

# Physiology of Sport and Exercise

## Endocrine System in Sport and Exercise

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# Learning Objectives



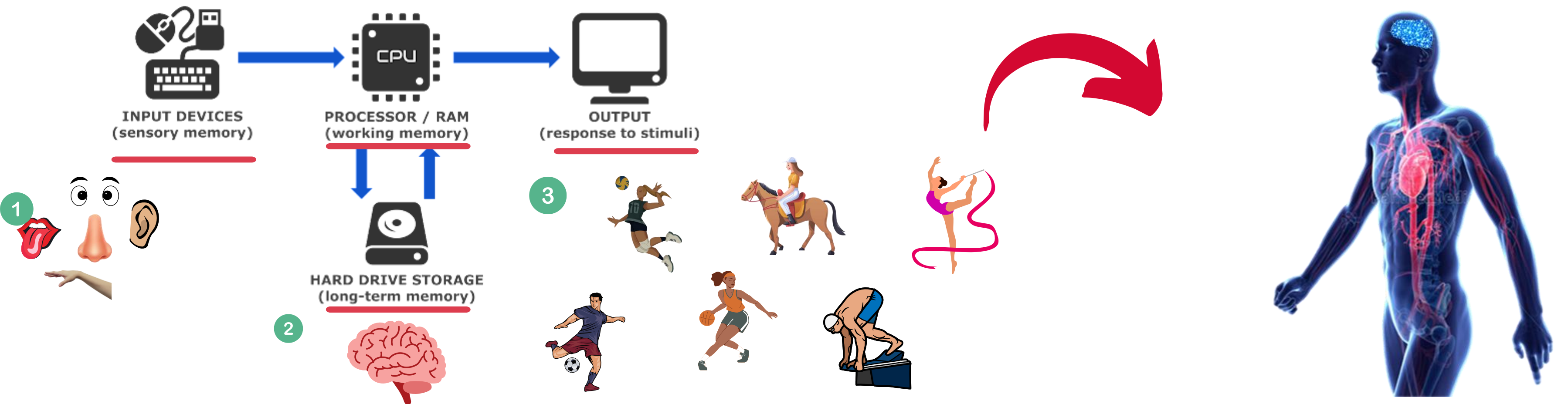
The basic structures of the endocrine system

How endocrine system works during the exercise

Hormones and behavior

Last class???

Today



What happen during the exercise??

