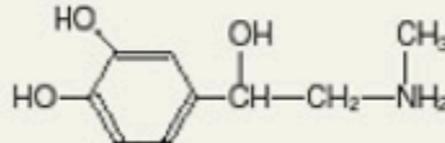
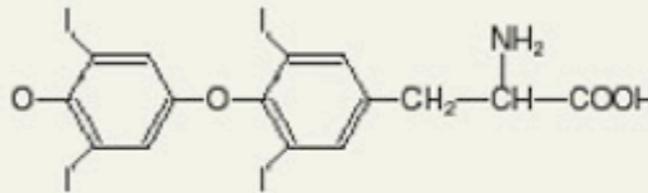
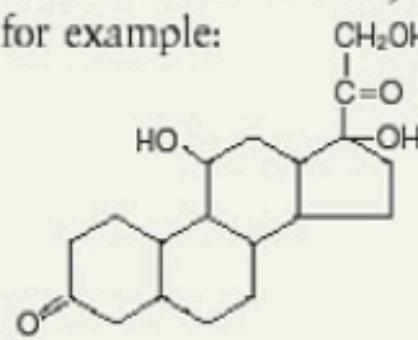
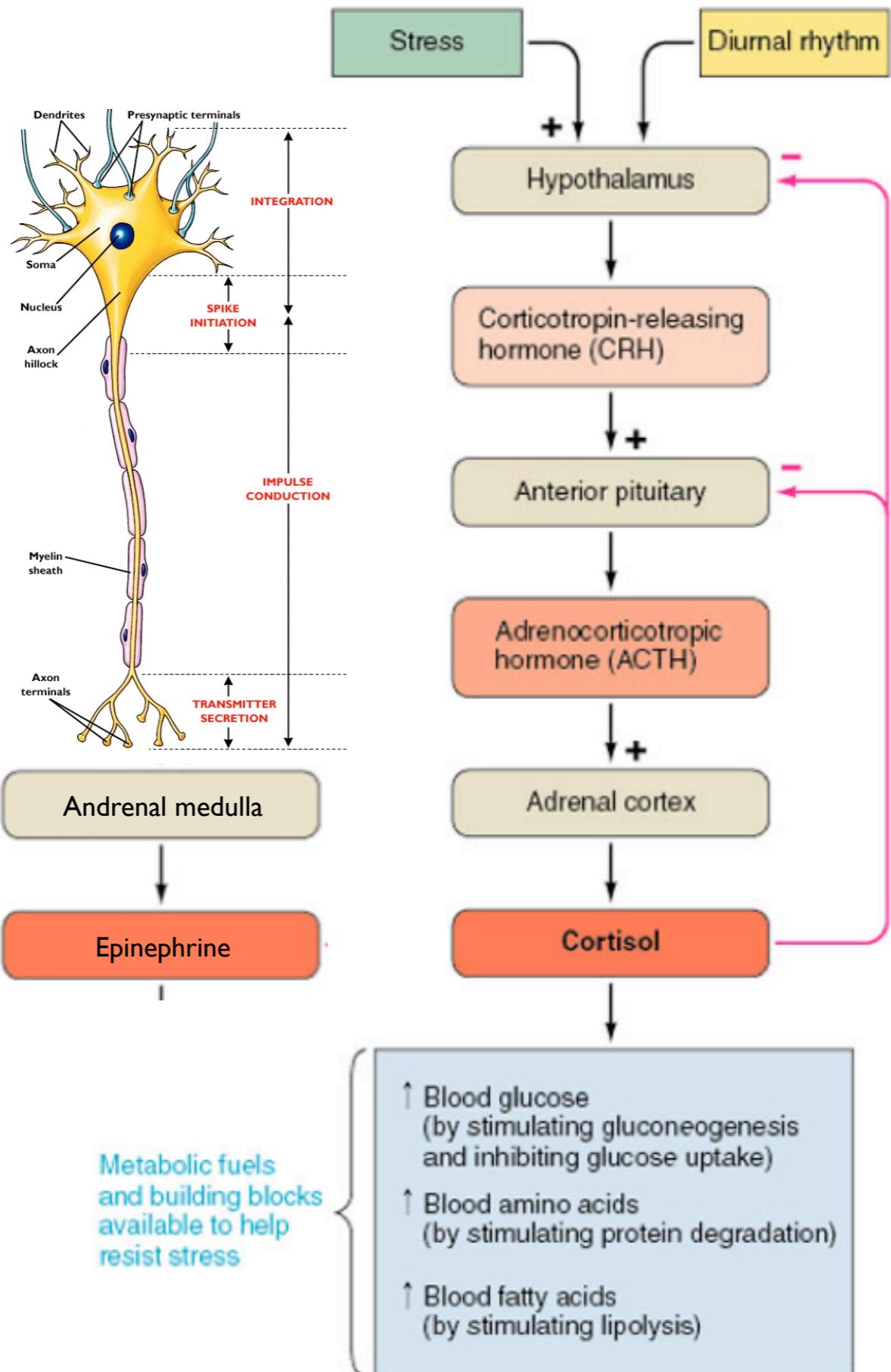


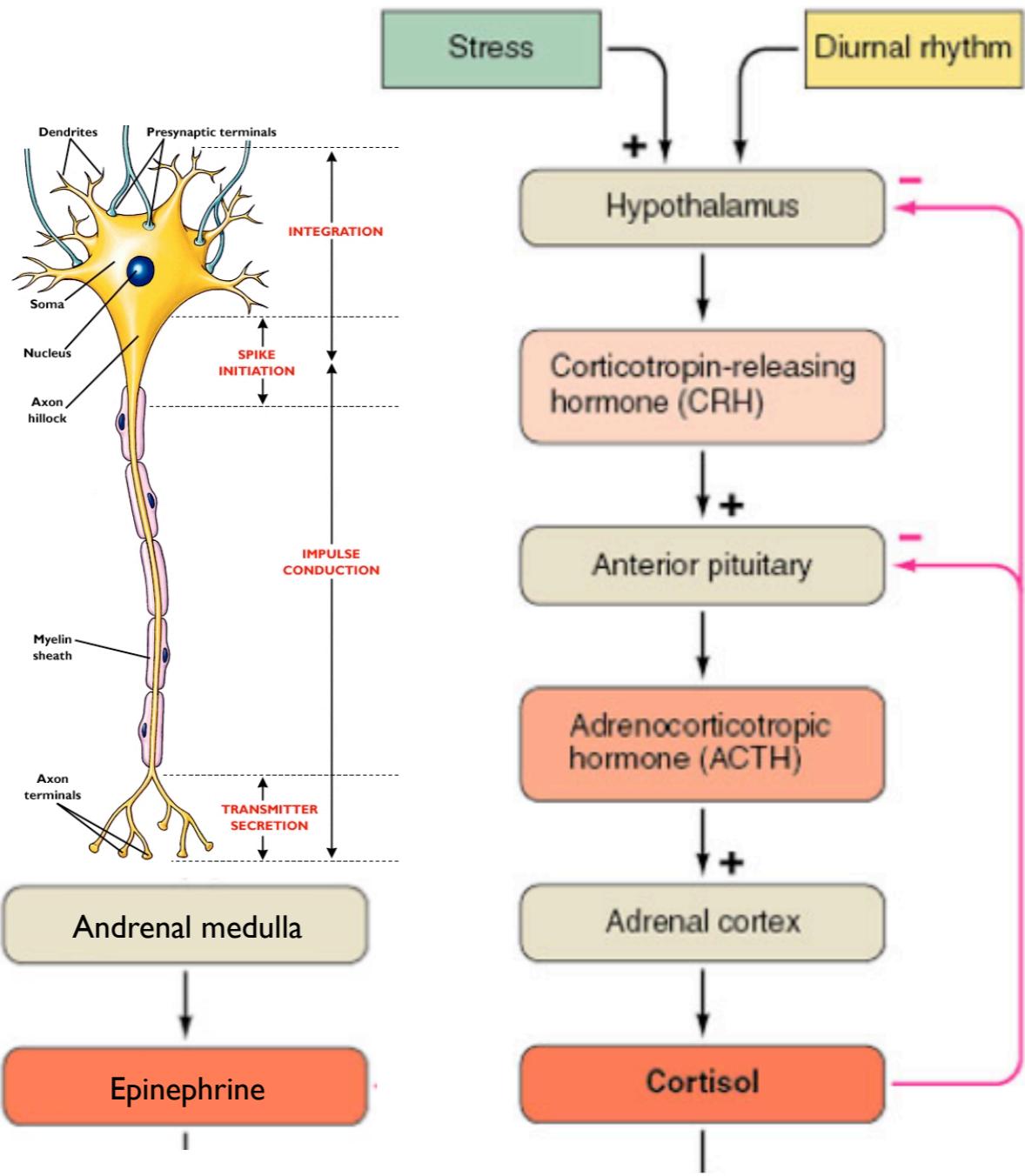
Today

Review

Table 7–1 ■ Chemical Classification of Vertebrate Hormones

Properties	Peptides	Amines		
		Catecholamines	Thyroid Hormone	Steroids
Structure	Chains of specific amino acids, for example: $\begin{array}{ccccccc} \text{Cys}^1-\text{s}-\text{s}-\text{Cys}^6-\text{Pro}^7-\text{Arg}^8-\text{Gly}^9\text{NH}_2 \\ & & & & & & \\ \text{Tyr}^2 & & \text{Asn}^5 & & & & \\ & & & & & & \\ \text{Phe}^3 & - & \text{Gln}^4 & & & & \end{array}$ (vasopressin)	Tyrosine derivative, for example:  (epinephrine)	Iodinated tyrosine derivative, for example:  (thyroxine, T ₄)	Cholesterol derivative, for example:  (cortisol)
Solubility	Hydrophilic (lipophobic)	Hydrophilic (lipophobic)	Lipophilic (hydrophobic)	Lipophilic (hydrophobic)





Adrenal Cortex

- The adrenal cortex secretes three different categories of steroid hormones:
 - mineralocorticoids (primarily aldosterone)
 - **glucocorticoids (primarily cortisol and corticosterone)**
 - adrenal sex hormones (primarily the weak androgen, dehydroepiandrosterone).

