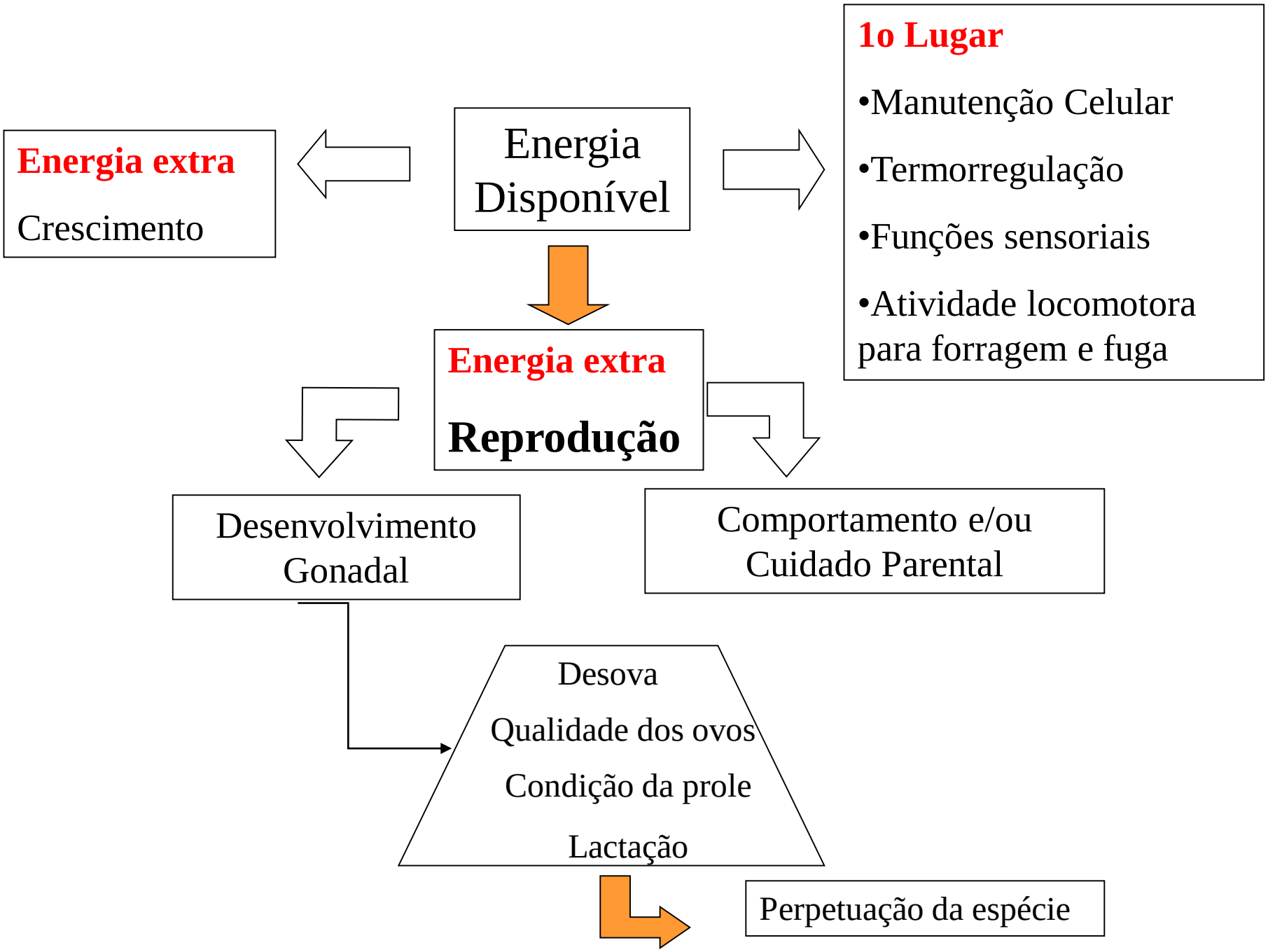
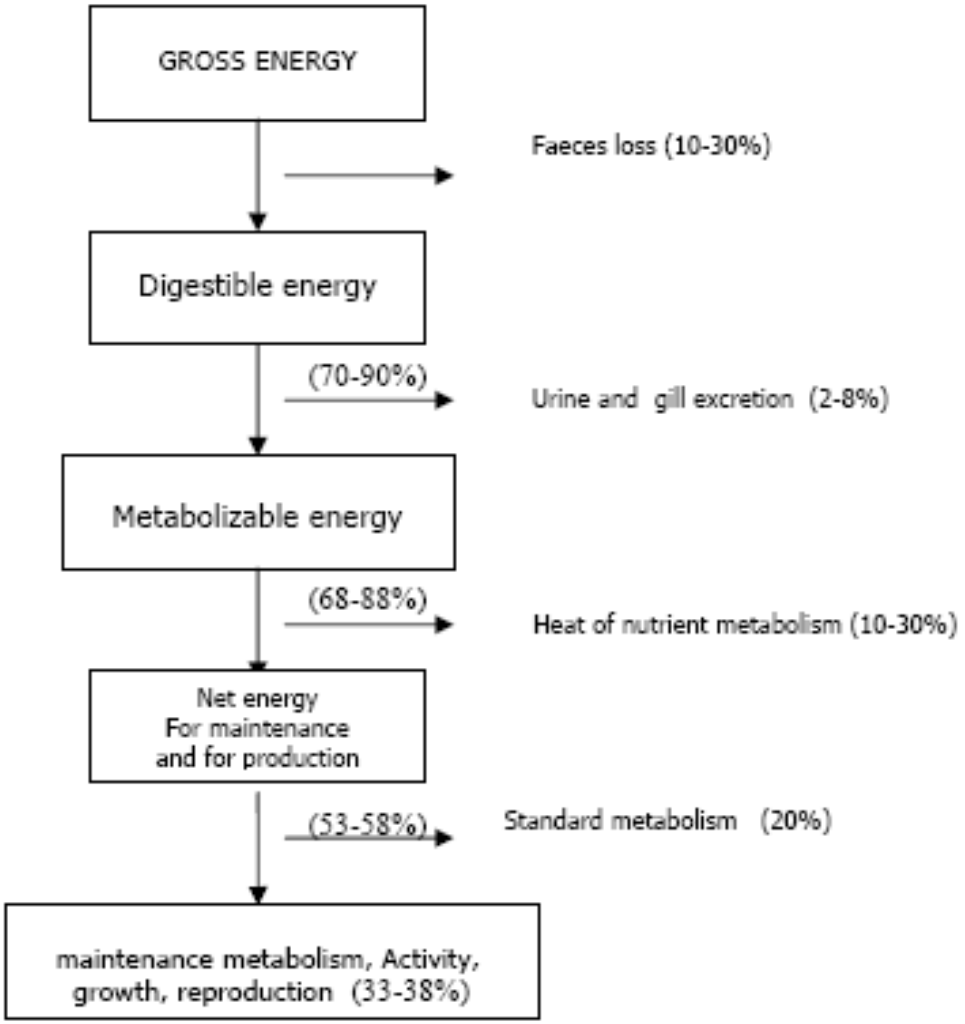
ESCASSEZ DE ALIMENTO E DESEMPENHO REPRODUTIVO

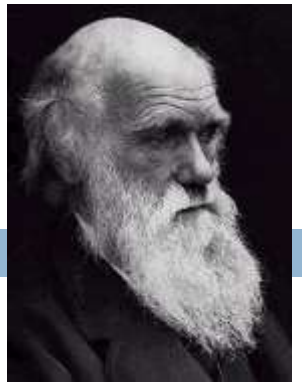

Energia extra
Crescimento
Energia Disponível
1o Lugar
•Manutenção Celular
•Termorregulação
•Funções sensoriais
•Atividade locomotora para forragem e fuga
Energia extra
Reprodução
Desenvolvimento Gonadal
Comportamento e/ou Cuidado Parental
Desova
Qualidade dos ovos
Condição da prole
Lactação
Perpetuação da espécie

Repartição (em %) da energia



(Luquet, 1982)

"*growth, nutrition, and reproduction are intimately allied processes...*" (Darwin, 1868)



Darwin,C.R. 1868. *The variation of animals and plants under domestication*. London: 1st ed.

Fisiologia e comportamento reprodutivos: geneticamente determinados & modulados por fatores ambientais

MODULADORES EXTERNOS DO SUCESSO REPRODUTIVO

- Diversidade de ambientes: temperatura, fotoperíodo, chuvas, umidade e fonte de alimento
- Influência social e nutricional na definição do período de maturação
- Estratégias/táticas reprodutivas – p.ex. restrição dos esforços reprodutivos no momento em que as condições do meio ambiente são adequadas para cuidar e nutrir a prole;
- Condições ambientais desfavoráveis – maturação sexual pode ser adiada e os esforços reprodutivos adiados até que as condições melhorem

SAZONALIDADE NA REPRODUÇÃO: TEMPERATURA

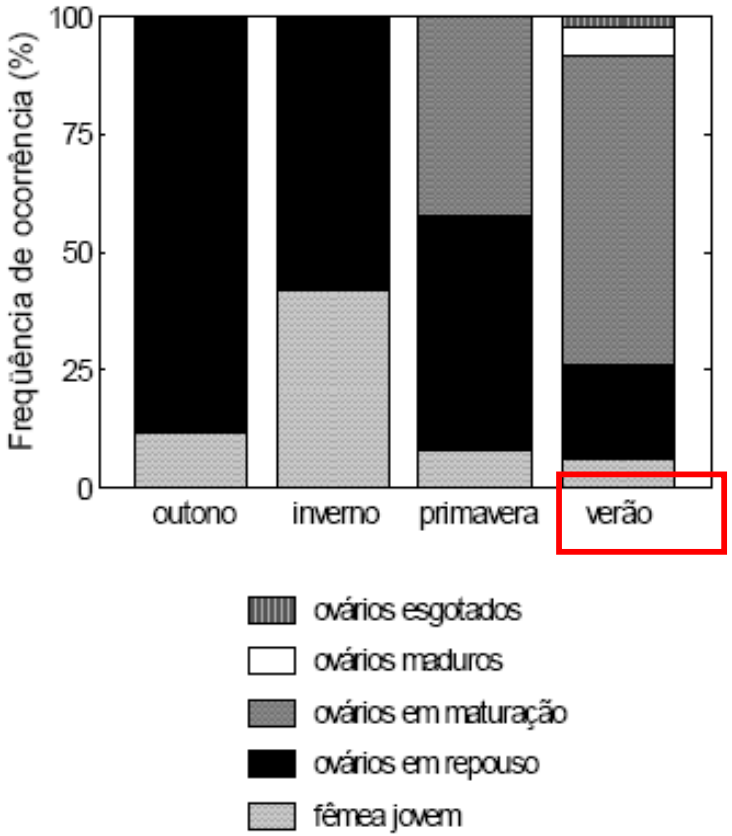


Figura 3. Freqüência de ocorrência (%) dos estádios de maturação gonadal das fêmeas de *Pimelodus maculatus* no Rio Piracicaba, no período mar./1998-fev./1999

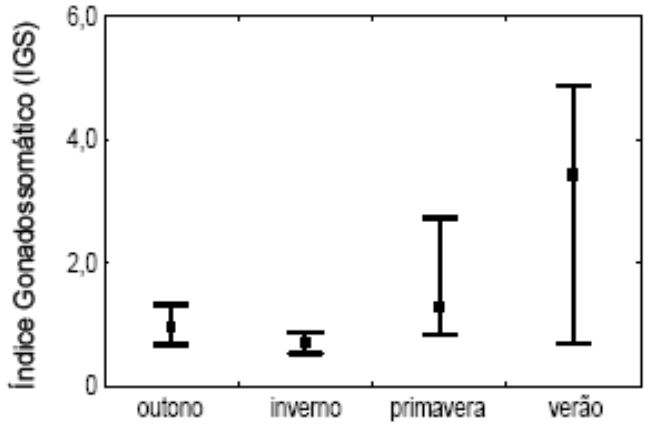


Figura 4. Medianas e desvios interquartílicos do Índice Gonadossomático de fêmeas de *Pimelodus maculatus* no Rio Piracicaba, no período mar./1998-fev./1999