# Stress System

# Cardiac System

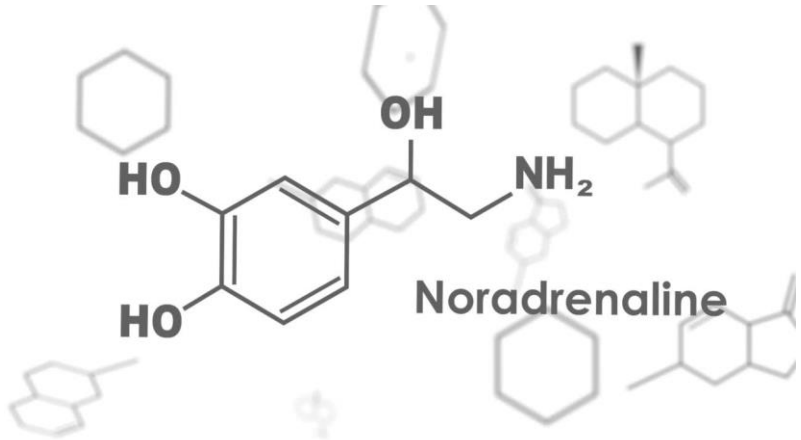


Switch on



Motor activity

Emotional response



Endocrine System

# Endocrine System

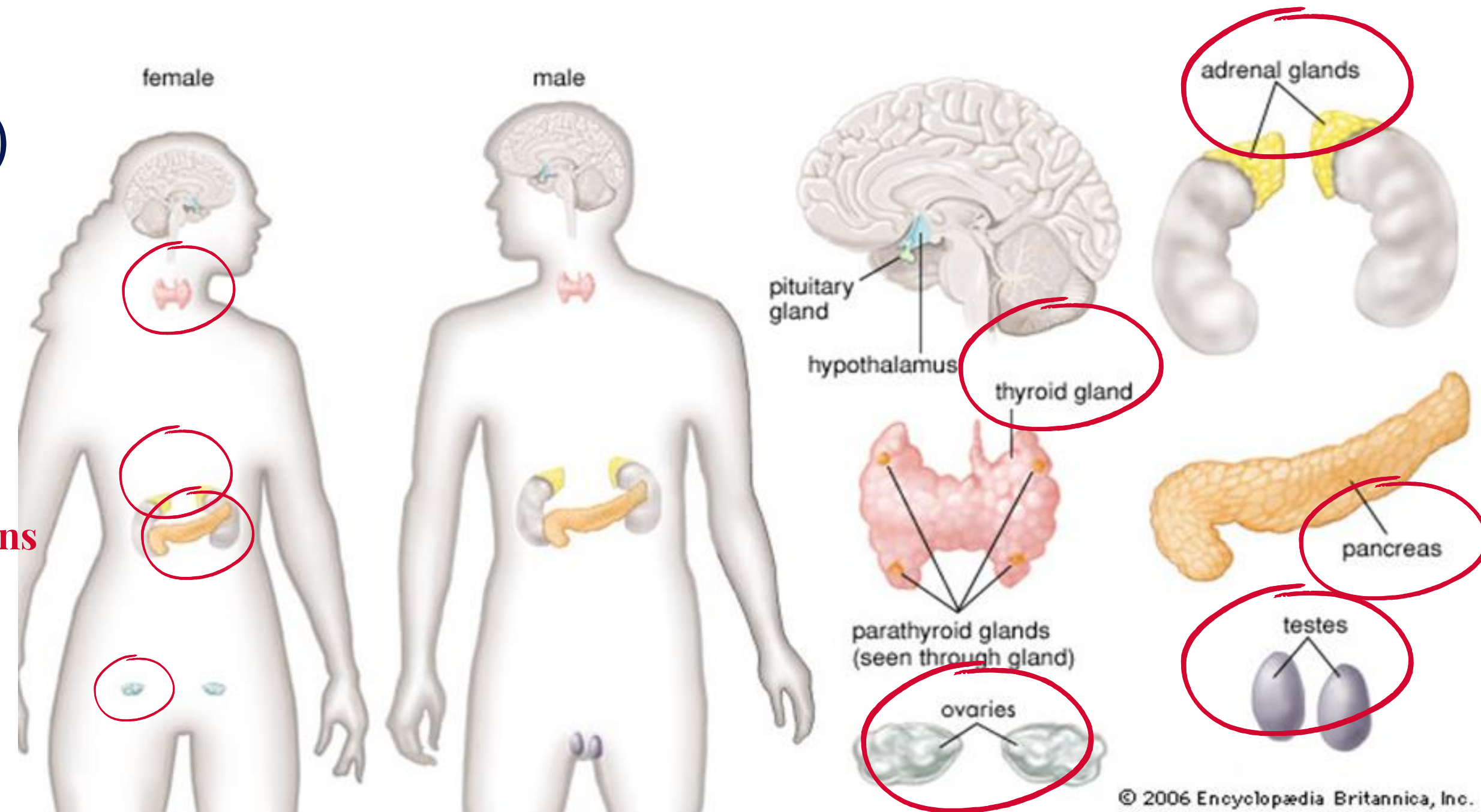
Endocrine Glands  
(production and secretion)

release hormones into the blood

Hormones  
(specifics)

travel into the blood to specific target organs

Transmitters  
(chemicals)