Adrenal medulla

- The adrenal medulla is composed of modified sympathetic postganglionic neurons, which secrete the catecholamine epinephrine into the blood in response to sympathetic stimulation.
- Epinephrine also exerts important metabolic effects, namely, increasing blood glucose and blood fatty acids.

Table 7–8 Summary of Hormonal Control of Fuel Metabolism

Hormone	Major Metabolic Effects				Control of Secretion	
	Effect on blood glucose	Effect on blood fatty acids	Effect on blood amino acids	Effect on muscle protein	Major stimuli for secretion	Primary role in metabolism
Epinephrine	↑ + Glycogenolysis + Gluconeogenesis – Insulin secretion + Glucagon secretion	↑ + Lipolysis	No effect	No effect	Sympathetic stimulation during stress and exercise	Provision of energy for emergencies and exercise
Cortisol	↑ + Gluconeogenesis – Glucose uptake by tissues other than brain; glucose sparing	↑ + Lipolysis	↑ + Protein degradation	↓ + Protein degradation	Stress	Mobilization of metabolic fuels and building blocks during adaptation to stress

Glucocorticoids - Metabolic Effects

- Stimulate gluconeogenesis
- Inhibits glucose uptake
- Stimulates protein degradation
- Facilitates lipolysis
- Acclimatization to seawater (fish)

Glucocorticoids - Immunosuppressive Effects

Stressed over a test? Pet your pooch

College students who own a pet are less lonely or frazzled, survey finds



Duane Hoffmann / msnbc.com

Evolution

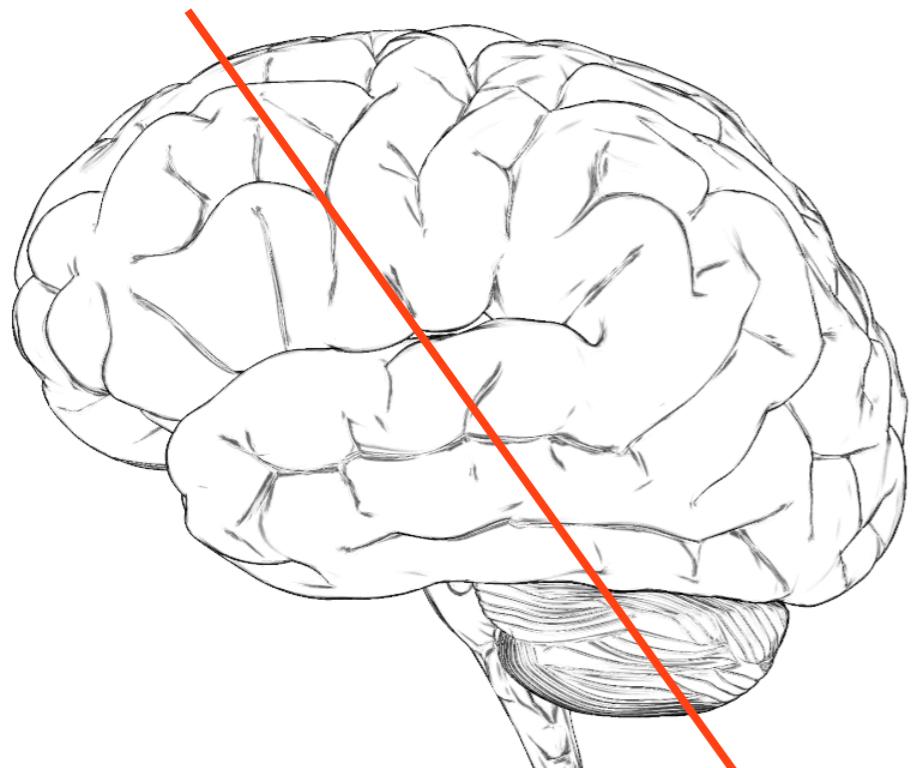
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OTTAVIANI *et al.*

Table 1. Hierarchical levels of stress response

Levels	Components	Biological role	Evolution
1. Cell e.g. invertebrate immunocytes	Mostly macrophages, lymphocytes secreting CRH, ACTH, BA, GC	Mobile immune-brain e.g. prototype stress response	Ancestral
2. Organ e.g. thymus	Cells producing CRH, ACTH, GC	Local circuitry e.g. positive and negative selection	Old
3. Body	Several organs e.g. hypothalamus, pituitary, adrenal gland	Co-ordination among organs and systems	Recent

An integration of these three levels of stress response can be predicted, resulting in a body homeostasis. As stress response is deeply interconnected with inflammation and natural immunity, the hierarchy proposed here can have important, far-reaching, pathophysiological consequences. CRH, corticotropin-releasing hormone; ACTH, adrenocorticotropin hormone; BA, biogenic amines; GC, glucocorticoids.

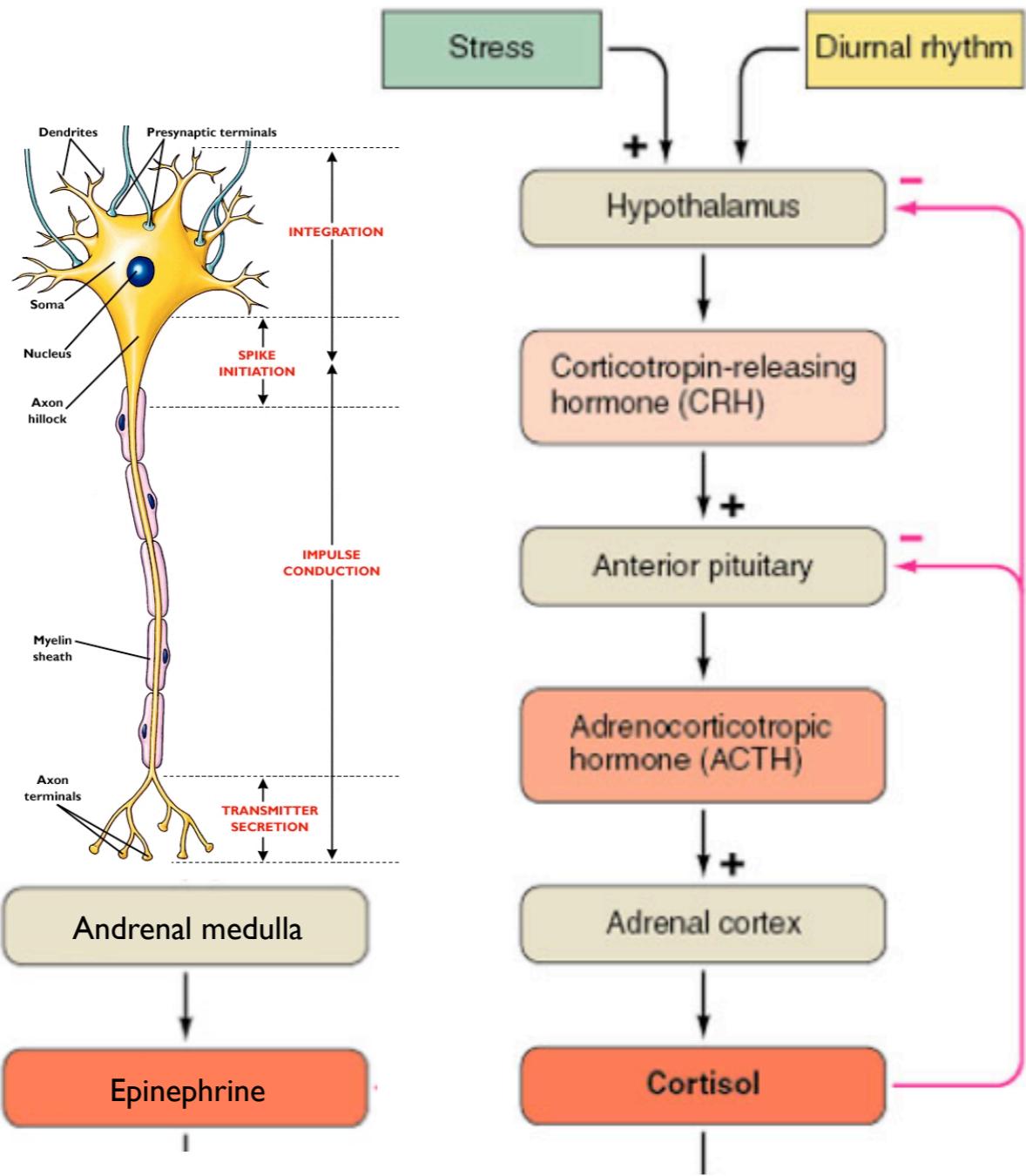


Histochemical Journal 30, 61–67 (1998)