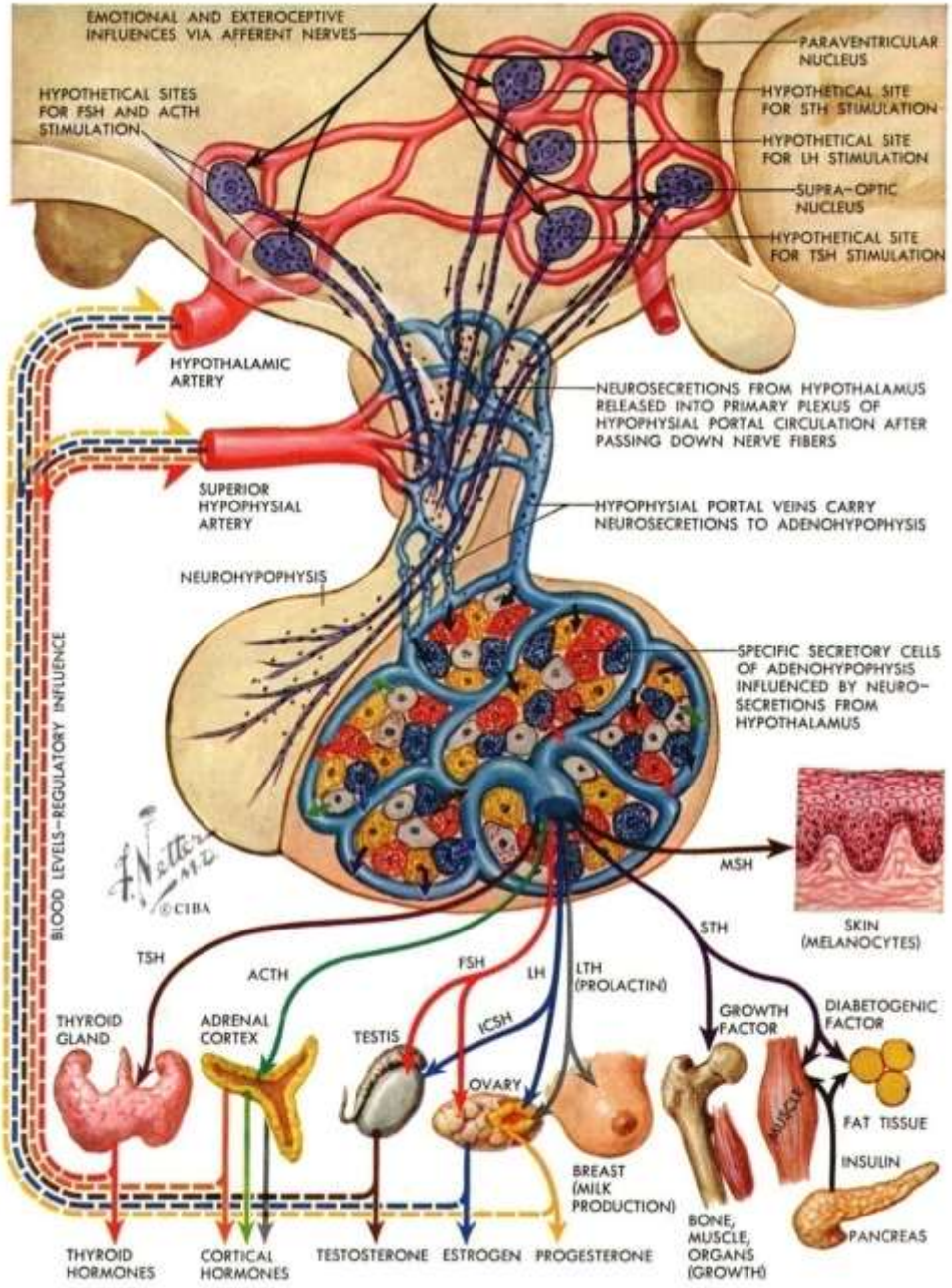
FATOR DE CONDIÇÃO E CICLO GONADAL DE FÊMEAS DE *Pimelodus maculatus* (OSTEICHTHYES, PIMELODIDAE) NO RIO PIRACICABA (SP, BRASIL) *

Sidnei Eduardo LIMA-JUNIOR [1] e Roberto GOITEIN [2]

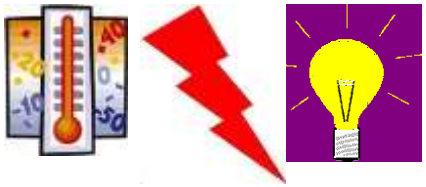
B. Inst. Pesca, São Paulo, 32(1): 87-94, 2006

Quais são os mecanismos que estabelecem a relação entre nutrição e fisiologia reprodutiva?

HIPÓFISE DE MAMÍFEROS

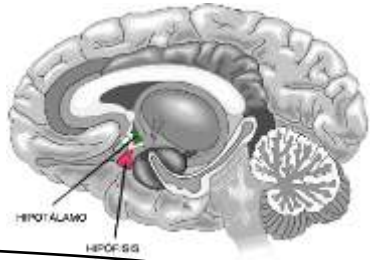


CONTROLE ENDÓCRINO DA REPRODUÇÃO EM VERTEBRADOS



Melatonina

PINEAL



HIPOTÁLAMO

GnIH (-)

Dopamina (-)

GnRH (+)

HIPÓFISE

-

-

FSH

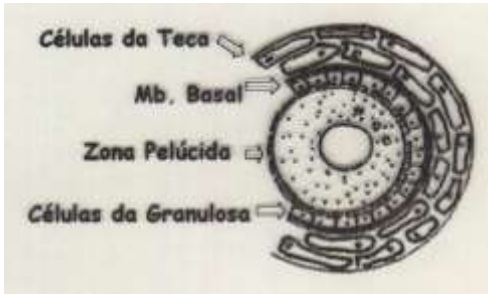
E

LH

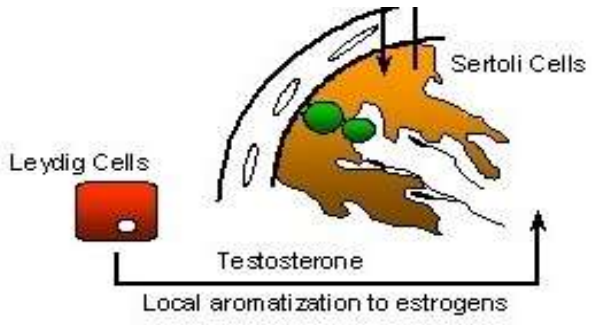
(+)