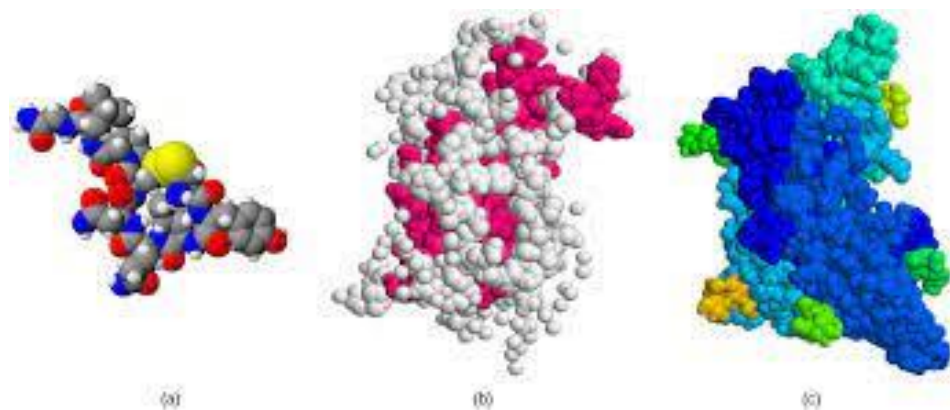
The molecules transmit **specific information** (in a slow way)

# Hormone

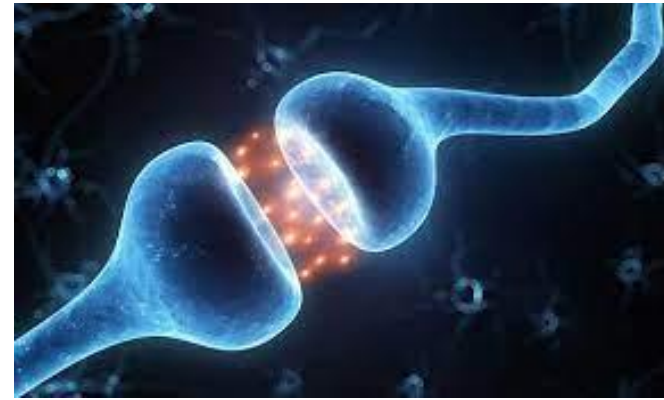
## Difference among the hormones

### Molecule chemical structure

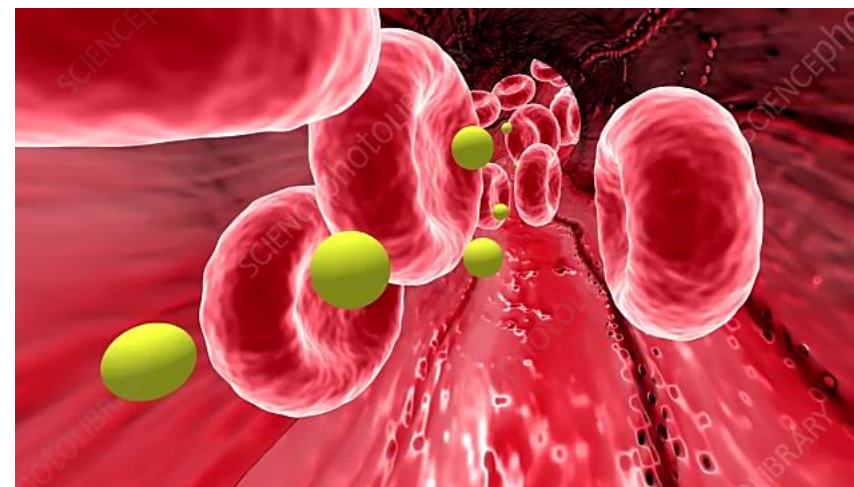
| Type            | Examples                                      | Derived From               |
|-----------------|---|----------------------------|
| <u>Steroids</u> | Aldosterone, cortisol, estrogen, testosterone | Cholesterol                |
| Amines          | Epinephrine, norepinephrine                   | Amino acids                |
| Glycoproteins   | FSH, LH, TSH                                  | Carbohydrates and proteins |
| Peptides        | ADH, oxytocin, thyrotropin-releasing hormone  | Amino acids                |
| Proteins        | GH, PTH, PRL                                  | Amino acids                |