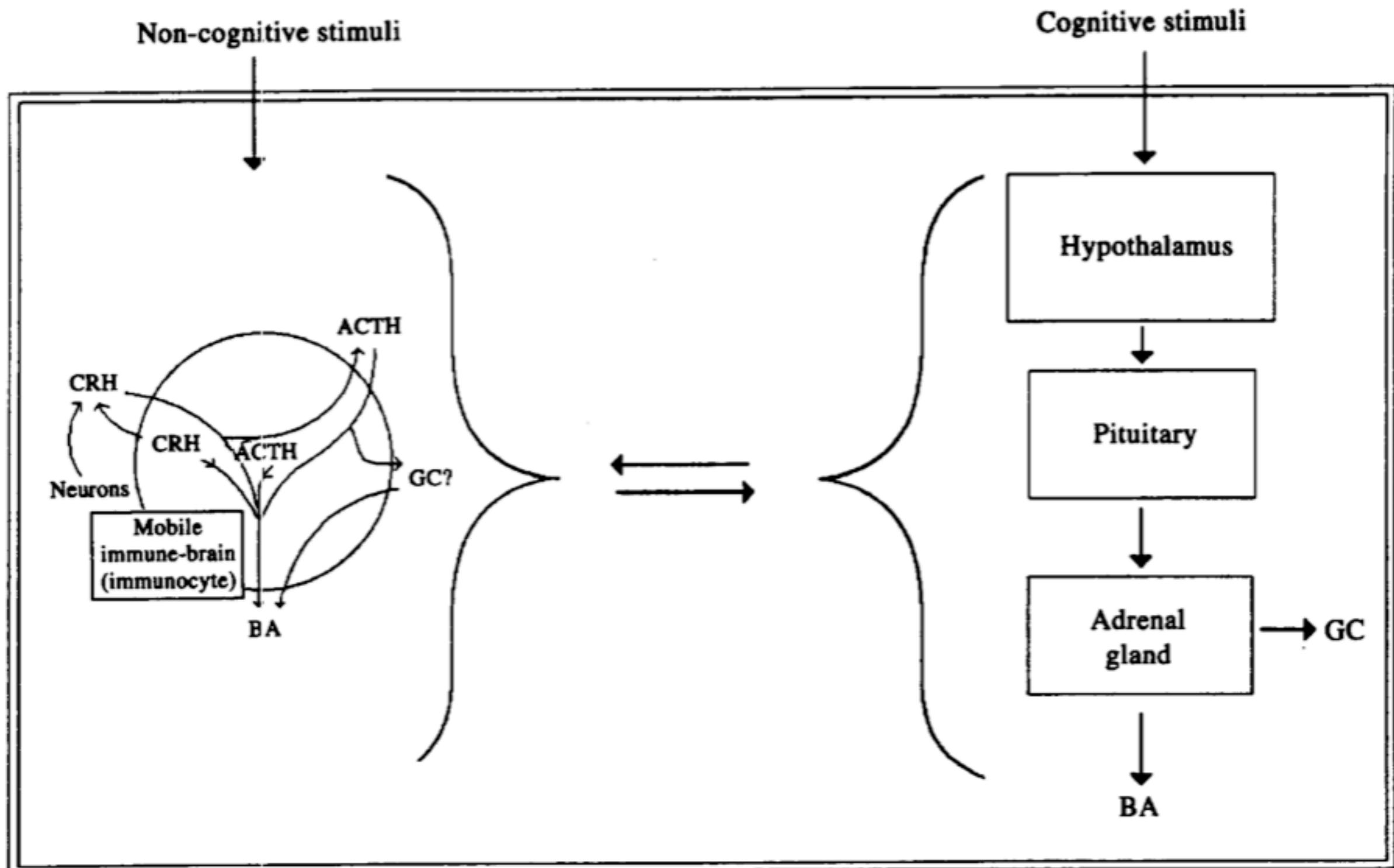
Presence of immunoreactive corticotropin-releasing hormone and cortisol molecules in invertebrate haemocytes and lower and higher vertebrate thymus

ENZO OTTAVIANI¹, ANTONELLA FRANCHINI¹ and CLAUDIO FRANCESCHI^{2,3}

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STRESS



CRH - Invertebrates

- Annelid (Remy et al 1982) CNS
- Insect (Verhaert et al 1984) CNS
- Mollusc (Ottaviani et 1994)

ACTH

- Protozoan (LeRoith et al 1982)
- Gastropods several (NS, *digestive tract*)
- Bivalves (Franchini et al 1994, others)
(*hemocytes*)

ACTH-like molecules in gastropod molluscs: a possible role in ancestral immune response and stress

ACTH

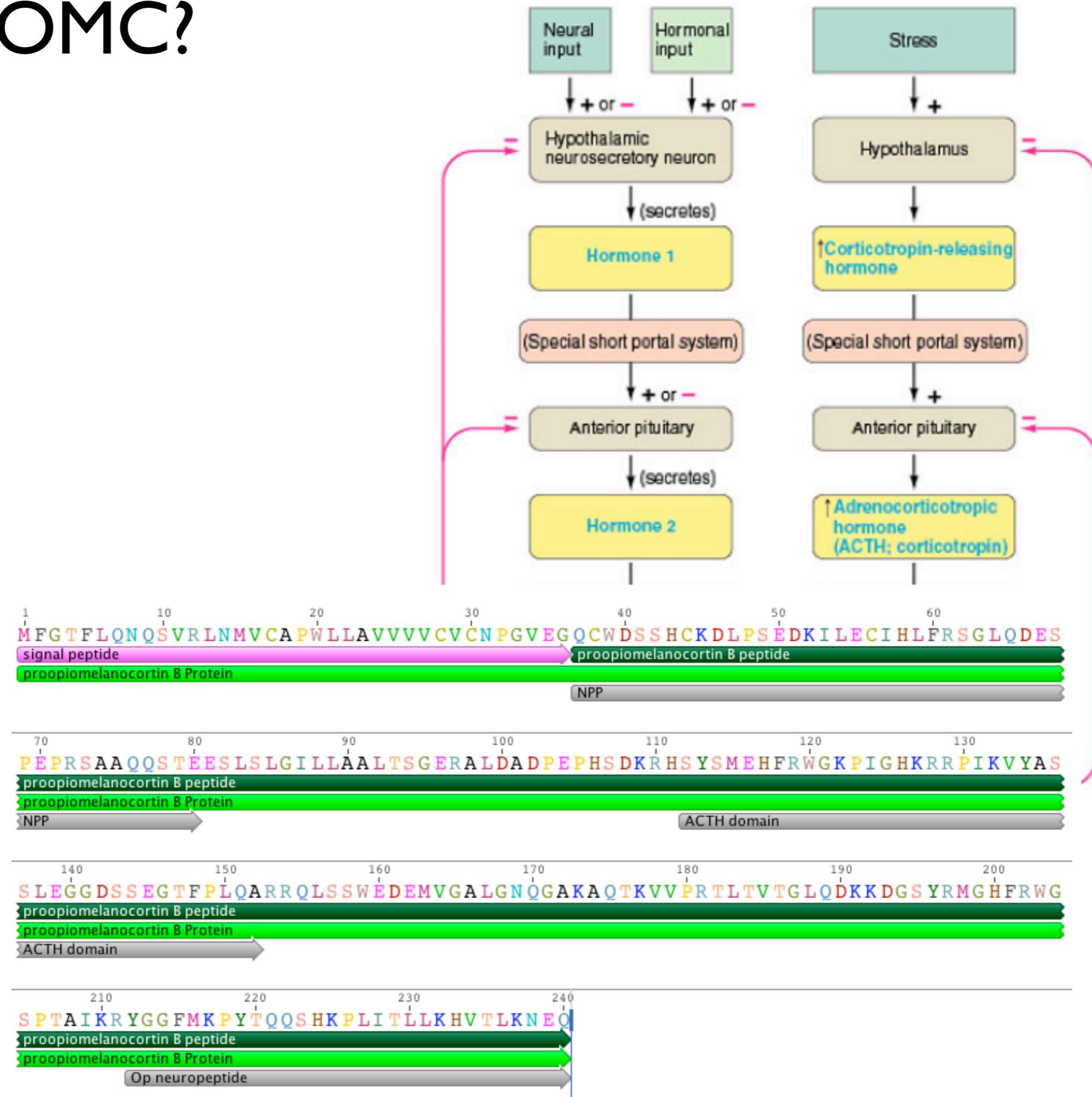
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(*hemocytes*)

ACTH-like molecules in gastropod molluscs: a possible role in ancestral immune response and stress