OVÁRIO

TESTÍCULO



Progesterona

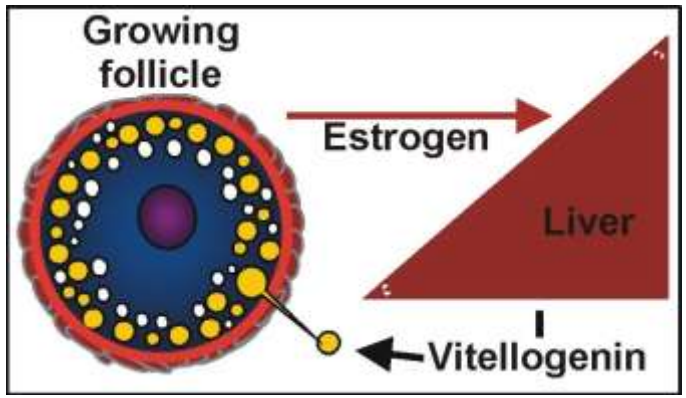


17β - Estradiol

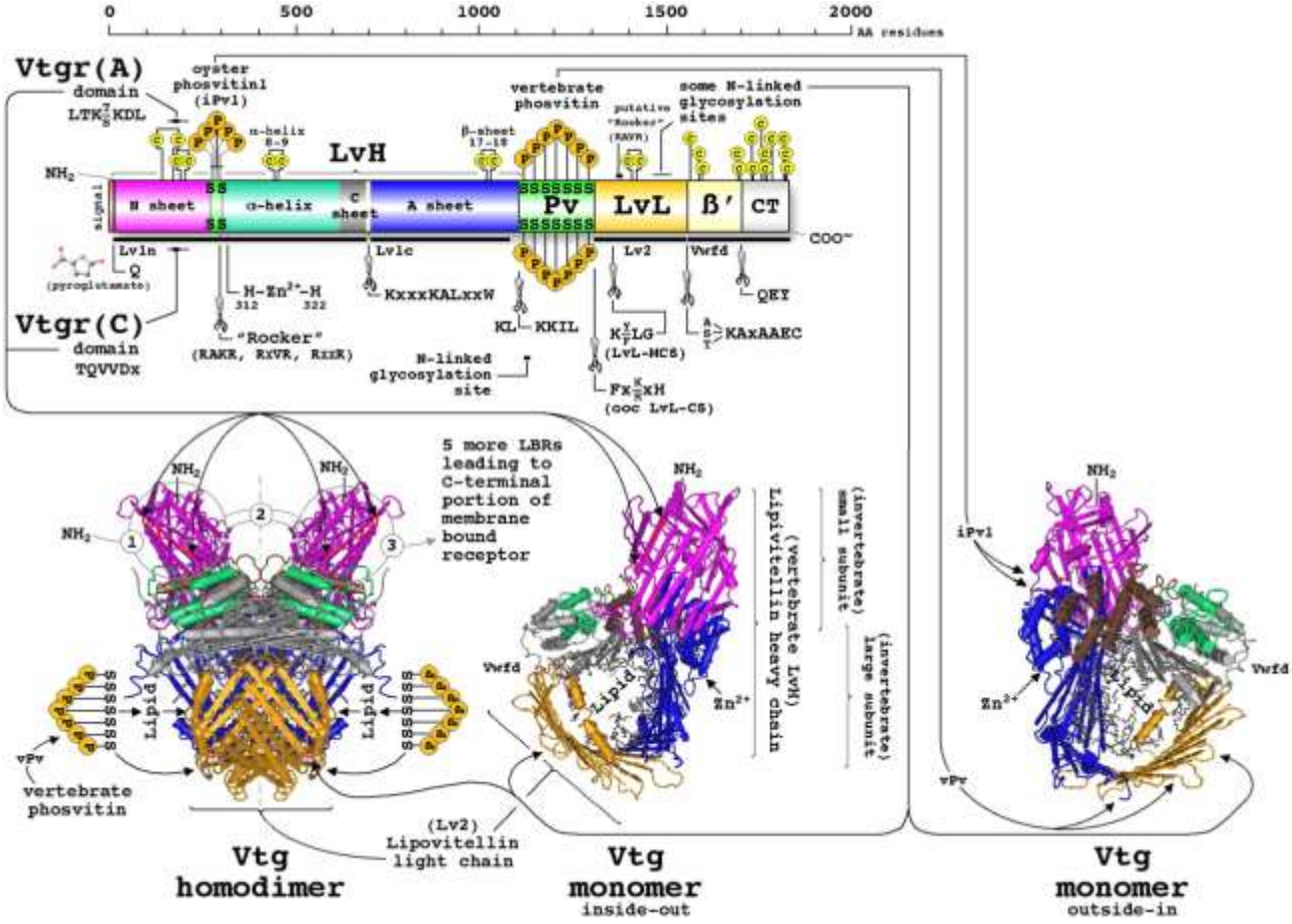
VITELOGENINA

Testosterona, 5-DHT

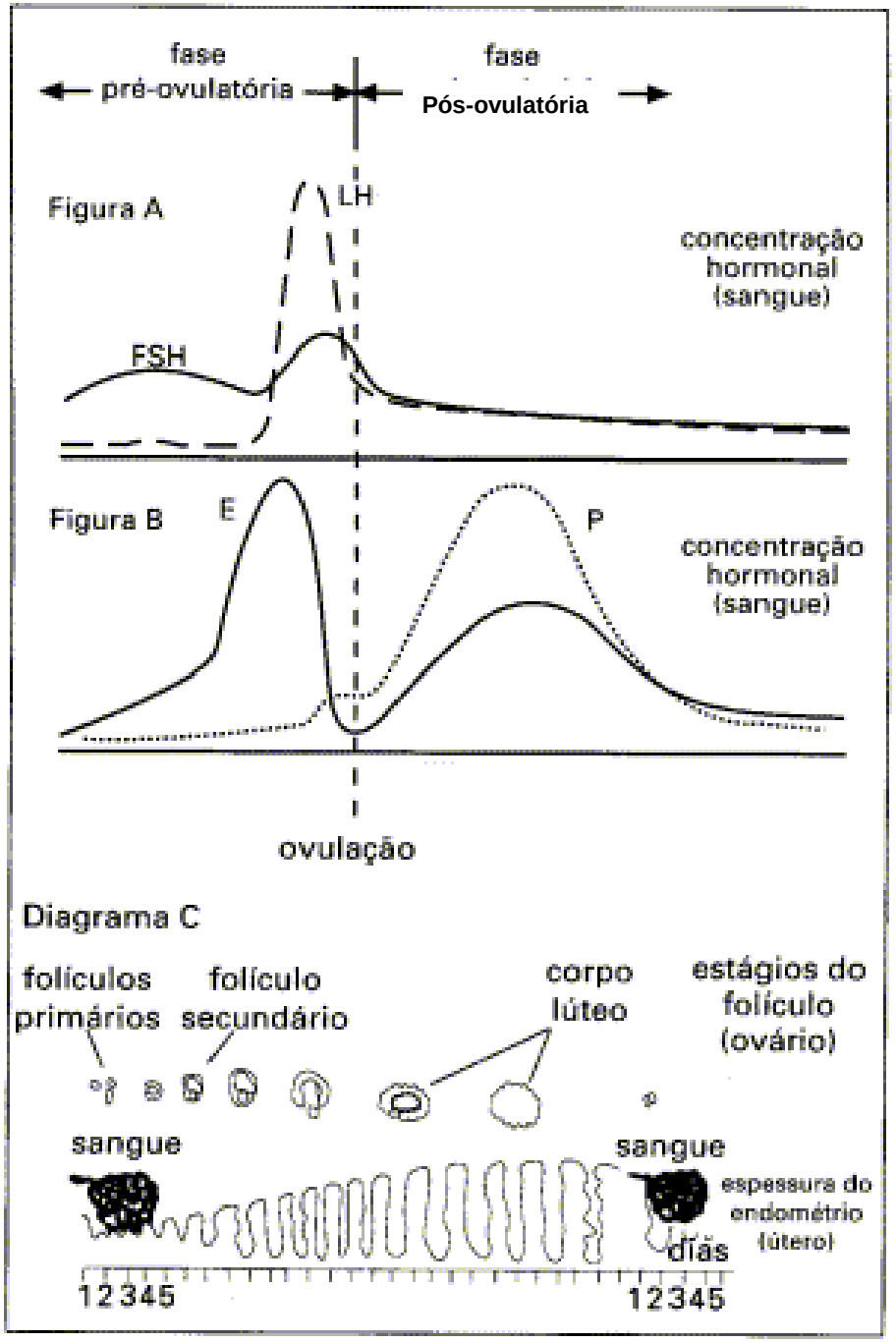
11-ceto-Testosterona



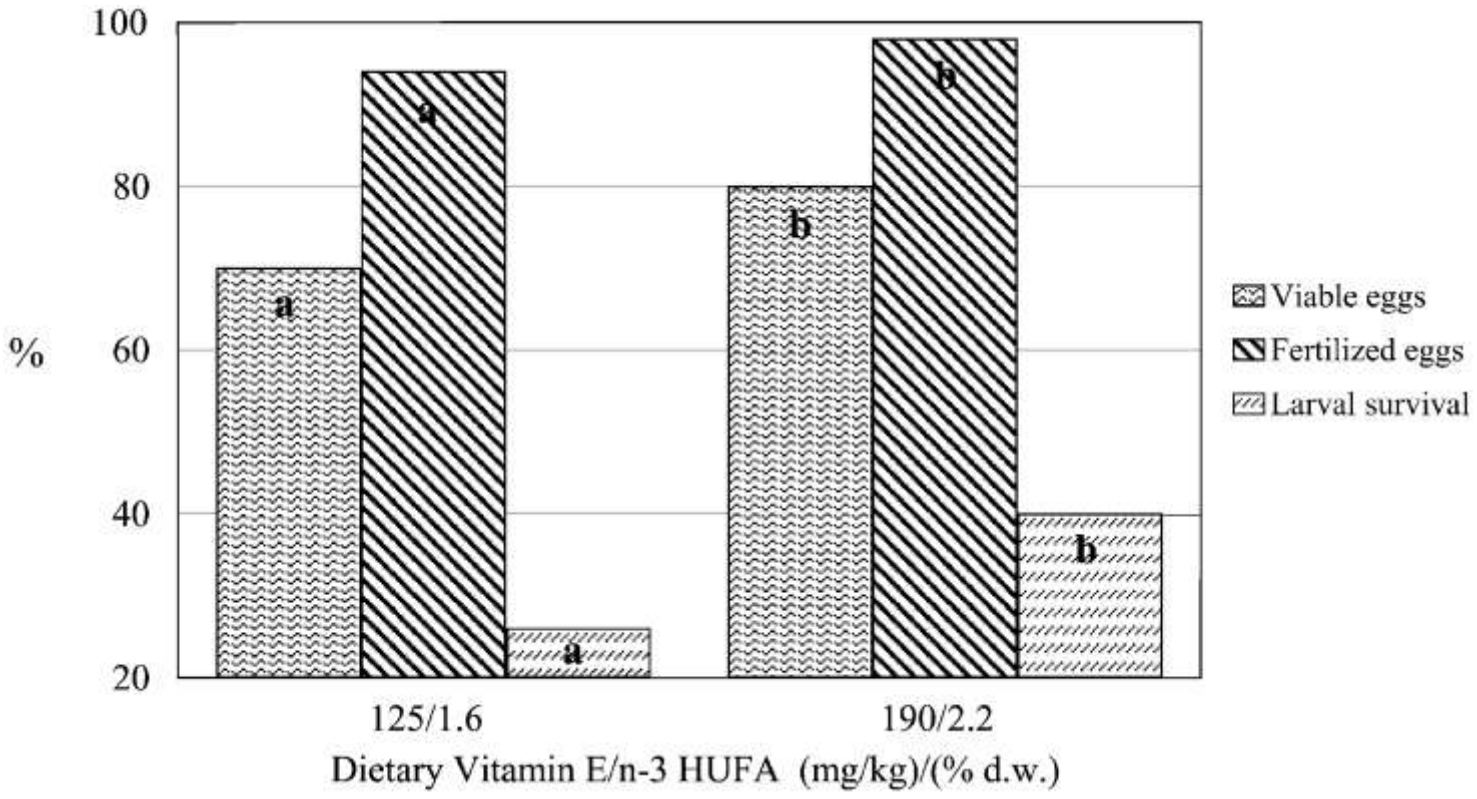
VITELOGENINA



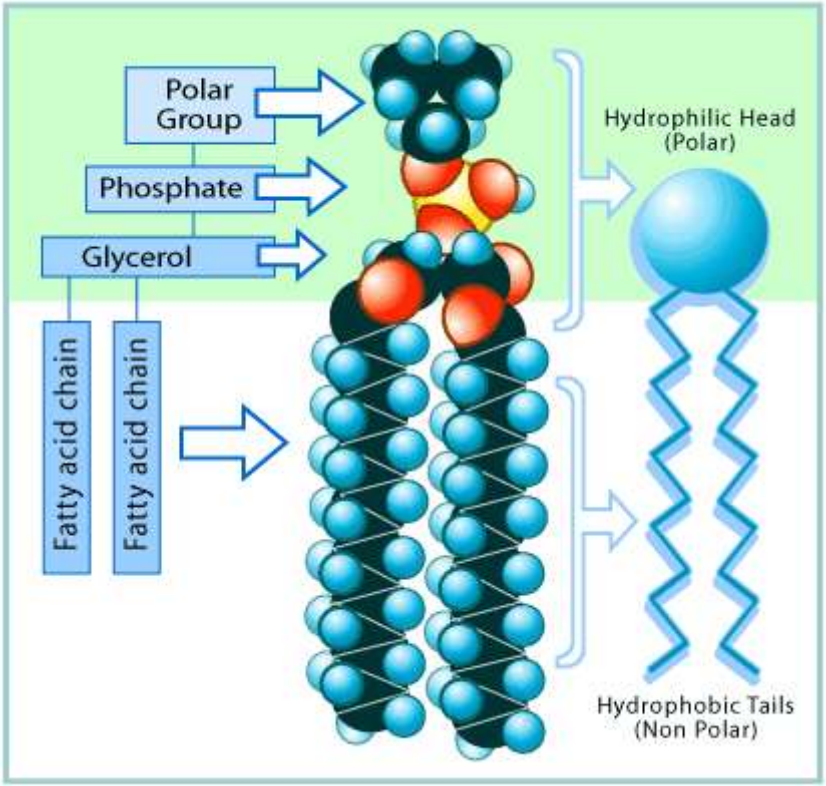
Ciclo Menstrual

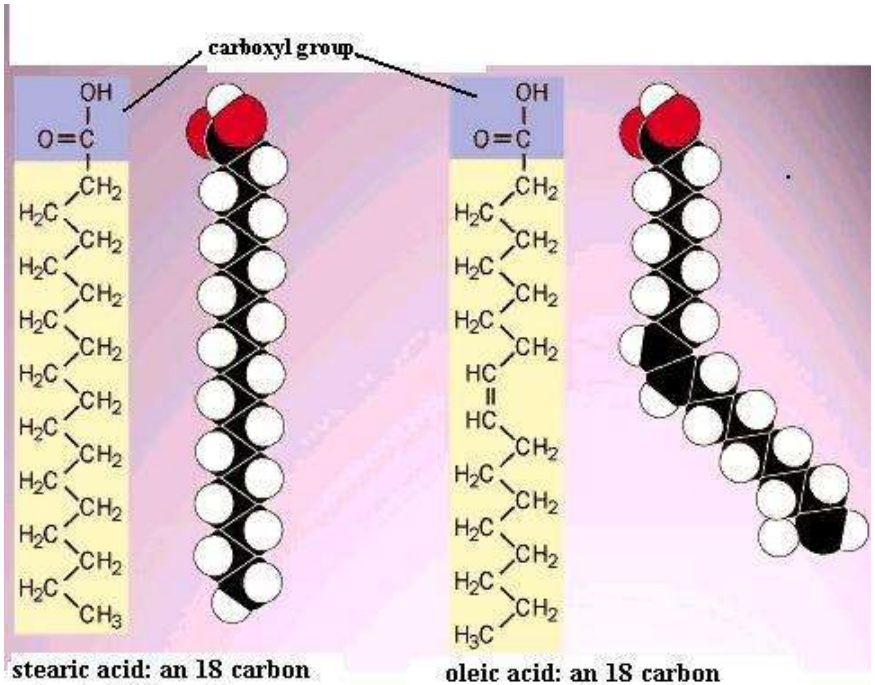


INFLUÊNCIA DE PARÂMETROS NUTRICIONAIS



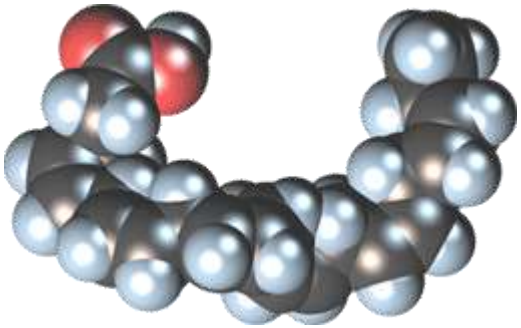
Composição dos fosfolipídios da vitelogenina





stearic acid: an 18 carbon saturated fatty acid

oleic acid: an 18 carbon unsaturated fatty acid



Fatores que influenciam a sensibilidade dos "desafios metabólicos":

- Sexo
- Tamanho corpóreo

- **Do ponto de vista evolutivo, a disponibilidade de alimento é a principal pressão seletiva que molda as estratégias reprodutivas dos animais que se reproduzem sazonalmente"**

(Krasnow & Steiner, 2006)

1) Diferença entre os sexos

- Gametogênese: custo
  - se os machos não exibirem cuidado parental, a demanda energética é muito menor;
  - Investimento dos machos na gametogênese é baixo – é vantagem manter-se ativo mesmo em períodos desfavoráveis
  - Gestação, lactação, manutenção da prole até que sejam independentes: alto custo
  - Espécies ovíparas: vitelogênese
  - Fêmeas são mais suscetíveis à deficiência de alimento, portanto o limiar de inibição de resposta é mais baixo

Behav Ecol Sociobiol (2006) 59: 381–388
DOI 10.1007/s00265-005-0061-4

ORIGINAL ARTICLE

F. Daunt · V. Afanasyev · J. R. D. Silk · S. Wanless

Extrinsic and intrinsic determinants of winter foraging and breeding phenology in a temperate seabird

Diferença na inclinação das retas?