fast



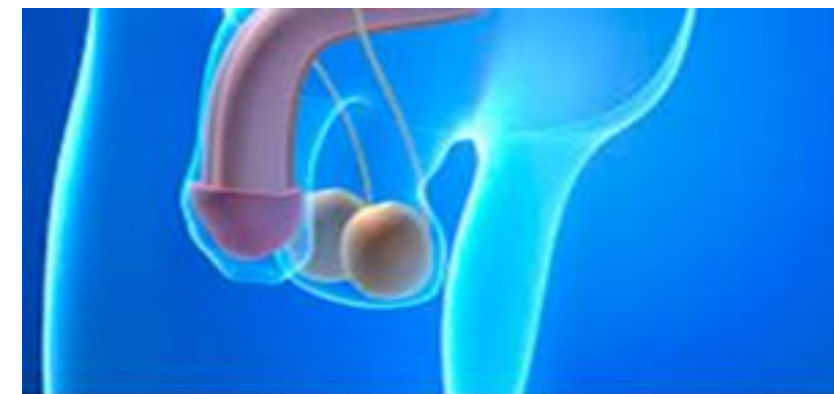
Very slow



|                            | Neurotransmitters  | Hormones  |
|----------------------------|--|---|
| <b>DEFINITION</b>          | Neurotransmitters are chemical messengers produced by the nervous system.  | Hormones are the chemical messengers produced by the endocrine system.  |
| <b>ORGAN SYSTEM</b>        | Nervous system   | Endocrine system  |
| <b>TRANSFERENCE</b>        | Through synaptic cleft.  | Through the circulatory system.   |
| <b>SPEED OF THE ACTION</b> | Fast   | Very slow   |
| <b>EXAMPLES</b>            | Acetylcholine, dopamine, glutamate, glycine, serotonin, histamine and noradrenaline.   | Estradiol, testosterone, melatonin, vasopressin, insulin and growth hormone, luteinizing hormone, follicle-stimulating hormone, thyroid-stimulating hormone, etc. |
| <b>FUNCTION</b>            | Facilitate the signal transmission through neurons by passing action potential from axon of one neuron to dendrite of the next neuron. | They affect many processes in our body including growth and development, mood, metabolism, sexual function, reproduction, etc.                                    |