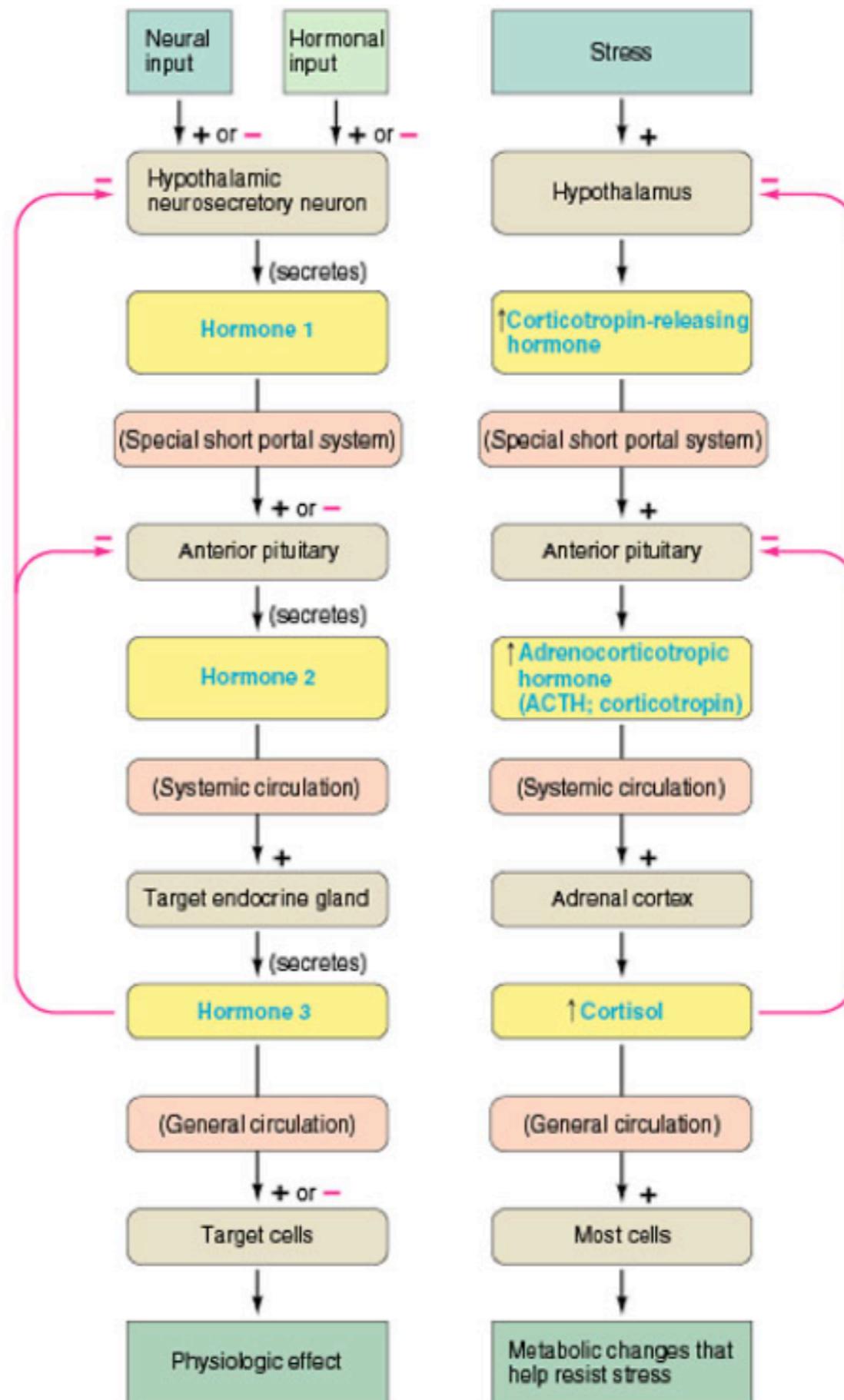
all immune cells that express ACTH have POMC mRNA and are phagocytic
ACTH increase phagocytosis-

What is POMC?

What is POMC?

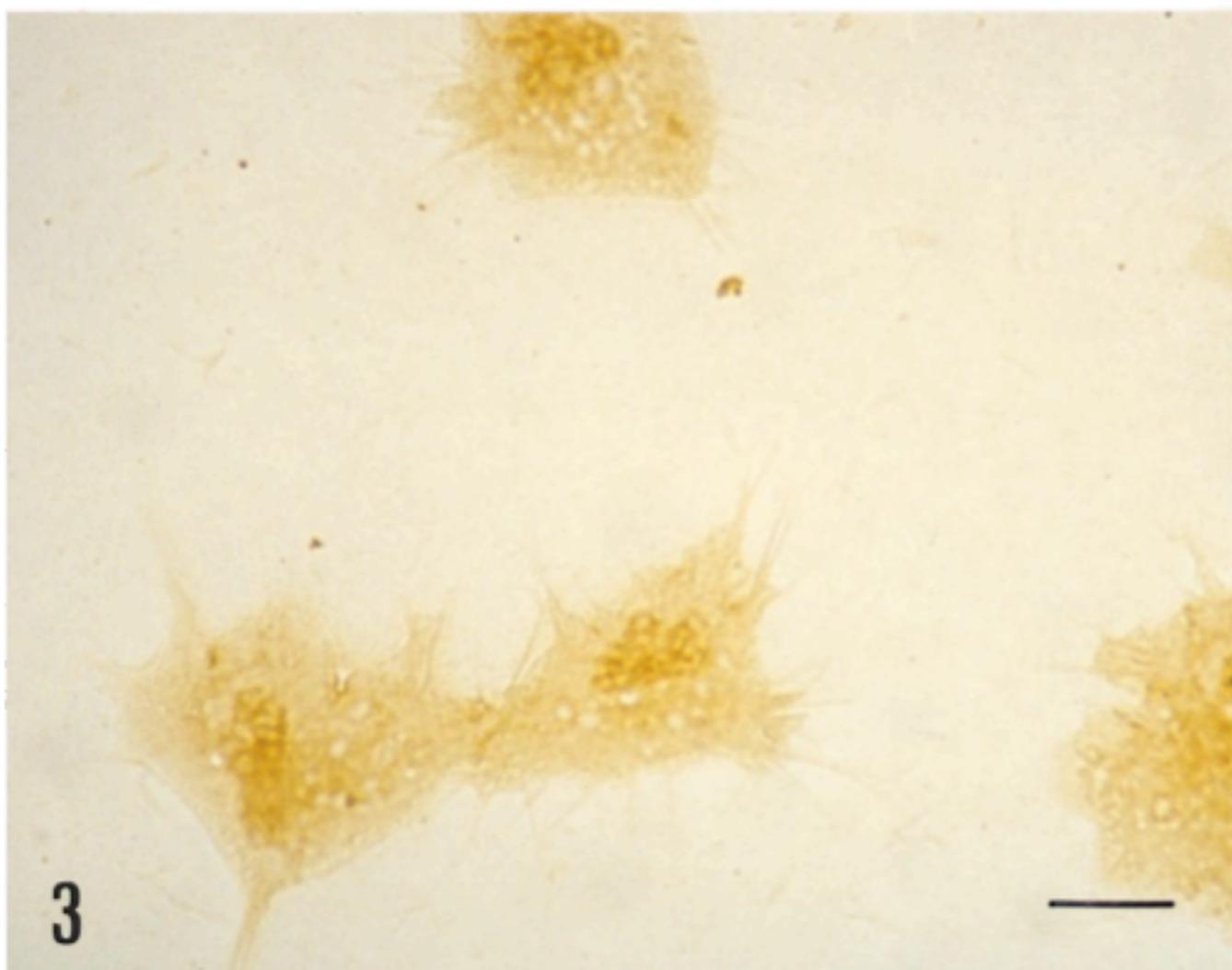


What is POMC?

