ R. T. Talbot,¹ and P. J. Sharp¹
General and Comparative Endocrinology 115, 354-363 (1999)

Editorial
Chicken leptin
P. J. Sharp,¹
L. C. Dunn,¹
D. Waddington
Editorial General and Comparative Endocrinology 138 (2000) 2-4

Reply to viewpoints by P.J. Sharp, L.C. Dunn, D. Waddington and T. Roswell [Chicken Leptin: General and Comparative Endocrinology, 158, 2-4 (2008)]
J. Simon,
N. Bideau,
M. Taché
General and Comparative Endocrinology 161 (2008) 150

Behavioral and physiological effects of photoperiod-induced migratory state and leptin on a migratory bird, *Zonotrichia albicollis*: I. Anorectic effects of leptin administration
David J. Cossard,^{1,2} Daria M. Zanic,¹ Christopher G. Cagidiaco²
General and Comparative Endocrinology 174 (2011) 276-280

Chicken leptin: properties and actions
M. Taché^{1,2}, S. Dridi³, S. Casay⁴, Y. Benoume⁵, N. Raver⁶, N. Bideau⁷, M. Picard⁸, J. Williams⁹, A. Gerlier⁹
Domestic Animal Endocrinology 21 (2001) 319-327

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GHRELIN: endogenous ligand for GHS-R

Post-translational processing

N-Octanoic acid
 $O=C(CH_2)_6-CH_3$

Unacylated ghrelin
NH₂-GSSFLSPF-EH
PKYSEKRPQQAQ
PAKLGPR-COOH

Acylated ghrelin
NH₂-GSSFLSPF-EH
PKYSEKRPQQAQ
PAKLGPR-COOH
 $O=C(CH_2)_6-CH_3$

Rat: 28 AA
Chicken: 26 AA

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Energy balance
Food intake
Energy expenditure

Obesity

Brain stem
GPR39
GHS-R

Vagus nerve

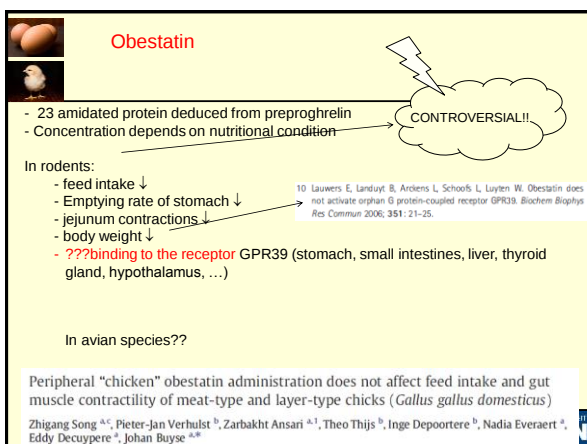
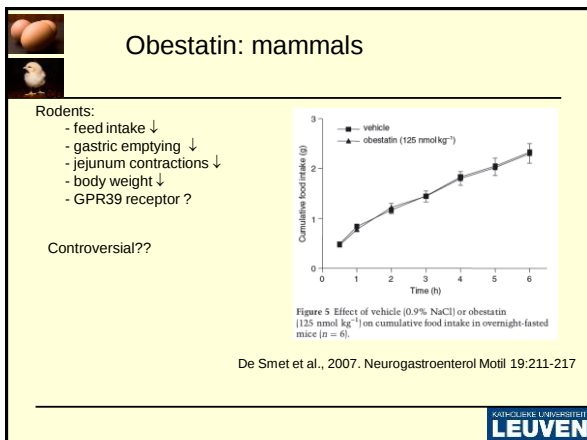
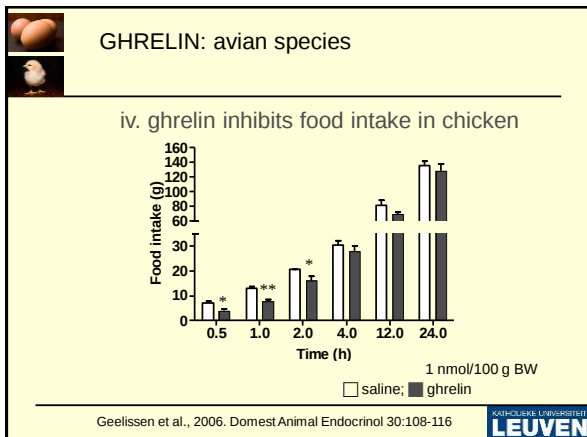
Preproghrelin
GHS-R
GHS-R

Gastric emptying
GHS-R

GH, leptin, insulin, CCK

- secretion of GH ↑
- feed intake ↑
- gastric motility ↑
- gastric acid production ↑
- hepatic gluconeogenesis ↑
- hyperglycemia
- lipogenesis ↑
- adipogenesis ↑
- inhibition of insulin production
- suppression of skeletal UCP expression ↓
- CRH ↑ ⇒ ACTH ↑ ⇒ cortisol ↑
- prolactin ↑