# Hormone release axis

# Steroid Hormones - Brain in charge



Adrenal

Gonodal

Hypothalamus

Pituitary

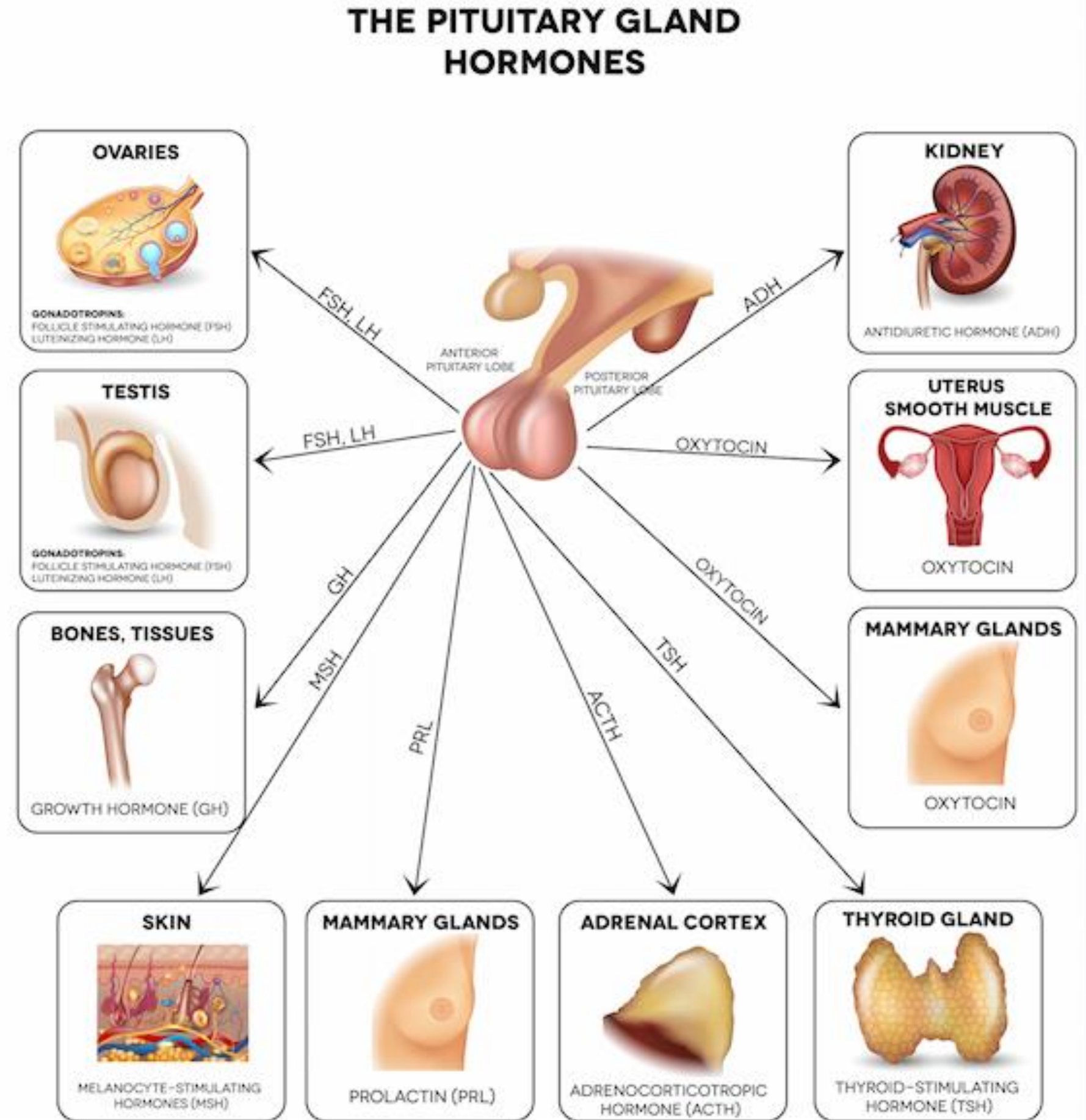
releasing and  
inhibiting hormones