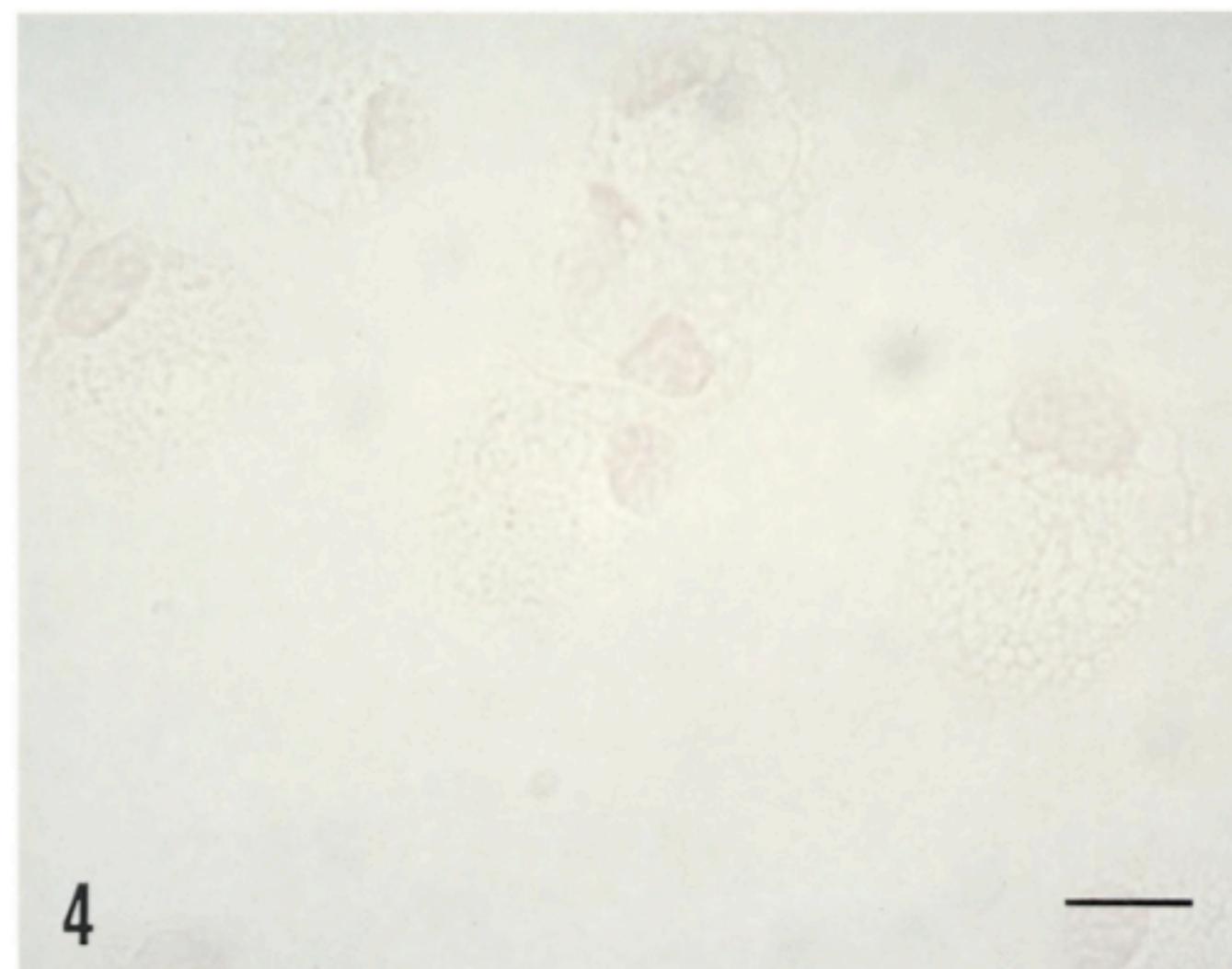


Glucocorticoids

Cortisol



3



4

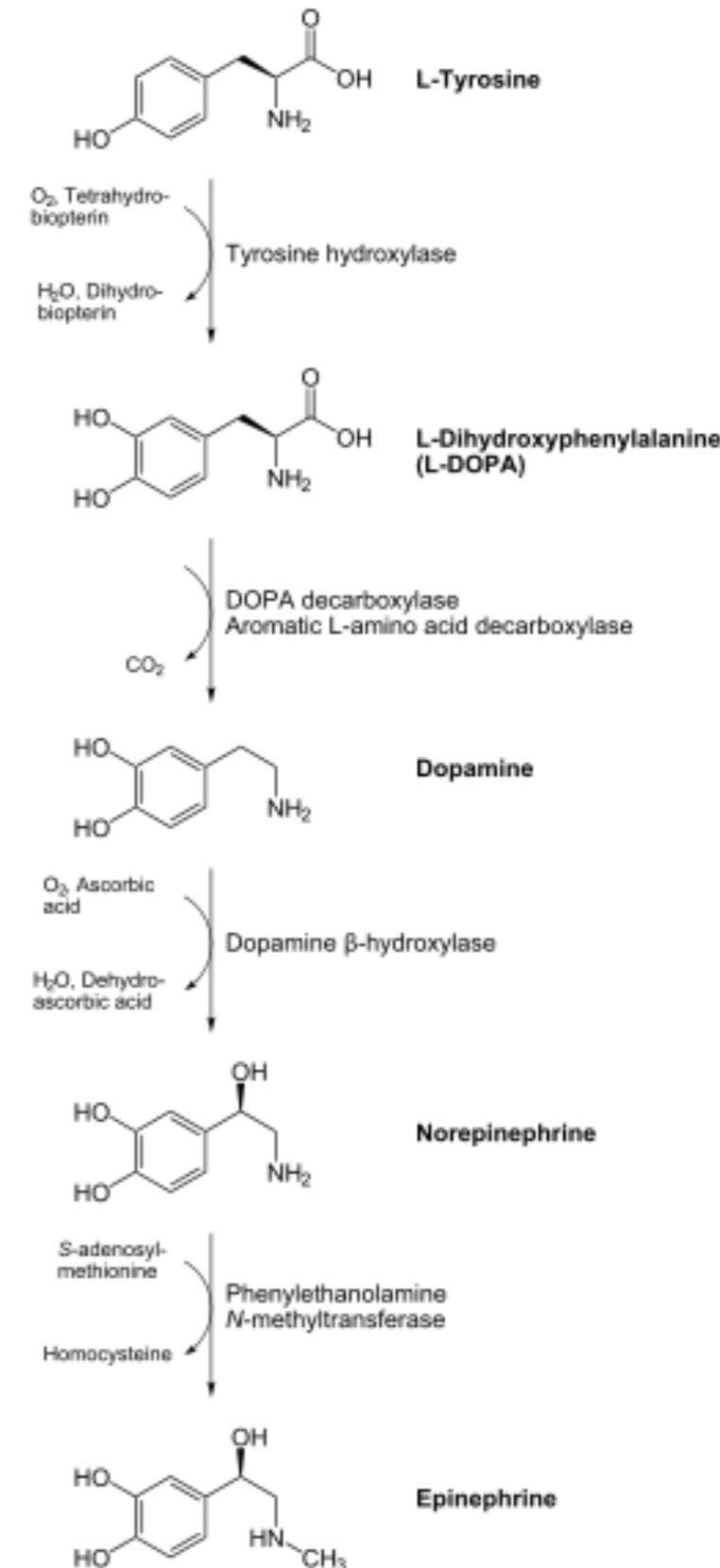
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Presence of immunoreactive corticotropin-releasing hormone and cortisol molecules in invertebrate haemocytes and lower and higher vertebrate thymus

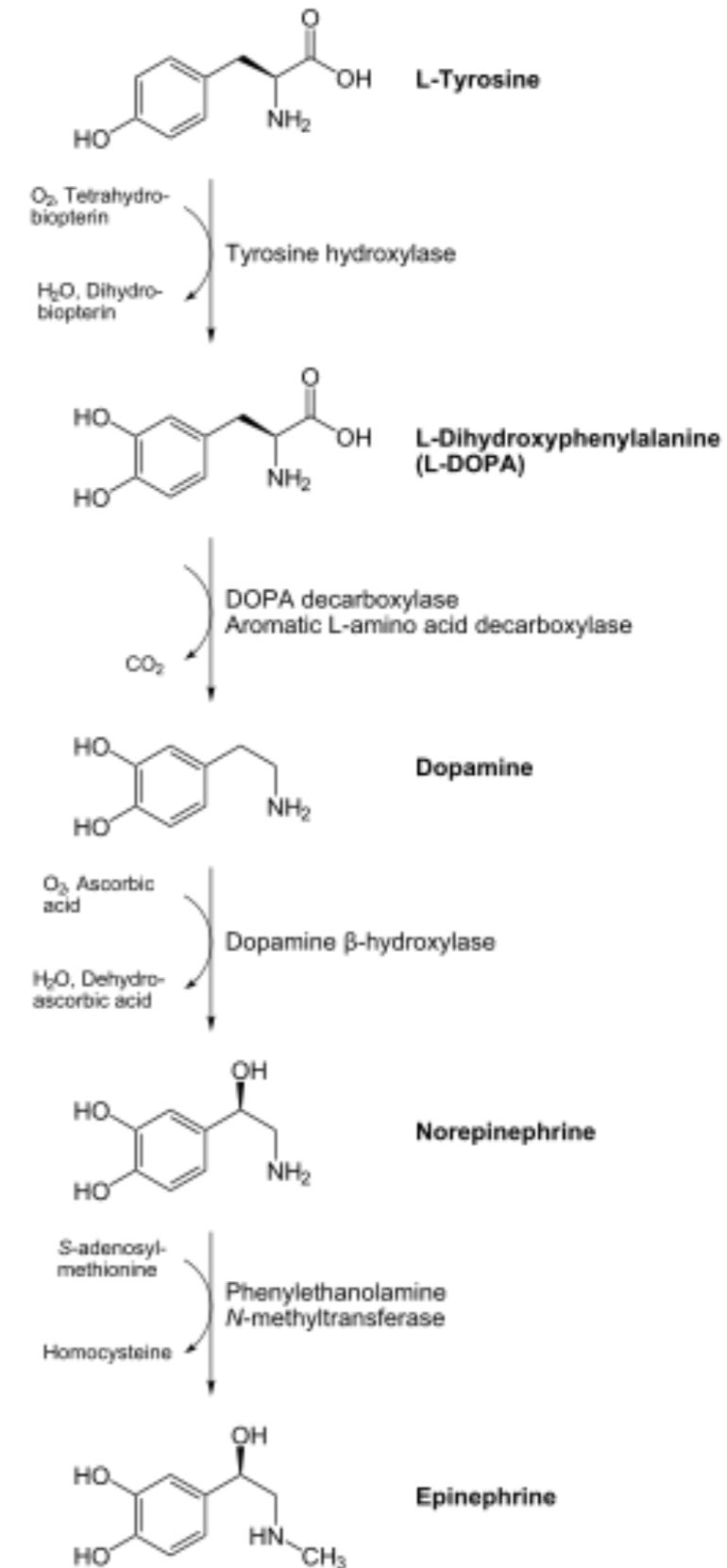
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Catecholamines