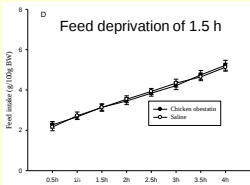
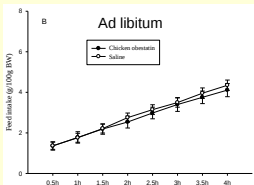
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Obestatin: avian species

iv injection of 1 nmol/kg BW 'chicken' obestatin in 7- to 9-d-old broilers



Other trials: 1 nmol or 10 nmol intraperitoneal
7- to 9-d-old layers
iv 10 nmol rat obestatin (layers)

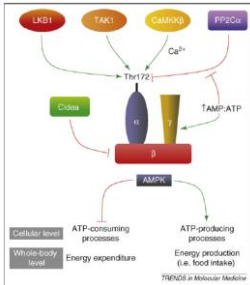
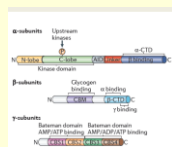
No effect on:
- feed intake
- duodenal contractions

Song et al., 2012. Regulatory Peptides, in press



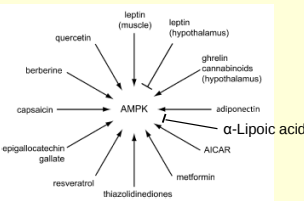


AMP-activated protein kinase



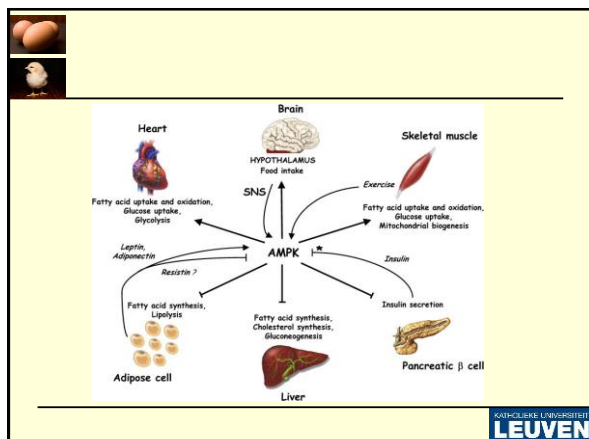
Lage et al., 2008. Trends Mol Med 14: 539-549

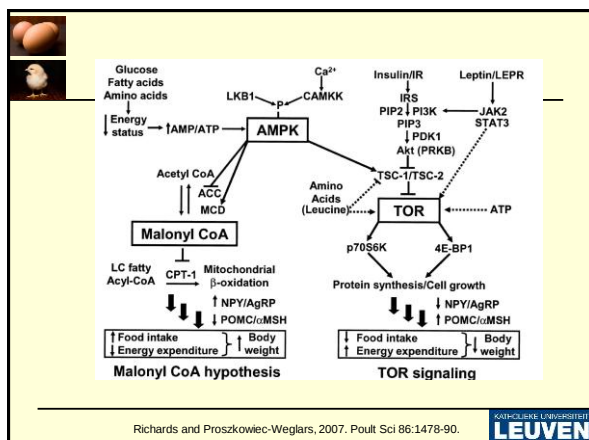


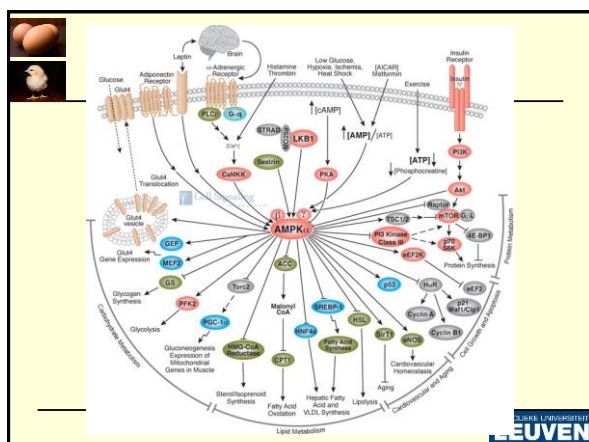


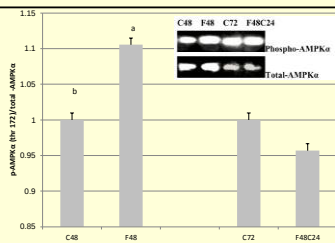
Hardie, DG. 2011. Am J Clin Nutr 93: S891-6.