**HPA axis**

**HPG axis**

# The pituitary

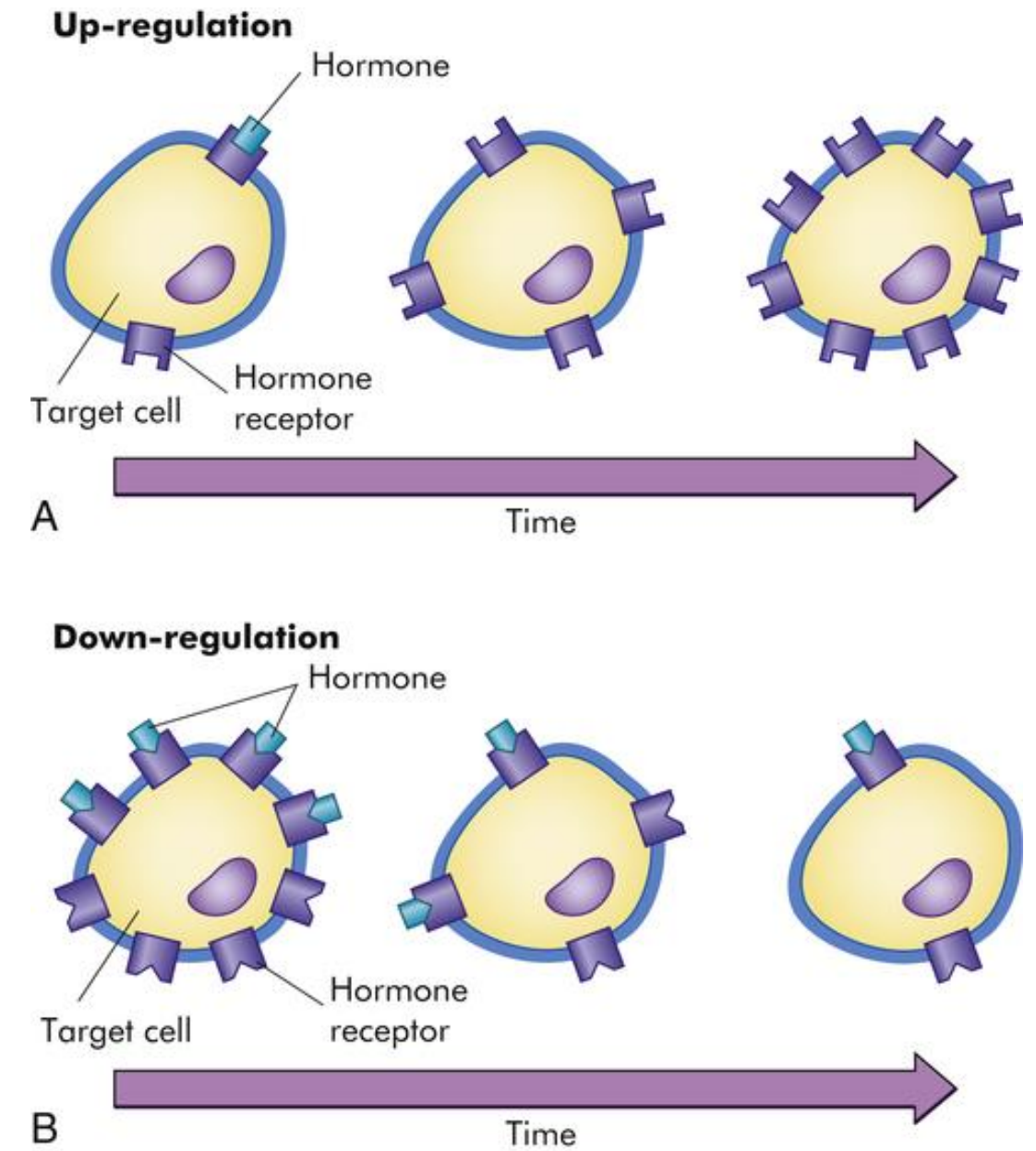
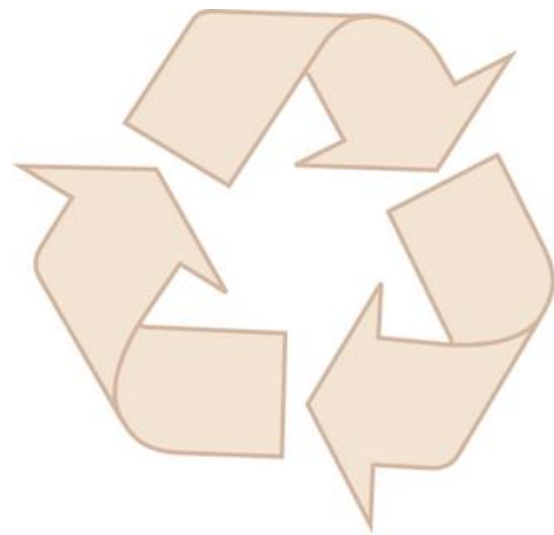
Different part of the pituitary is responsible for the secretion of **specific hormones**