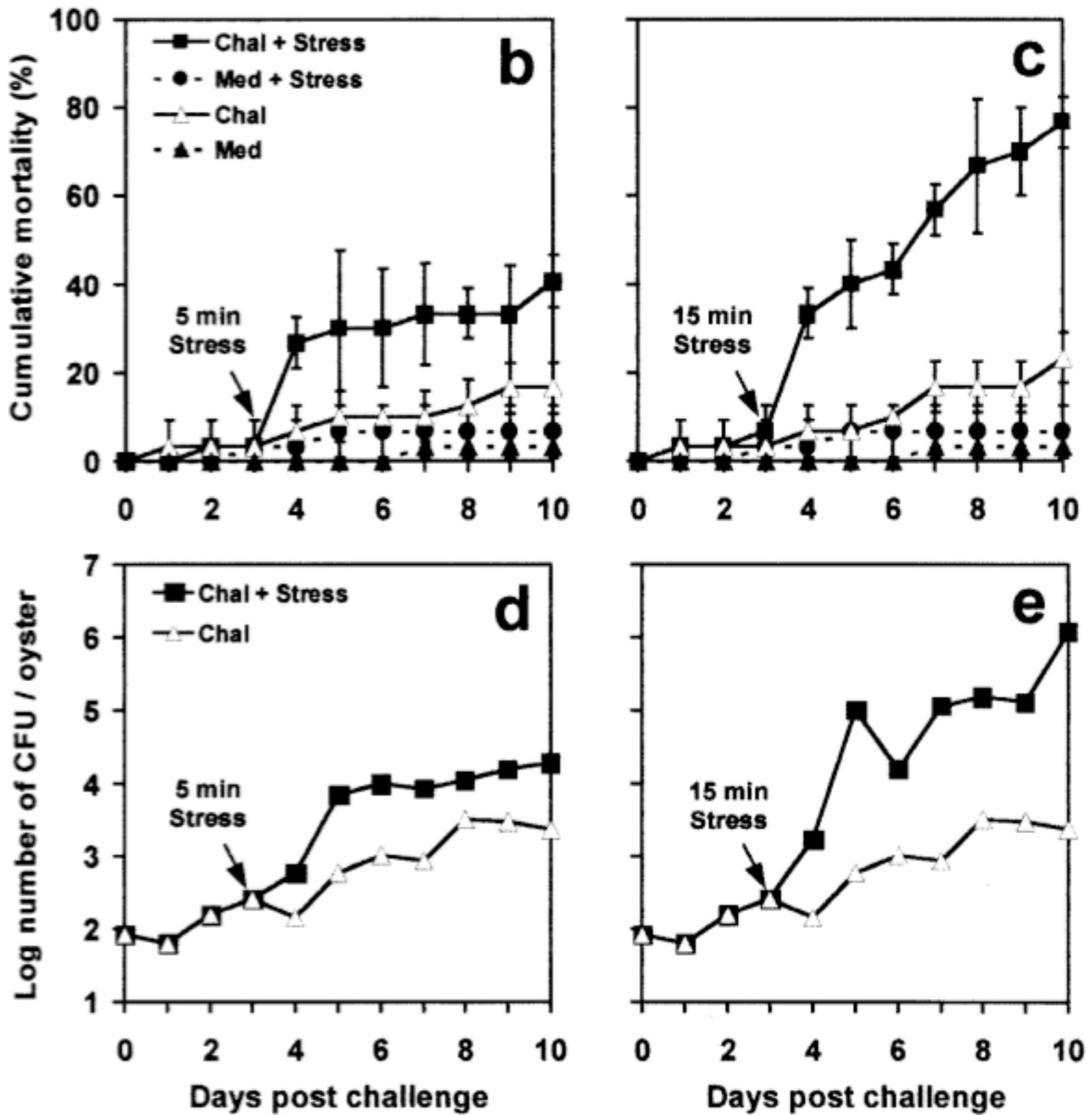


Catecholamines



high NA/A primitive
low NA/A - tetrapods adult mammals

Catecholamines

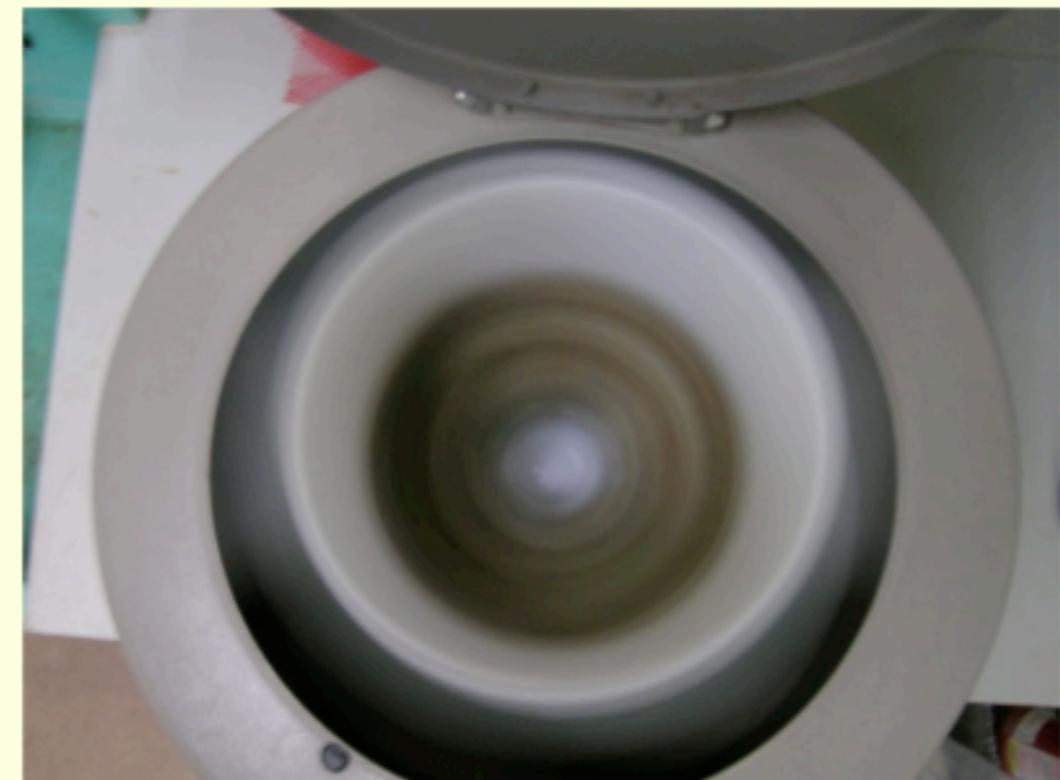


Stress and Stress-Induced Neuroendocrine Changes Increase
the Susceptibility of Juvenile Oysters (*Crassostrea gigas*)
to *Vibrio splendidus*

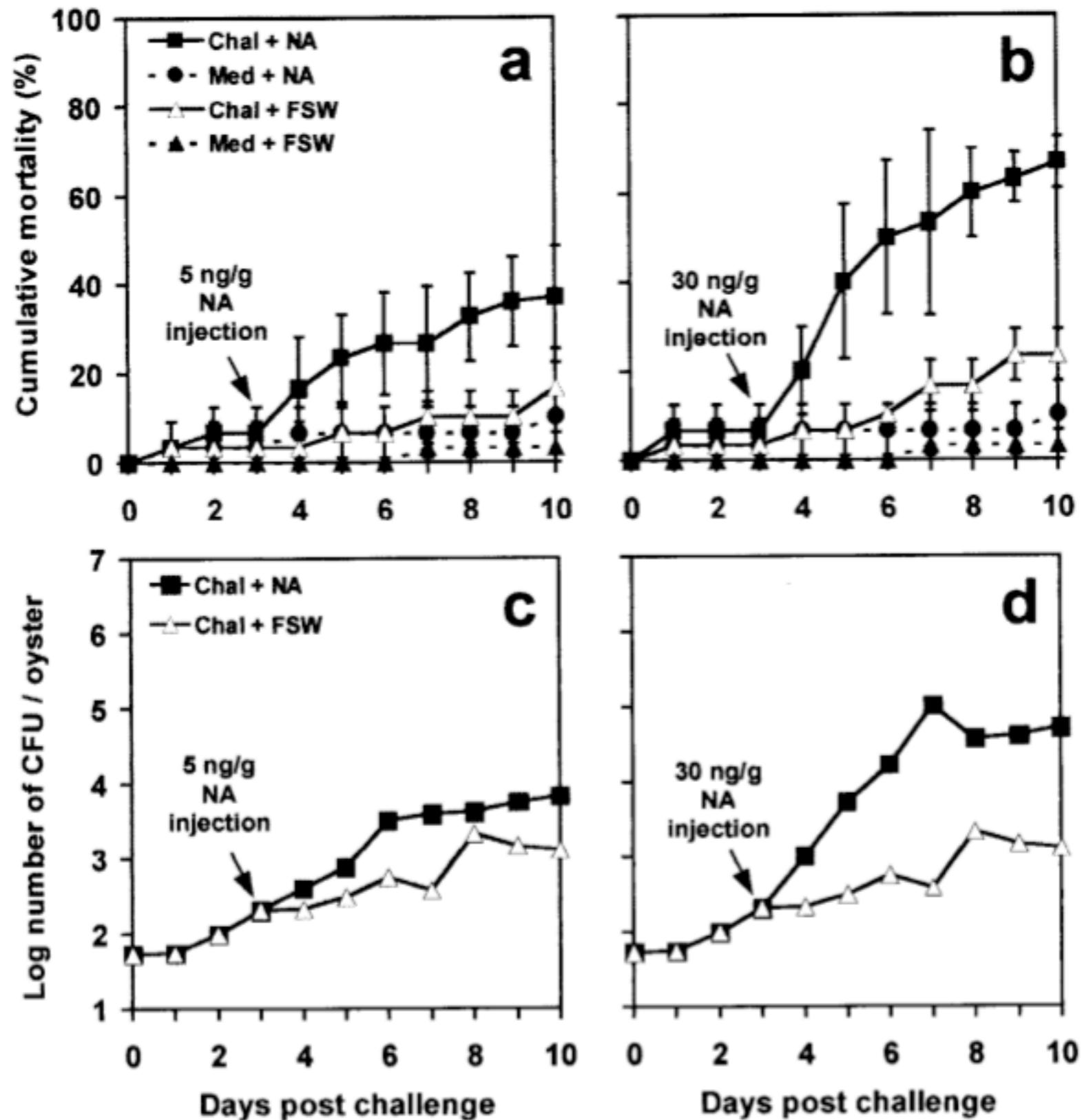
ARNAUD LACOSTE, FABIENNE JALABERT, SHELagh K. MALHAM, ANNE CUEFF,
AND SERGE A. POULET*