Temperatura baixa

↓

Diminui a oferta de alimento

↓

Aumenta o tempo de forrageamento

↓

Atraso na postura

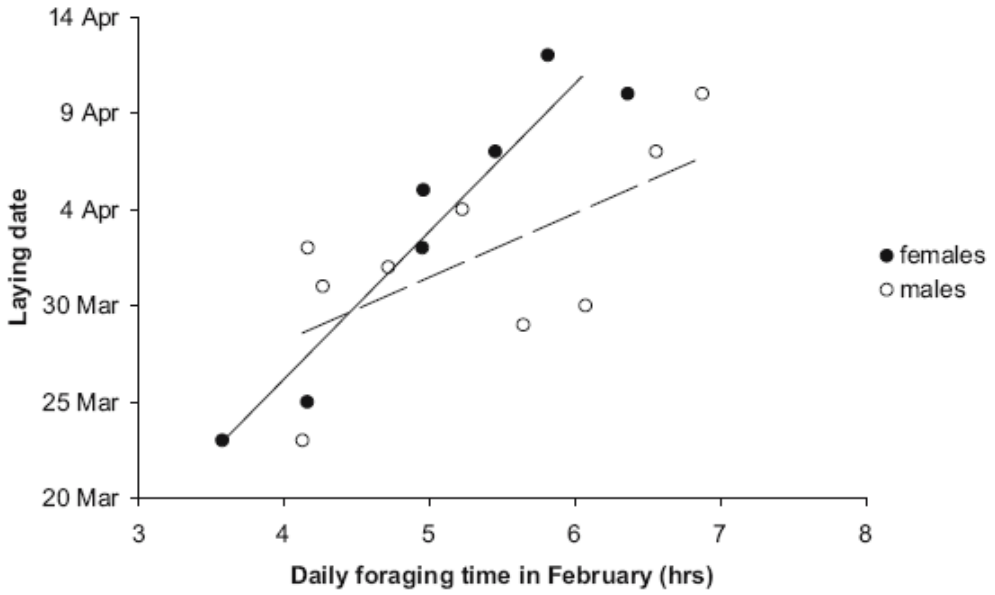


Fig. 4 Relationship between hours spent foraging in February and laying date of females and males

2. Tamanho do Corpo

- Mamíferos de menor massa corpórea são em geral mais sensíveis aos desafios nutricionais;
  - menor estoque energético;
  - reduzida capacidade de estocar alimento quando este é abundante e mobilizar quando é escasso;
- Mamíferos de maior massa corpórea:
  - Produzem um menor número de filhotes;
  - Filhotes são menores em relação ao tamanho da mãe (quando comparados aos menores)- menor demanda energética na lactação

Fertilidade associada com obesidade

Vênus de Willendorf - 25.000-23.000 AC

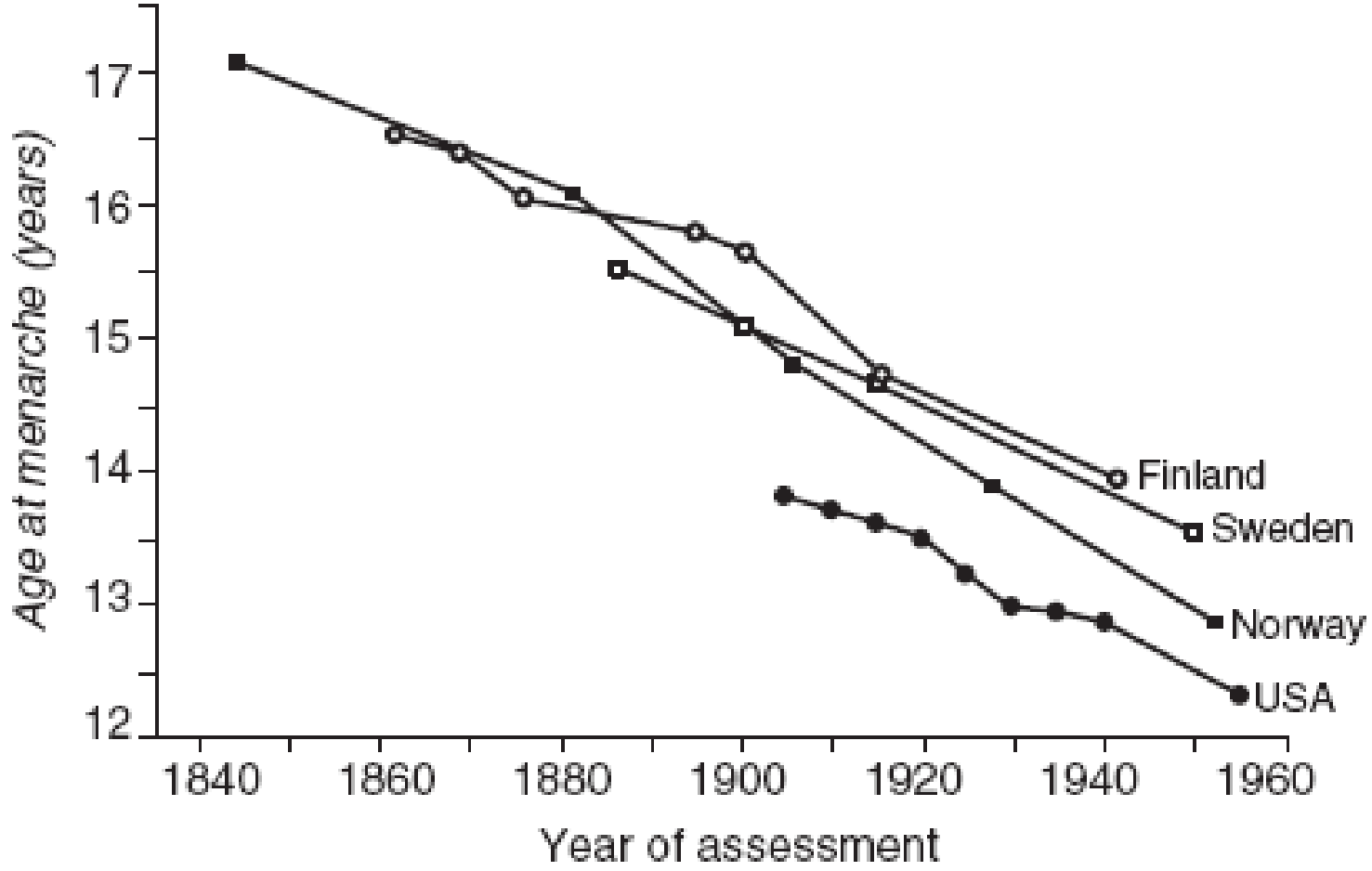


FIG. 1. Average age of menarche in girls in Finland, Sweden, Norway, and the United States from 1840 to 1960. [Redrawn from (14).]

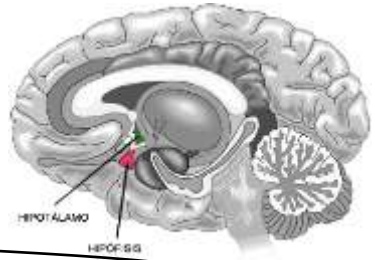
- Qual seria a relação direta entre escassez de alimento e a fisiologia reprodutiva?

.....lembrando novamente o eixo hipotálamo – hipófise- gônadas...

CONTROLE ENDÓCRINO DA REPRODUÇÃO EM VERTEBRADOS

Melatonina

PINEAL



HIPOTÁLAMO

GnIH (-)

Dopamina (-)

GnRH (+)

HIPÓFISE

-

-

FSH

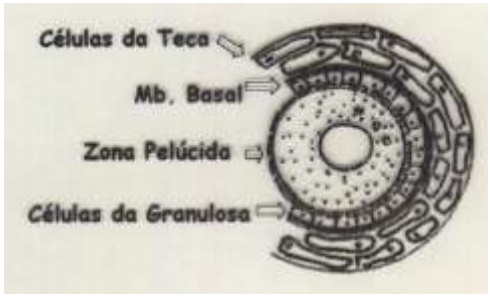
E

LH

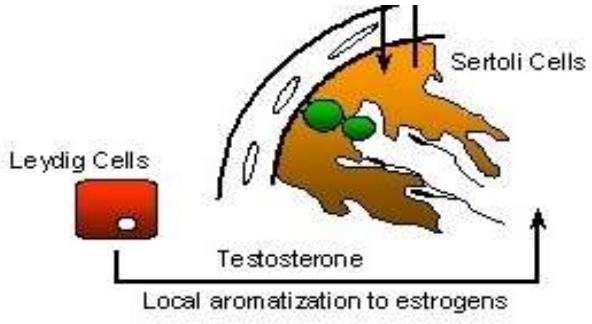
(+)