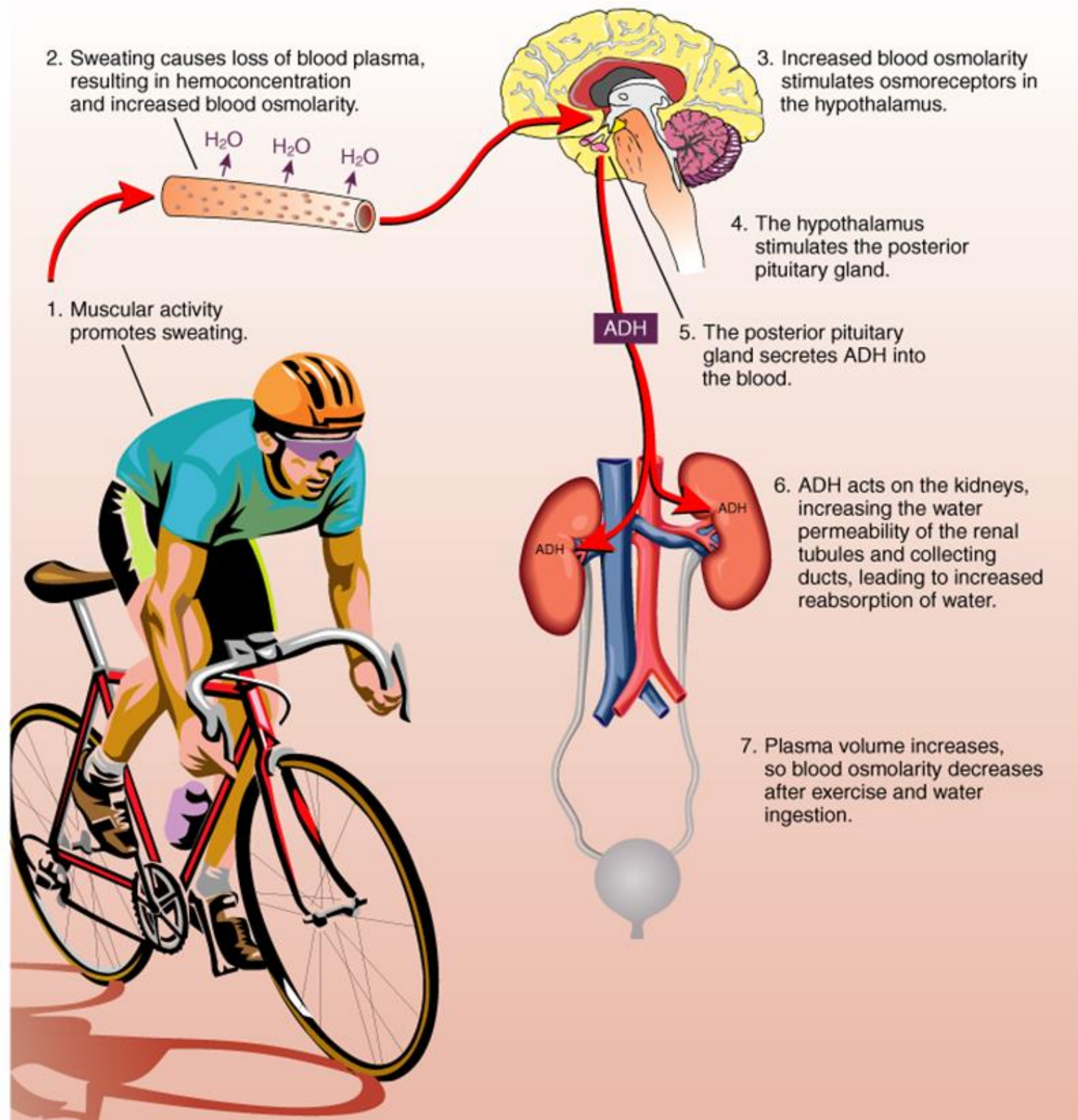


# Hormone in the blood system

- ◆ Plasma levels of specific hormones fluctuate.
- ◆ Secretion is regulated by a negative feedback system.
- ◆ Cells can also alter their number of hormone receptors via down- or up-regulation.