- **Experimental Design**

- 1. Compare *C. virginica* exposed to *P. marinus* with ones without the parasite
- 2. Evaluate effects of physical stress

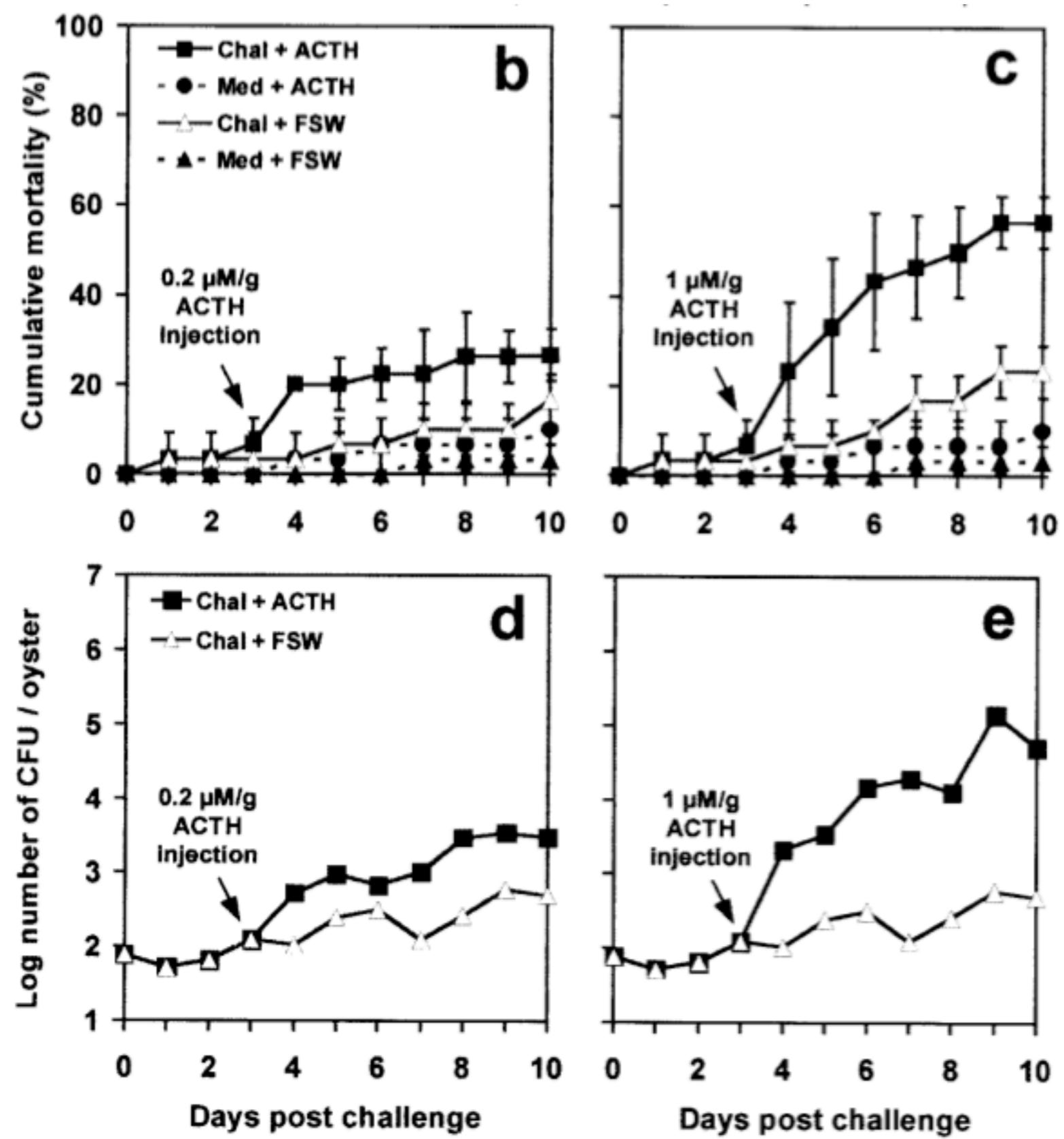


Catecholamines



Stress and Stress-Induced Neuroendocrine Changes Increase
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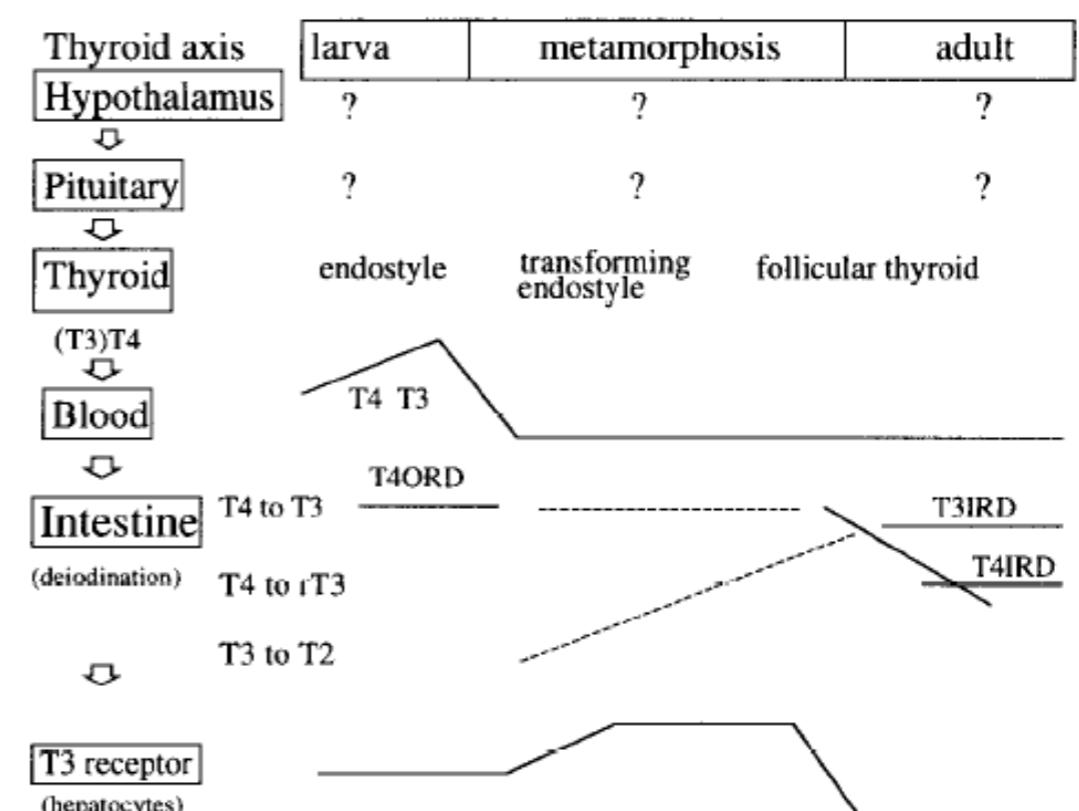
more to think about..

Iodothyronine Deiodinase

- Tissue Distribution in Adult Bay Scallops
 - Endostyle

Mucus secreting pharyngeal organ that facilitates filter feeding. Iodine concentrating ability and can synthesize thyroid hormone.