OVÁRIO

TESTÍCULO



Progesterona



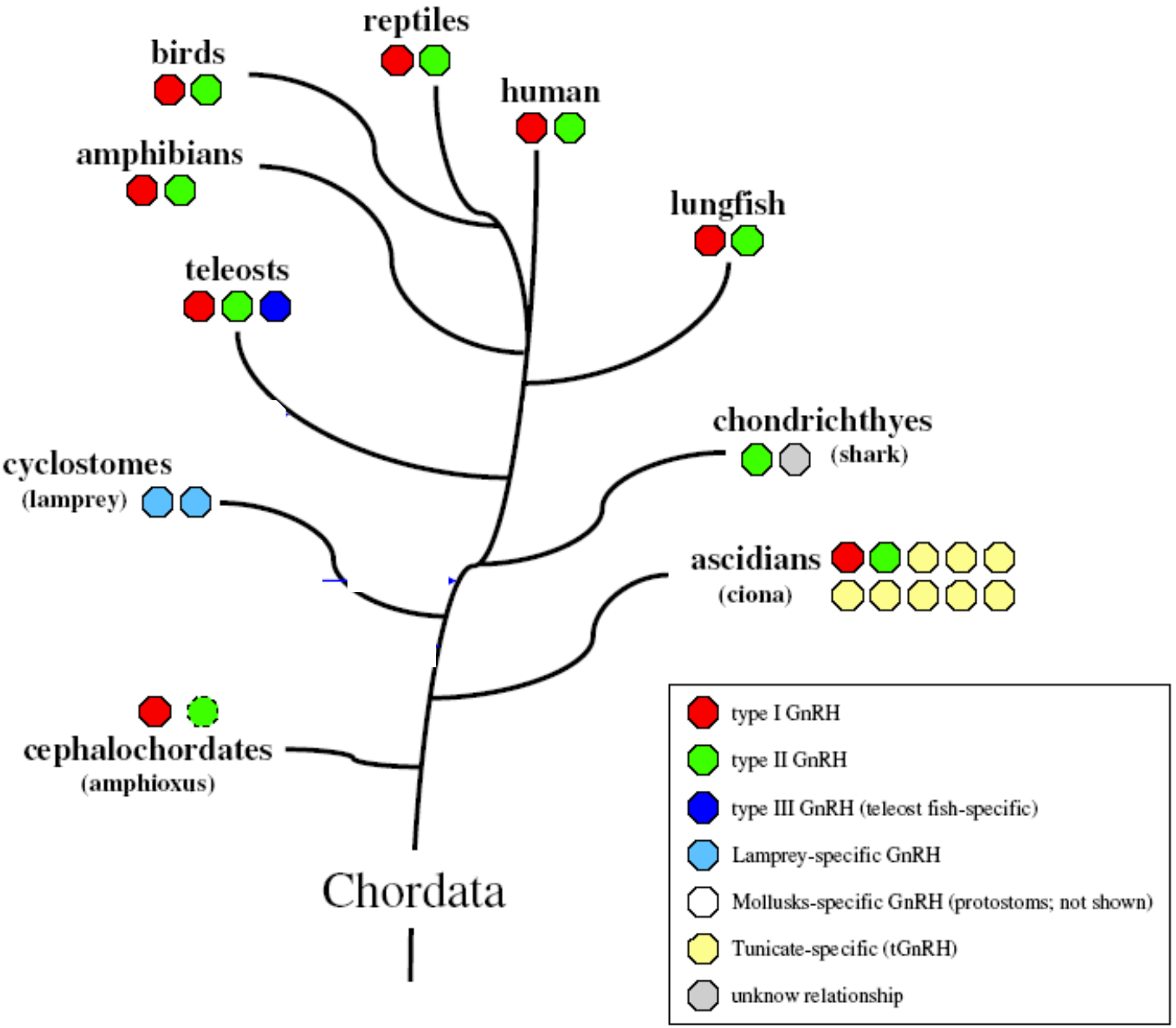
17β - Estradiol

VITELOGENINA

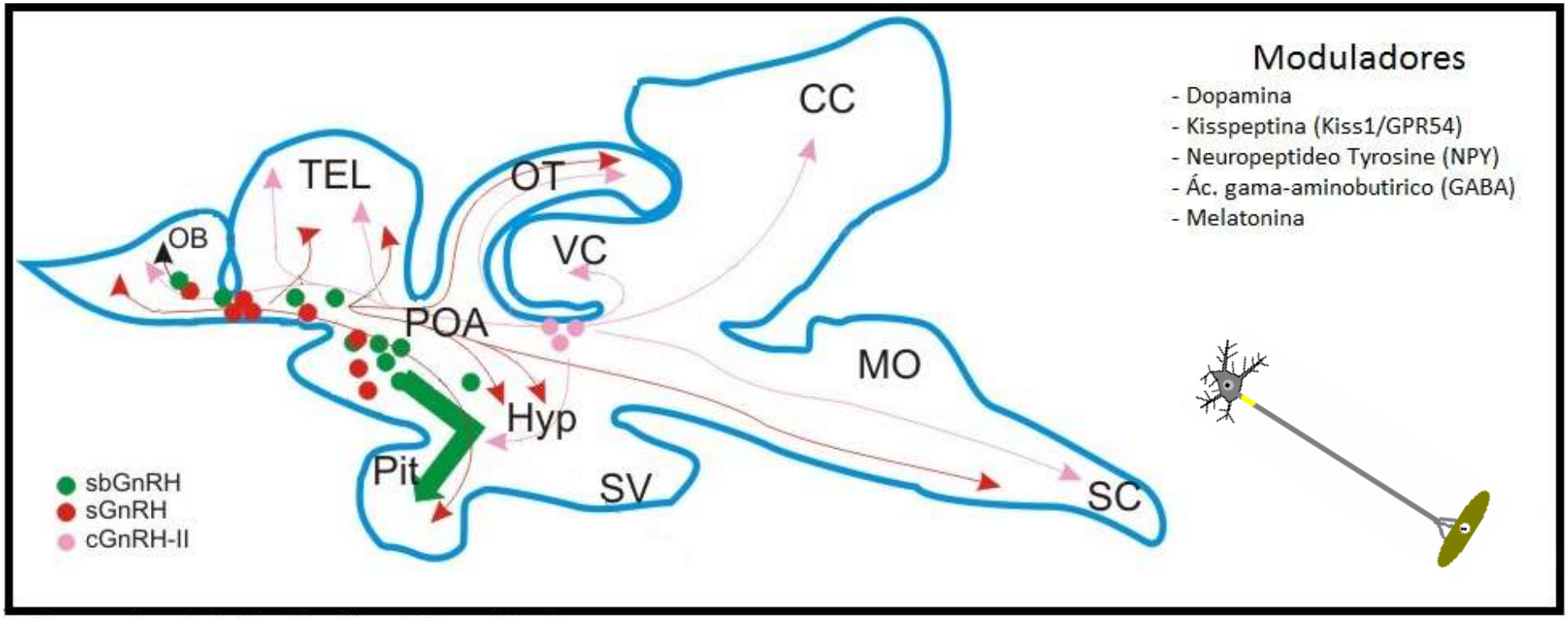
Testosterona, 5-DHT

11-ceto-Testosterona

Tipos de GnRH



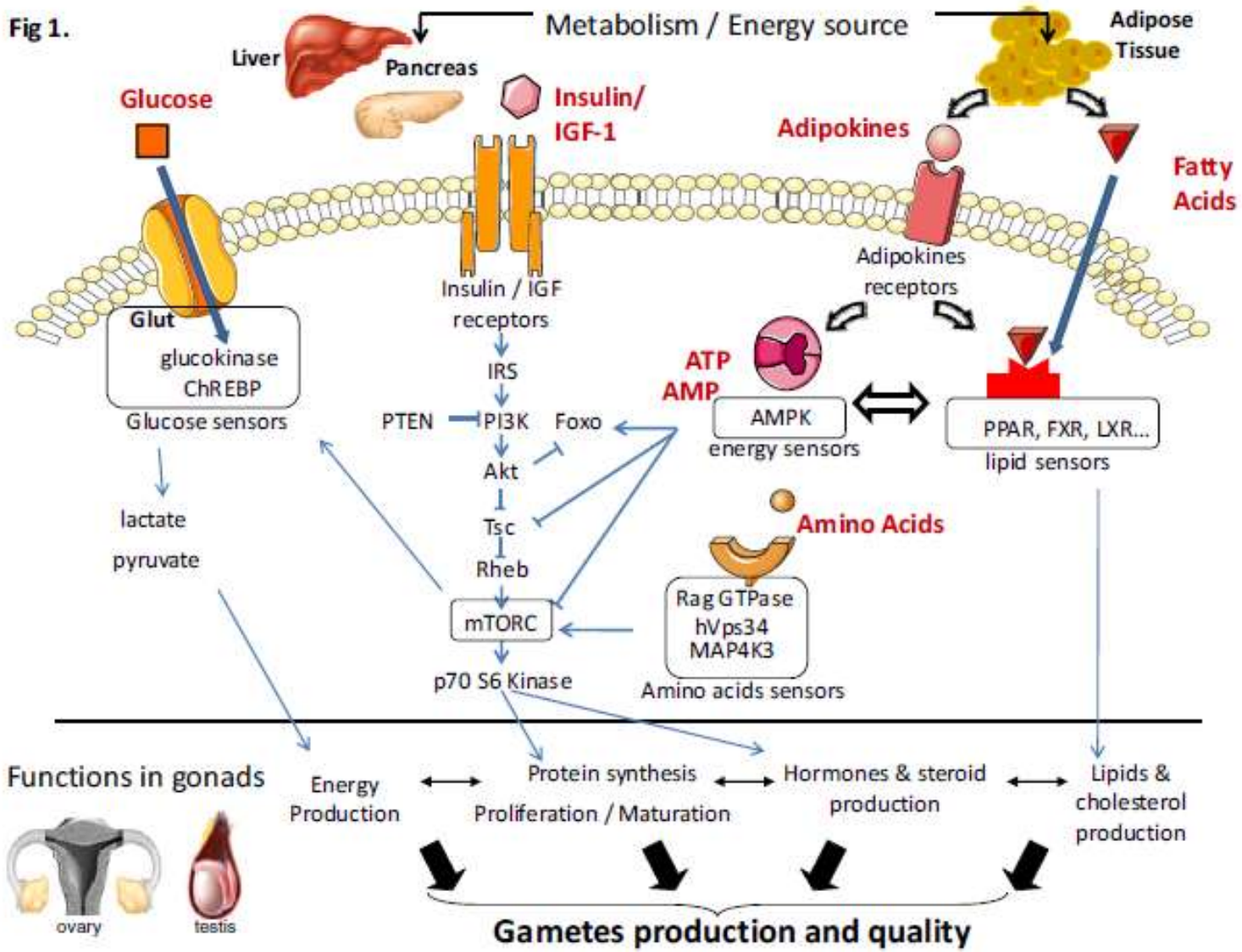
Hipotálamo



CC: corpo do cerebelo; **Hyp:** hipotálamo; **MO:** medula oblonga; **OB:** bulbo olfatório; **OT:** teto óptico; **Pit:** hipófise; **POA:** área preoptica; **SV:** saco vasculoso; **Tel:** telencéfalo; **SC:** medula espinhal; **VC:** valvula do cerebelo;

Retirado e modificado de Zohar *et al.* 2009

Interações moleculares entre metabólitos e sensores que controlam a produção e qualidade dos gametas



(Dupont et al., 2014)

Grelina – “hormônio da fome”

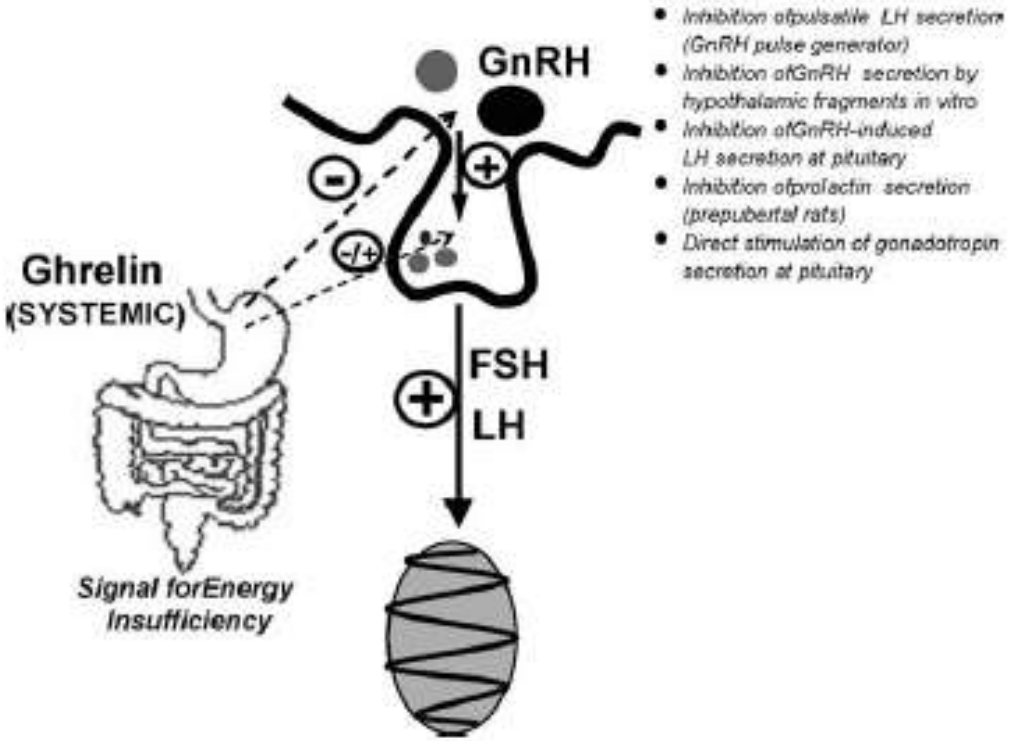


Fig. 1. Diagrammatic presentation of the potential actions of ghrelin in the control of reproductive function, with special emphasis on the reported effects of ghrelin on the gonadotropin axis, at the hypothalamic and pituitary levels. Biological actions of ghrelin may include regulation of GnRH secretion at the hypothalamus, as well as modulation of basal gonadotropin release and responsiveness to GnRH at the pituitary. Modified from Tena-Sempere (2005a).

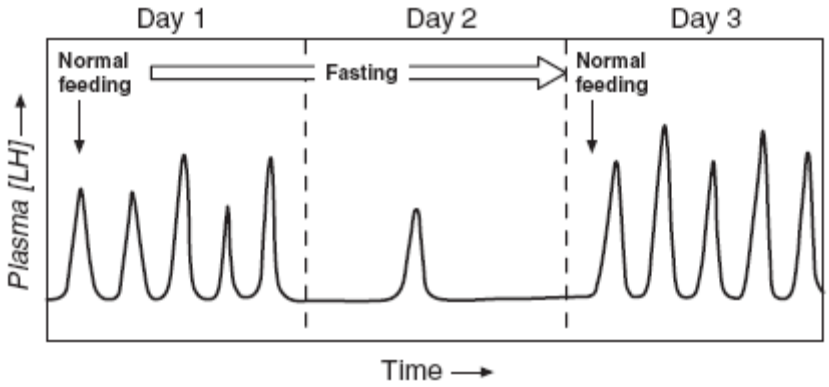


FIG. 3. Effects of fasting and subsequent refeeding on pulsatile LH secretion in male rhesus macaques. LH pulsatility is abolished when food is withheld but is rapidly reinstated when feeding resumes on the following day. [Adapted from (69).]

0013-7227/97/8303-0/0
Endocrinology
Vol. 138, No. 1
Printed in U.S.A.

Regional Differences in the Distribution of Gonadotropin-Releasing Hormone Cells between Rapidly Growing and Growth-Restricted Prepubertal Female Sheep*

HELEN I'ANSON†, SONJA K. TERRY‡, MICHAEL N. LEHMAN, AND DOUGLAS L. FOSTER

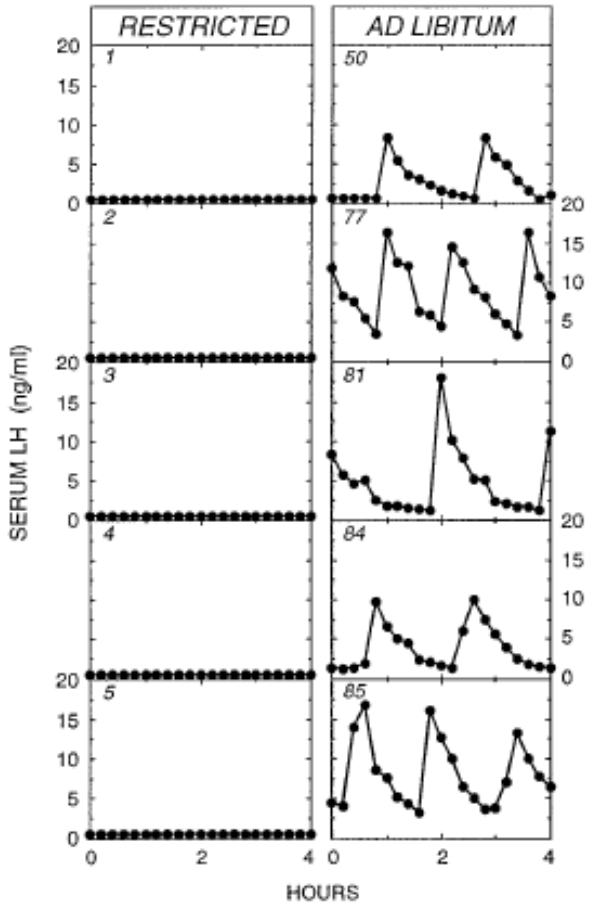


FIG. 2. Pulsatile LH secretion during the 4-h frequent sampling period in ovariectomized growth-restricted (*left panel*) and rapidly growing (*right panel*) lambs.

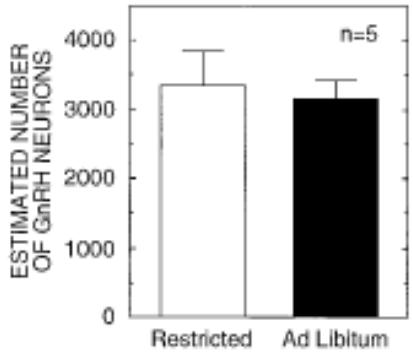


FIG. 3. Mean estimated number of GnRH-containing neurons (±SE) in the brains of growth-restricted (*open bar*) and rapidly growing (*shaded bar*) lambs.