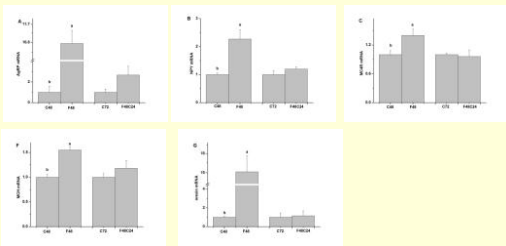




Effect of 48 h of feed deprivation (F48) and 24 h of refeeding (F48C24) compared to age-matched ad libitum fed controls (respectively C48 and C72) on hypothalamic phospho-AMP-activated protein kinase levels

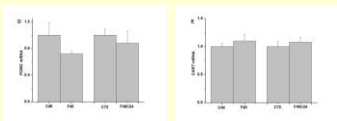
Song et al., 2012. Gen Comp Endocrinol, under revision





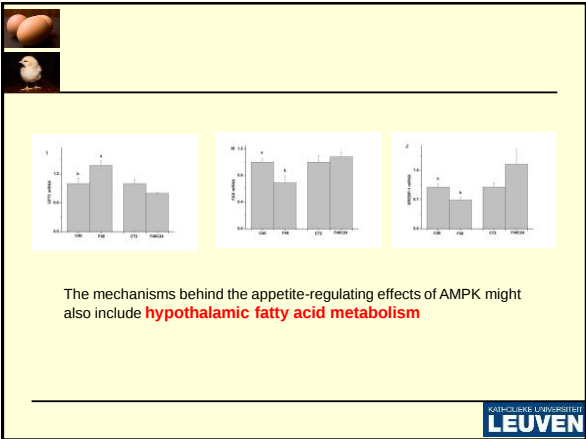
The appetite-regulating effects of hypothalamic AMPK are mediated by **orexigenic** neuropeptides

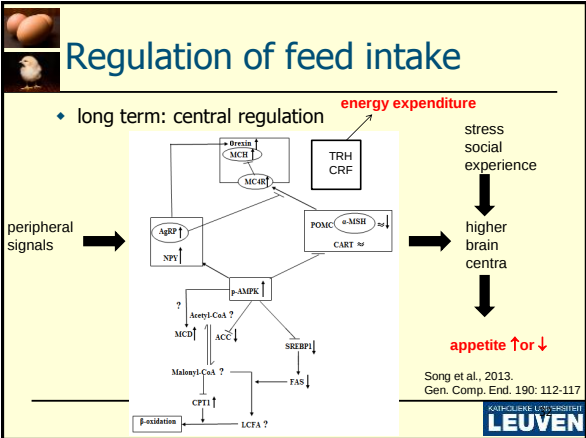


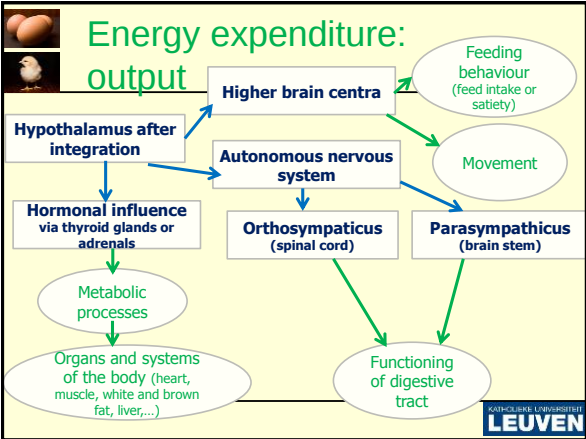


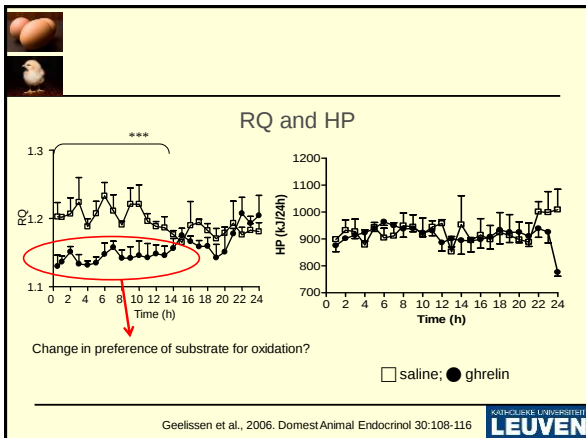
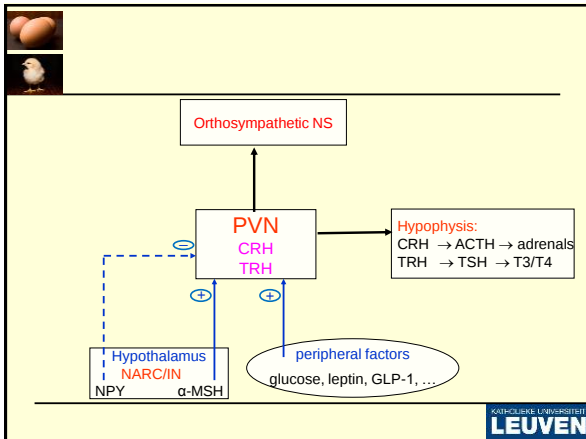
...and not by **anorexigenic** neuropeptides











Conclusions

- Control of feed intake in avian species is complex
- Differences between avian and mammalian species
- Functionality of obestatin?
- Hypothalamic AMPK is involved by acting upon
 - orexigenic neuropeptides
 - fatty acid metabolism
- Control of energy expenditure needs more investigations

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