THYROID HORMONES-LAMPREY METAMORPHOSIS



AMER. ZOOL., 37:441-460 (1997)

Is Lamprey Metamorphosis Regulated by Thyroid Hormones?¹

JOHN H. YOUSON²

Department of Zoology and the Division of Life Sciences, University of Toronto at Scarborough,
Scarborough, Ontario M1C 1A4, Canada



Iodothyronine Deiodinases

	10	20	30	40	
aiDu	M Q K S R T L W T D E I P F R W I K T T G T L F L V L F K I L F V A F V V L I Q K I S F F				
aiDv	M K T P D A F W T D S V P F I W V K R A G R L I G V L S H V I F I G T L I A L S K I T F L	M W T D P F W . K G L . V L . . F . . . K I . F			
	50	60	70	80	90
aiDu	K R M A N S S L K R - - - T P G T Q M L D L N L S T Q S I R A R S K T L L V D A F I R N T				
aiDv	K K F T M I N F K K R S K I A G I Q T L D L N F S T K T L V S S T R G L L A D I L F R E T	K . K . R S K G Q L D L N S T T L V S S T R G L L . D . R T			
	100	110	120	130	
aiDu	Y L G R K A P N T T L Y D M D T K S D R K L F S F Q K A G R P L V L N F G S C S * P P F I				
aiDv	Y L G R K A P N T N L Y D M D T K S Y R K L H S F Q K A G R P L V L N F G S C T * P P F I	Y L G R K A P N T L Y D M D T K S R K L S F Q K A G R P L V L N F G S C . P P F I			
	140	150	160	170	180
aiDu	A K V E E V K T I I R D F A D V A D F L T I Y I R E A H P V E G W Q I F G H R F Q D M K D				
aiDv	A K V E E V K T I I V R D F A D V A D F L T I Y I R E A H P V E G W Q I F G H R F Q D M K D	A K V E E V K T I . R D F A D V A D F L T I Y I R E A H P V E G W Q I F G H R F Q D M K D			
	190	200	210	220	
aiDu	H Q T L E D R V E A A E M L R E F D L K C P I L V D P M D N Q N G L K F A A V P E R L Y I				
aiDv	H Q T L E D R V E A A E M L R E F D L K C P I L V D P M D N Q N G L K F A A V P E R L Y I	H Q T L E D R V E A A E M L R E F D L K C P I L V D P M D N Q N G L K F A A V P E R L Y I			
	230	240	250	260	270
aiDu	L Y D N T V M Y L G G L G P H D Y K P H E I R A W L Q R F R N E S				
aiDv	L Y D N T V M Y L G G L G P H D Y K P H E I R A W L Q R F R N E S	L Y D N T V M Y L G G L G P H D Y K P H E I R A W L Q R F R N E S			



Selenoproteins

A peculiar class of proteins that contain the essential trace element selenium. The selenium in these proteins is in the amino acid selenocysteine

Evidence in Invertebrates

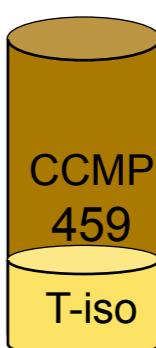
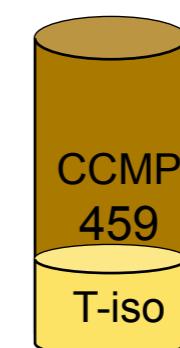
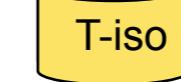
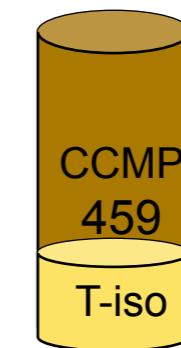
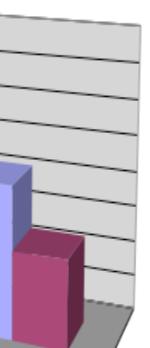
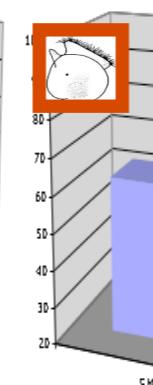
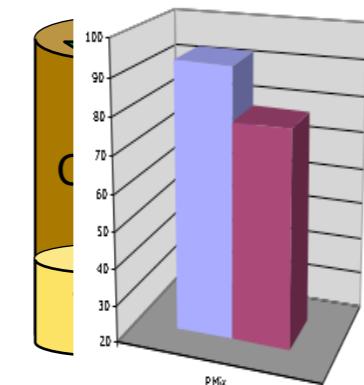
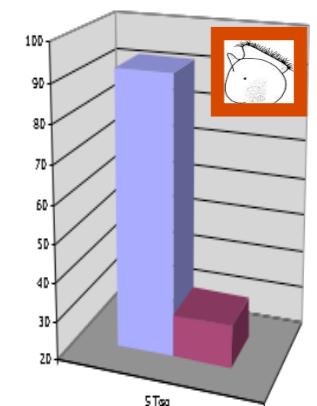
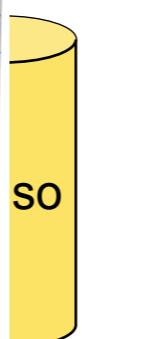
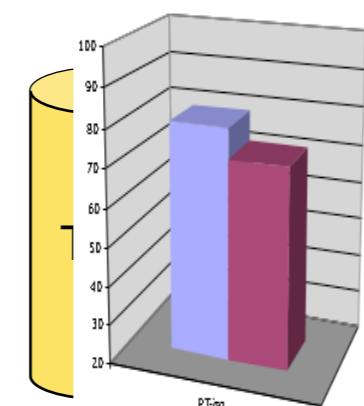
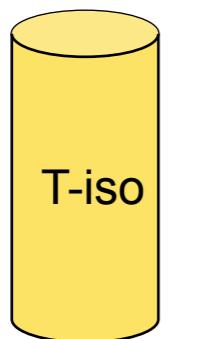
- Ascidian iodothyronine outer-ring deiodinase (*Shepherdley et al 2004*)
- Only one isoform described for *Halocynthia*, two for *Ciona* (*Shepherdley et al 2004*)
- Thyroid hormone shown to influence sea urchin (*Chino et al 1994*) and abalone (*Fukazawa et al 2001*) development



Deiodinase u (*ai Du*)

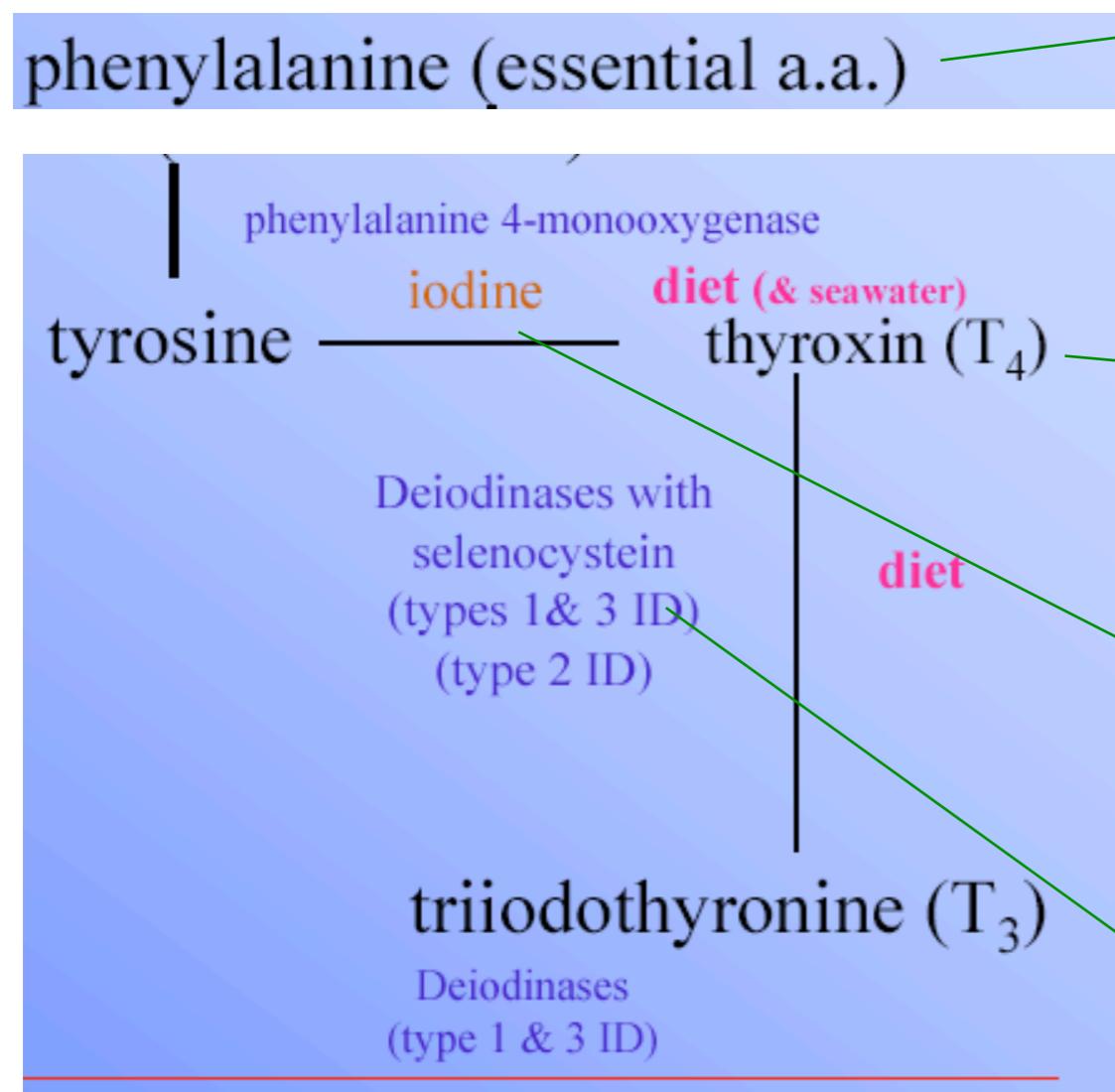


Deiodinase v (*ai Dv*)



Day 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Interrelationship with External Factors



Diet: Pavlova (e.g. CCMP549) has over 3 times more (%) phenylalanine than Isochrysis

Thyroid hormone uptake directly from micro-algae

Iodine accumulated through diet and seawater

Selenium required for synthesis of deiodinases. Available in diet and seawater. Differential uptake by algae