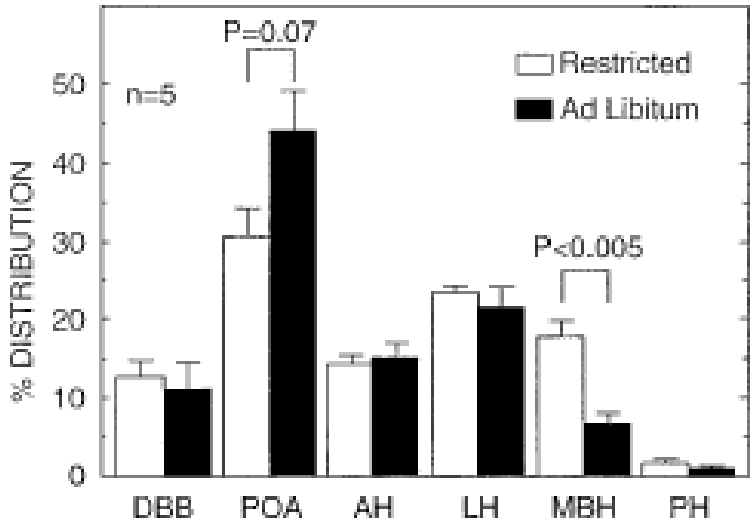


FIG. 5. Relative distribution of GnRH-containing neurons in different brain regions throughout the POA and hypothalamus in growth-restricted (*open bars*) and rapidly growing (*shaded bars*) lambs (mean ± SE). LH, Lateral hypothalamus.

POA – área pré-optica
MBH – hipotálamo médio-basal

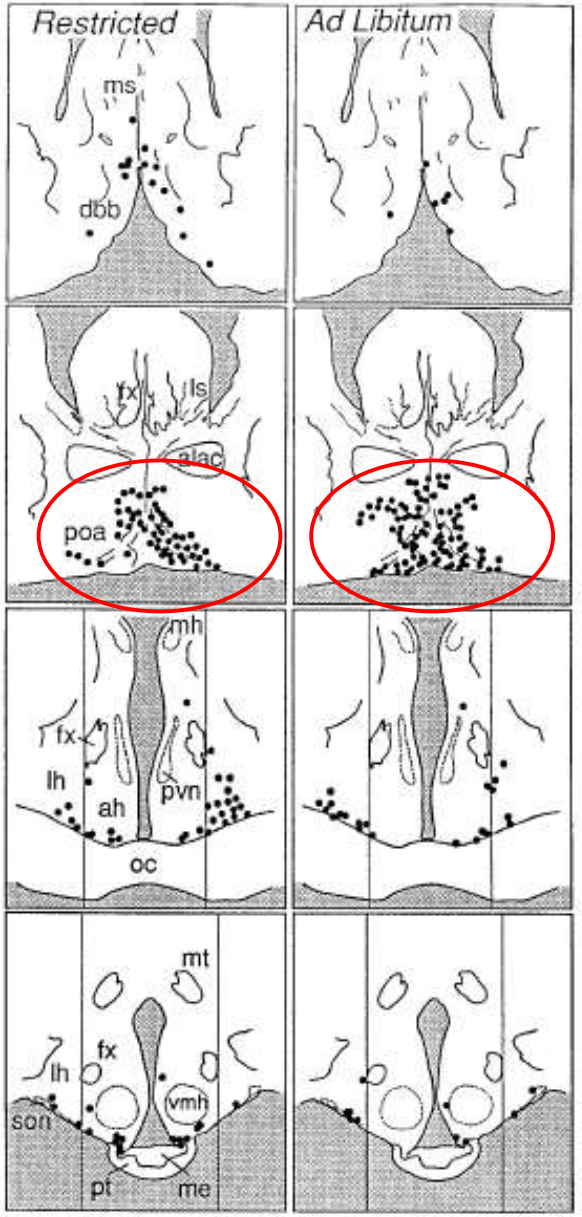


FIG. 4. The distribution of GnRH-containing neurons (*closed circles*) in schematic drawings of coronal brain sections from a representative growth-restricted (*left panel*) and rapidly growing (*right panel*) lamb. The drawing illustrates single sections at the level of the DBB (dbb; *first panel*), POA (poa; *second panel*), AH (ah; *third panel*), and MBH (*fourth panel*). The lateral hypothalamus is shown in the *third and fourth panels* as the region lateral to the fornix (*vertical lines* show the inner margins of the lateral hypothalamus). ms, Medial septum; fx,

Leptina na sinalização do eixo H-H-G

Journal of Physiology (2002), 545.1, pp. 255–268
DOI: 10.1113/jphysiol.2002.023895
www.jphysiol.org

Leptin directly acts within the hypothalamus to stimulate gonadotropin-releasing hormone secretion *in vivo* in rats

Hajime Watanobe

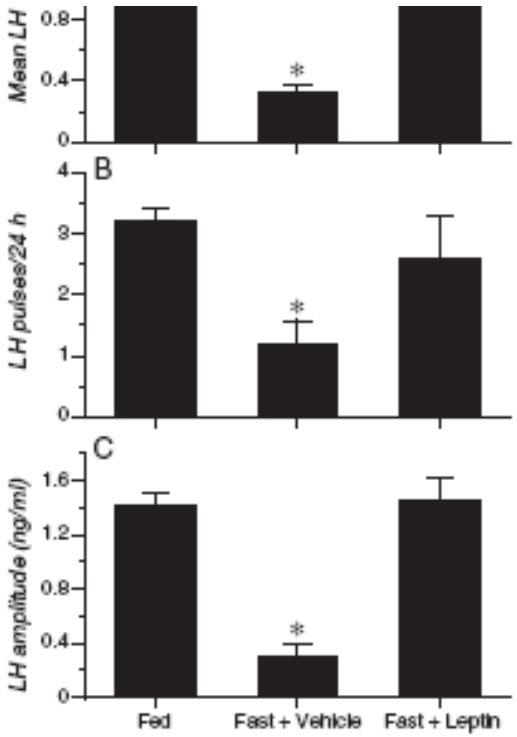


FIG. 6. Leptin reverses the inhibitory effect of food deprivation on pulsatile LH secretion. (**A**) Mean plasma LH concentrations, (**B**) LH pulse frequency, and (**C**) LH pulse amplitude in fed and fasted estradiol-treated OVX female rats. Serial blood samples were obtained while the rats fed normally (Fed) and again when the same animals were fasted for 48 hours while receiving peripheral injections of the vehicle (Fast + Vehicle) or leptin (3 μg/g; Fast + Leptin). *P <0.05 vs. Fed and Fast + Leptin groups. [Redrawn from (63).]

INFUSÃO DE LEPTINA

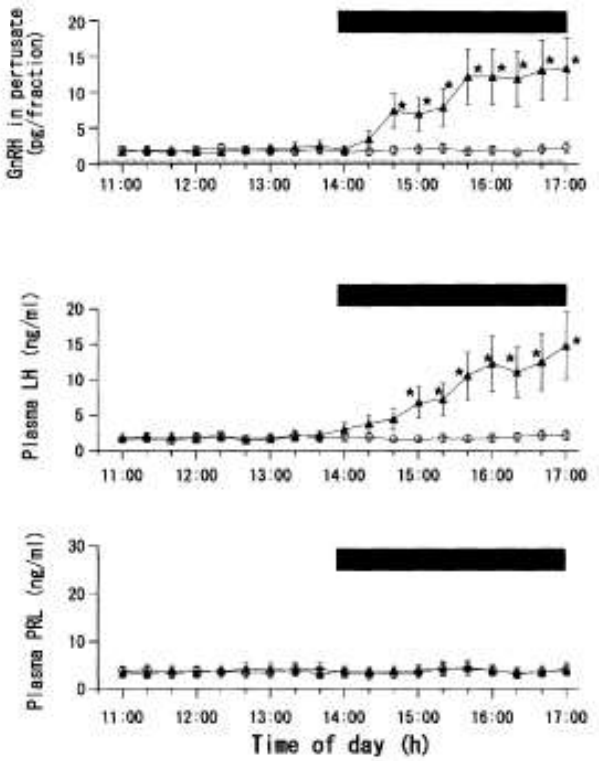


Figure 2. Effects of MPOA perfusion with leptin or vehicle on local release of α-MSH, NPY and GnRH, as well as on plasma levels of LH and PRL ,in fasted female rats

Number of rats in each subgroup = 8–11. * Statistically significant *vs.* the control group.

Receptores de Leptina em neurônios que sintetizam GnRH?
Quennell et al. (2009) - Interneurônios?

ELSEVIER
journa

Review

Leptin and reproductive fu

Gary J. Hausman [a,*], C. Richard Ba

[a] USDA, ARS, Richard B. Russell Research Center, RRC, 950
[b] USDA, ARS, U.S. Meat Animal Research Center, Clay Cent

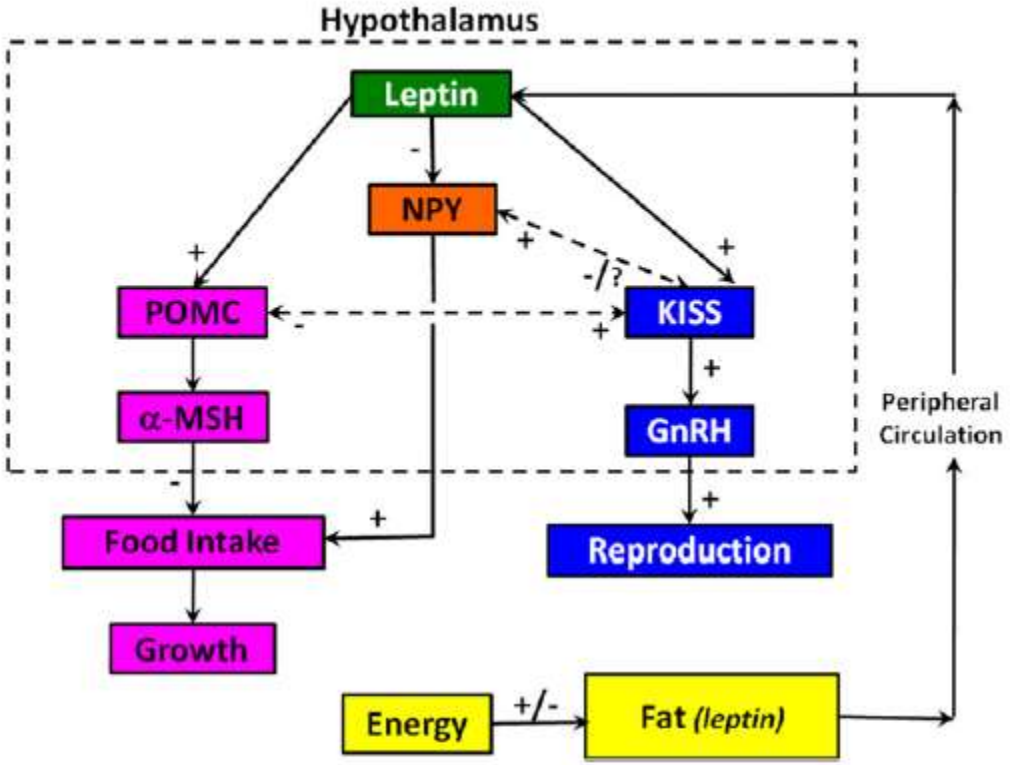
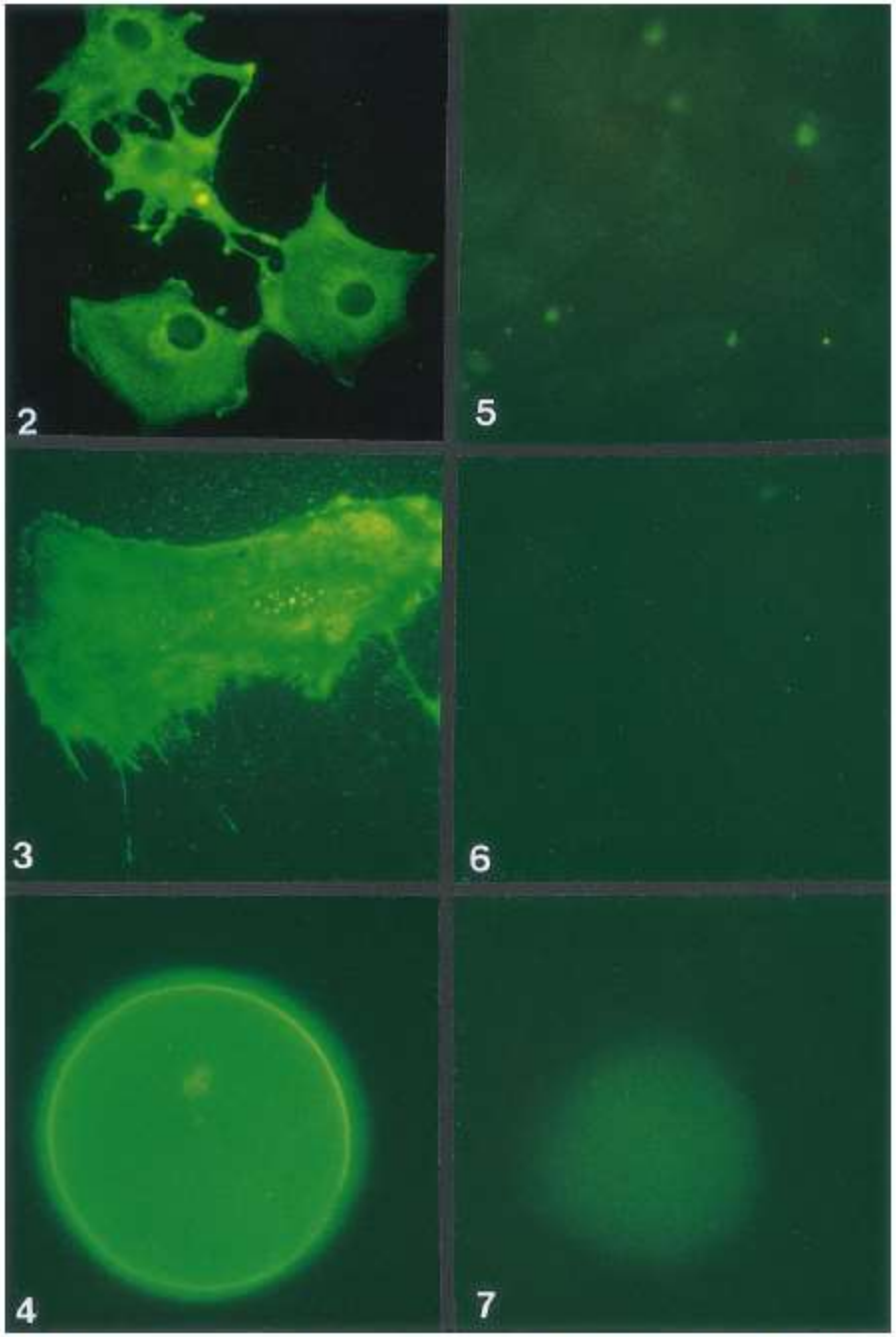


Fig. 1. Leptin is synthesized in adipose tissues and secreted into the peripheral circulation. It acts centrally in the hypothalamus to suppress activity of NPY (neuropeptide-Y) neurons, which reduces the stimulatory drive on food intake and lessens NPY inhibition of kisspeptin cell bodies. Acting directly on POMC (proopiomelanocortin) neurons, leptin stimulates α-MSH (melanocyte stimulating hormone) release which functions to suppress food intake and alter growth. Activation of POMC cells stimulates kisspeptin neurons, which have axons that terminate near NPY and POMC expressing cell bodies where kisspeptin stimulates and inhibits each, respectively. Leptin can also act directly on subpopulations of kisspeptin neurons to further increase the stimulatory drive on GnRH (gonadotropin-releasing hormone) release and gonadotropin secretion from the pituitary gland. Leptin may further enhance LH (luteinizing hormone) secretion and support reproduction by acting to increase the sensitivity of gonadotrope cells in the pituitary gland to GnRH. A fluctuation in energy balance changes leptin secretion and alters these pathways. Solid lines represent established pathways. Dashed arrows represent recently proposed mechanisms.

Receptores de leptina nos ovários (humanos)



Figures 2–7. Anti-leptin immunofluorescent staining in human granulosa cells (**Figure 2**), cumulus oophorus cells (**Figure 3**) and mature oocytes (**Figure 4**). Non-specific fluorescence in negative cellular controls exposed to rabbit immunoglobulin (Ig)G are shown in **Figures 5, 6,** and **7**.

Manutenção da imaturidade em condições de restrição alimentar:

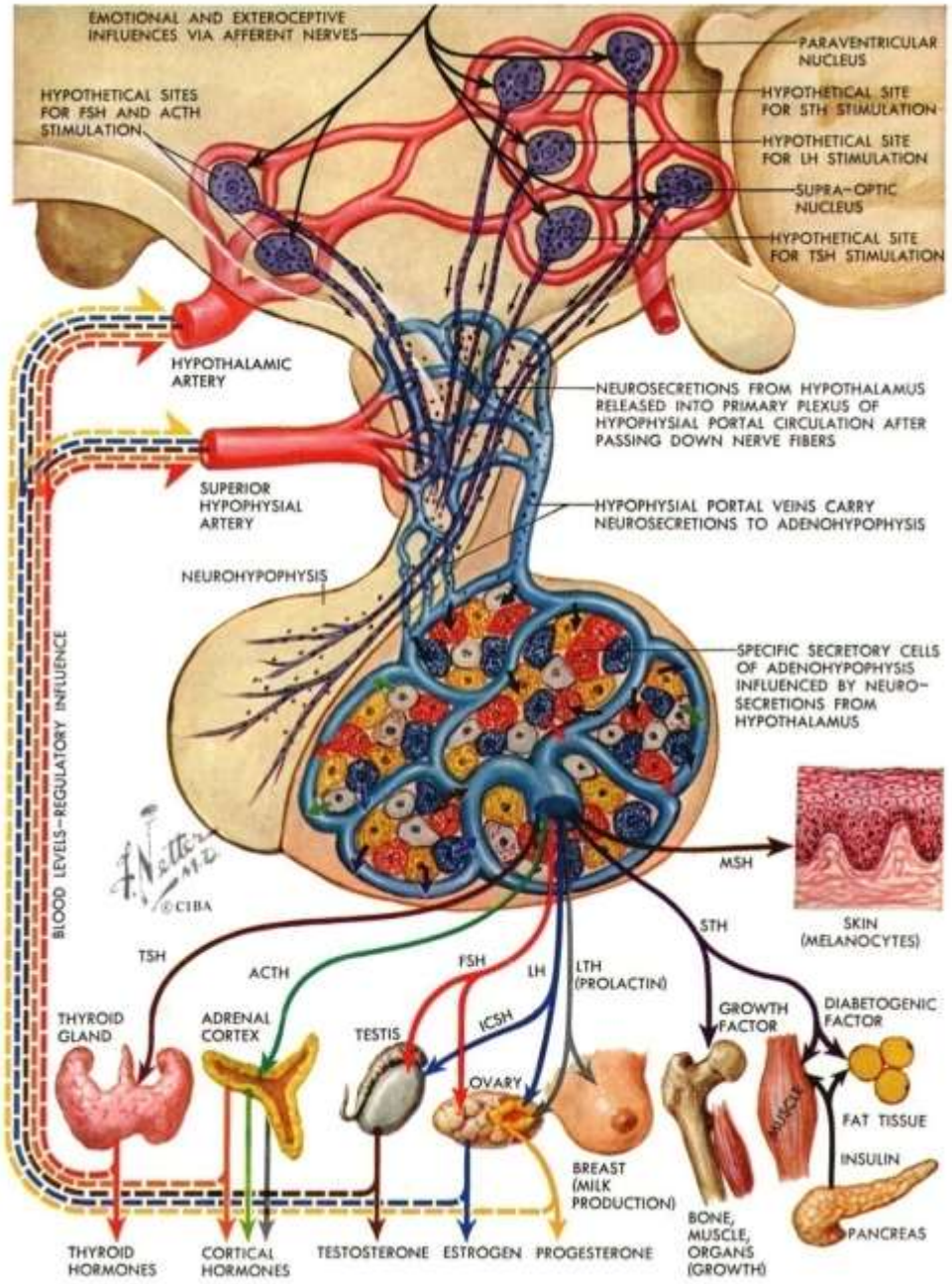
- Insuficiência na produção de gonadotropinas;
- Diminuição da concentração de esteroides gonadais;
- Hipogonadismo;
- Impedimento da espermatogênese;
- Ausência ou diminuição do ciclo estral;
- Ausência de ovulação;
- Ausência do comportamento de corte.

MODELO – LACTAÇÃO

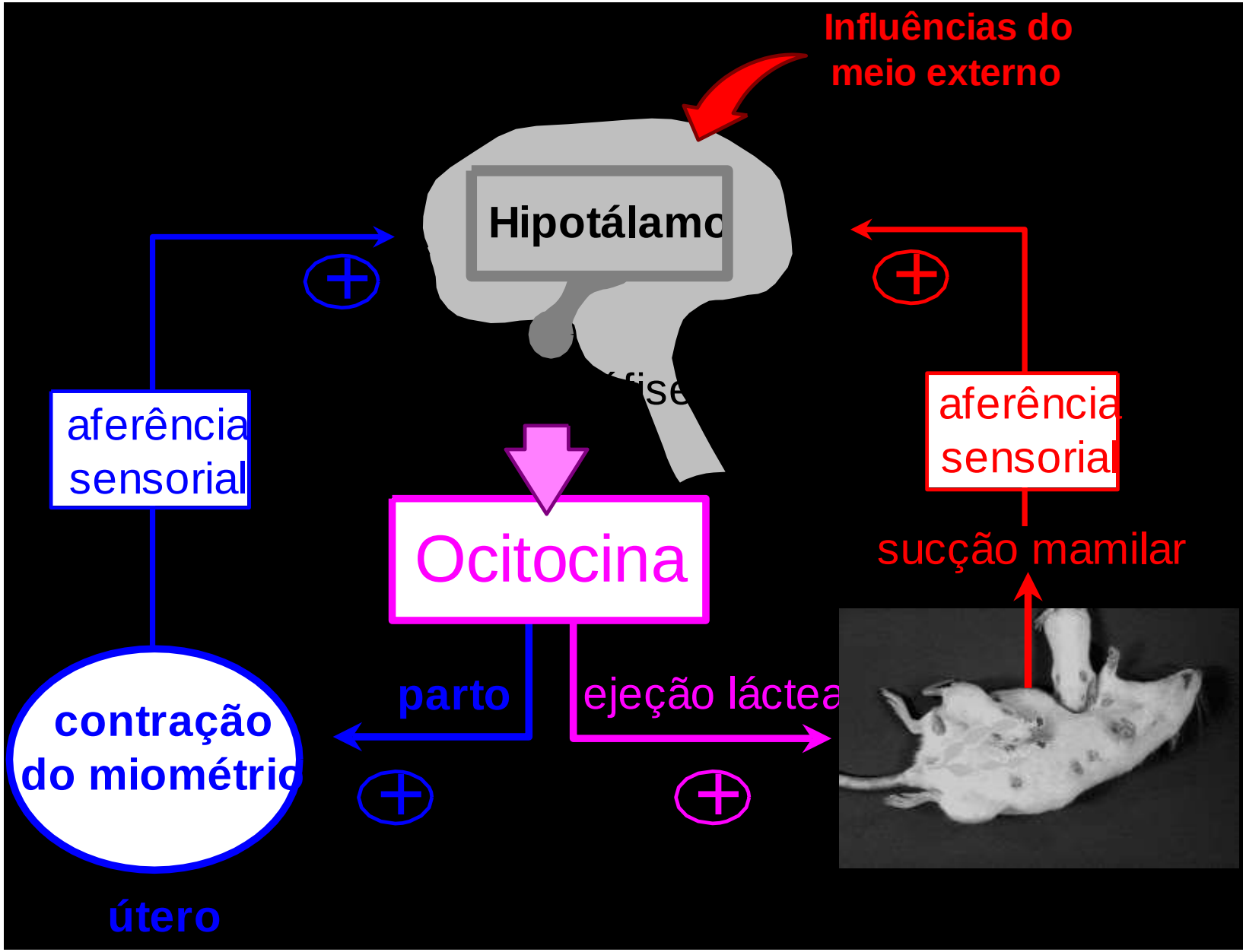
- Hiperfagia
- Mobilização de reservas
- Redução das atividades físicas

Controle hormonal: ocitocina e prolactina

MAMÍFERO

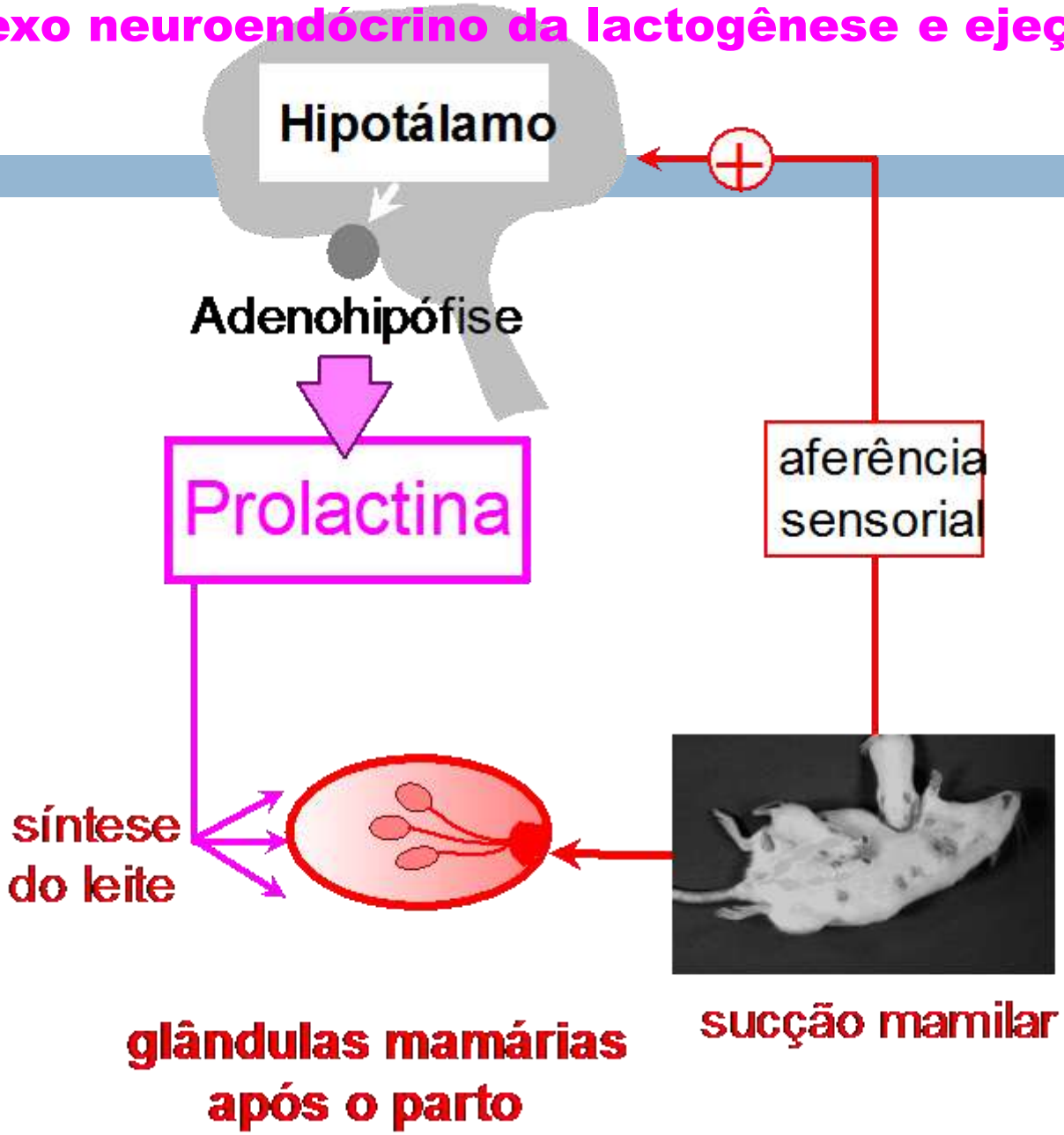

EMOTIONAL AND EXTEROCEPTIVE INFLUENCES VIA AFFERENT NERVES
PARAVENTRICULAR NUCLEUS
HYPOTHETICAL SITES FOR FSH AND ACTH STIMULATION
HYPOTHETICAL SITE FOR STH STIMULATION
HYPOTHETICAL SITE FOR LH STIMULATION
SUPRA-OPTIC NUCLEUS
HYPOTHETICAL SITE FOR TSH STIMULATION
HYPOTHALAMIC ARTERY
NEUROSECRETIONS FROM HYPOTHALAMUS RELEASED INTO PRIMARY PLEXUS OF HYPOPHYSIAL PORTAL CIRCULATION AFTER PASSING DOWN NERVE FIBERS
SUPERIOR HYPOPHYSIAL ARTERY
HYPOPHYSIAL PORTAL VEINS CARRY NEUROSECRETIONS TO ADENOHYPOPHYSIS
NEUROHYPOPHYSIS
SPECIFIC SECRETORY CELLS OF ADENOHYPOPHYSIS INFLUENCED BY NEURO-SECRETIONS FROM HYPOTHALAMUS
BLOOD LEVELS-REGULATORY INFLUENCE
©CIBA
MSH
SKIN (MELANOCYTES)
STH
TSH
ACTH
FSH
LH
LTH (PROLACTIN)
ICSH
GROWTH FACTOR
DIABETOGENIC FACTOR
THYROID GLAND
ADRENAL CORTEX
TESTIS
OVARY
FAT TISSUE
INSULIN
BREAST (MILK PRODUCTION)
BONE, MUSCLE, ORGANS (GROWTH)
PANCREAS
THYROID HORMONES
CORTICAL HORMONES
TESTOSTERONE
ESTROGEN
PROGESTERONE

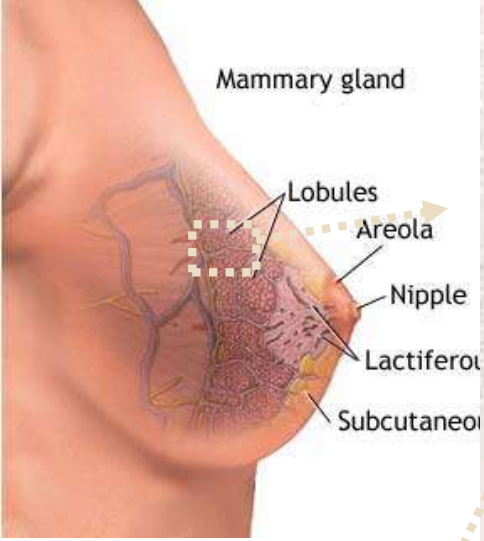
HORMÔNIOS DA NEUROHIPÓFISE: OCITOCINA



Modificado do Atlas de Fisiologia, 2002

Secreção de Prolactina pela adenohipófise
O reflexo neuroendócrino da lactogênese e ejeção láctea





Ácino mamário

Células mioepiteliais

Luz do ácino mamário

Exocitose de grânulos com leite

OCITOCINA

+

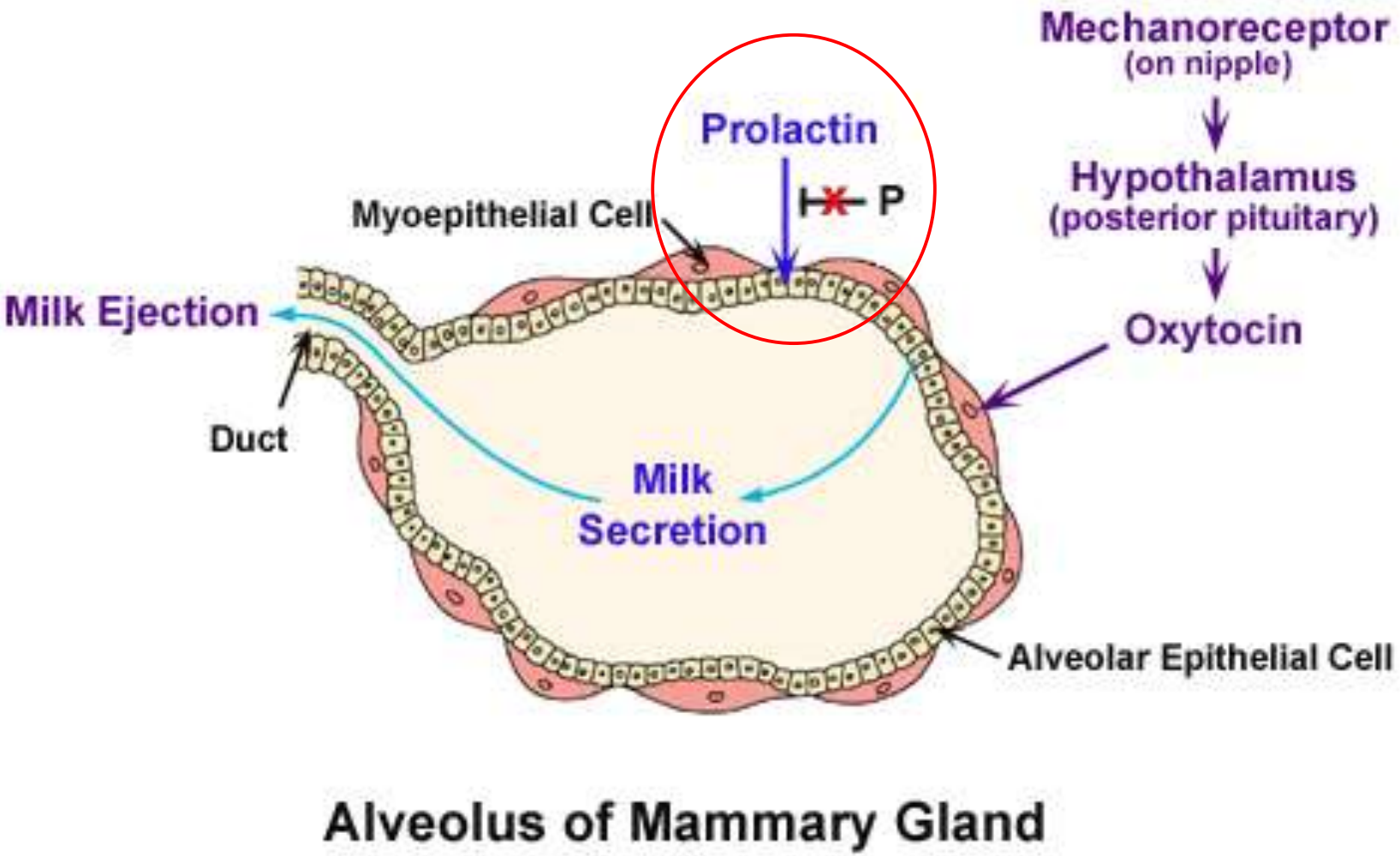
Células acinares

+

PROLACTINA

http://mammary.nih.gov/reviews/development/Hennighausen001/index.ht

Alvéolo (ou ácino) da glândula mamária



P: a progesterona inibe a lactação durante a gravidez

ACADEMIC PRESS
Frontiers in Neuroendocrinology 23 (2002) 225–256
Frontiers in Neuroendocrinolgy
www.academicpress.com

Integration of the regulation of reproductive function and energy balance: lactation as a model

M. Susan Smith [a,b,c,*] and Kevin L. Grove [a,b]

Inibição da produção de LH durante a lactação – via ação do GnRH:
-diminuição da concentração de leptina;
-diminuição da responsividade dos receptores de GnRH nas células gonadotrópicas;

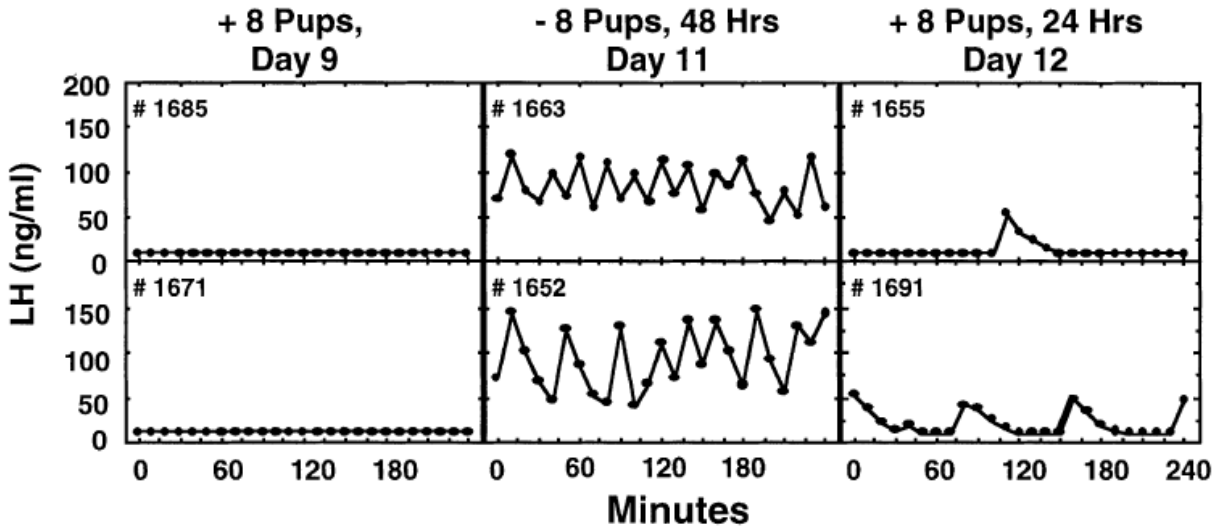


Fig. 1. Patterns of LH secretion in representative lactating rats: role of the suckling stimulus in the suppression of LH secretion. On day 2 postpartum, the lactating rats are ovariectomized and litter size is adjusted to 8 pups. The rats are then continuously suckled. On day 9, the pulsatile pattern of LH secretion is inhibited in the presence of chronic suckling. Removal of pups on day 9 leads to a resumption of pulsatile LH secretion by day 11. Returning the 8-pup litters on day 11 reimposes the suppression of LH secretion by day 12.