# Hormonal response to exercise



Acute responses to exercises

↑ Insulin contrarregulatory hormones

↑ GH

↑ Catecholamines

↑ Cortisol

↑ Glucagon

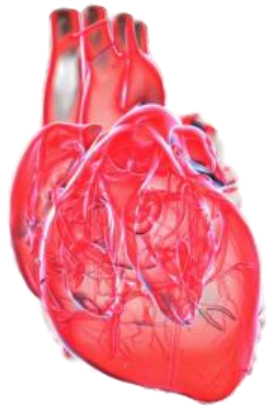
Chronic responses to exercises

↑ Testosterone

All other hormonal responses to exercise showed inconclusive findings

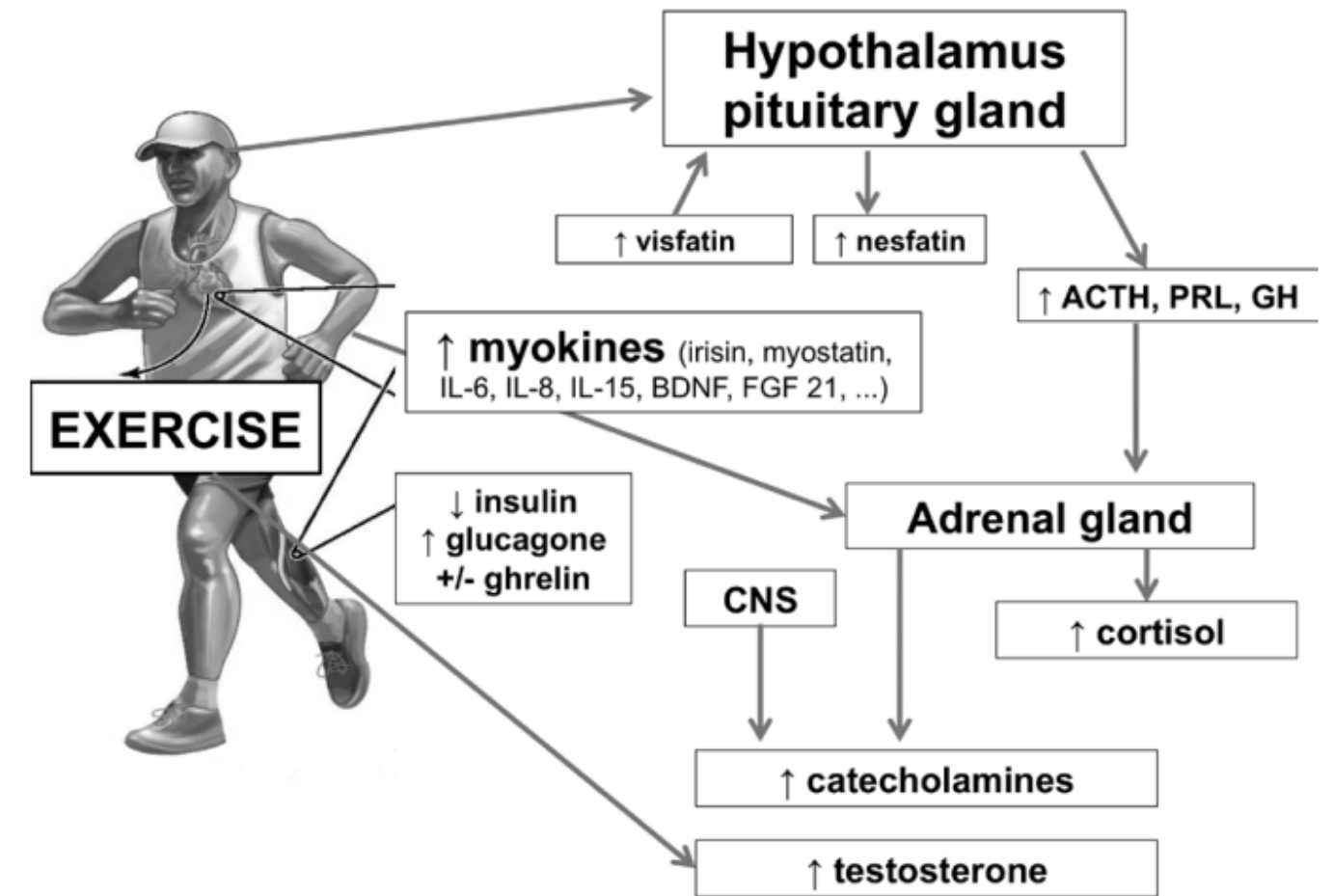
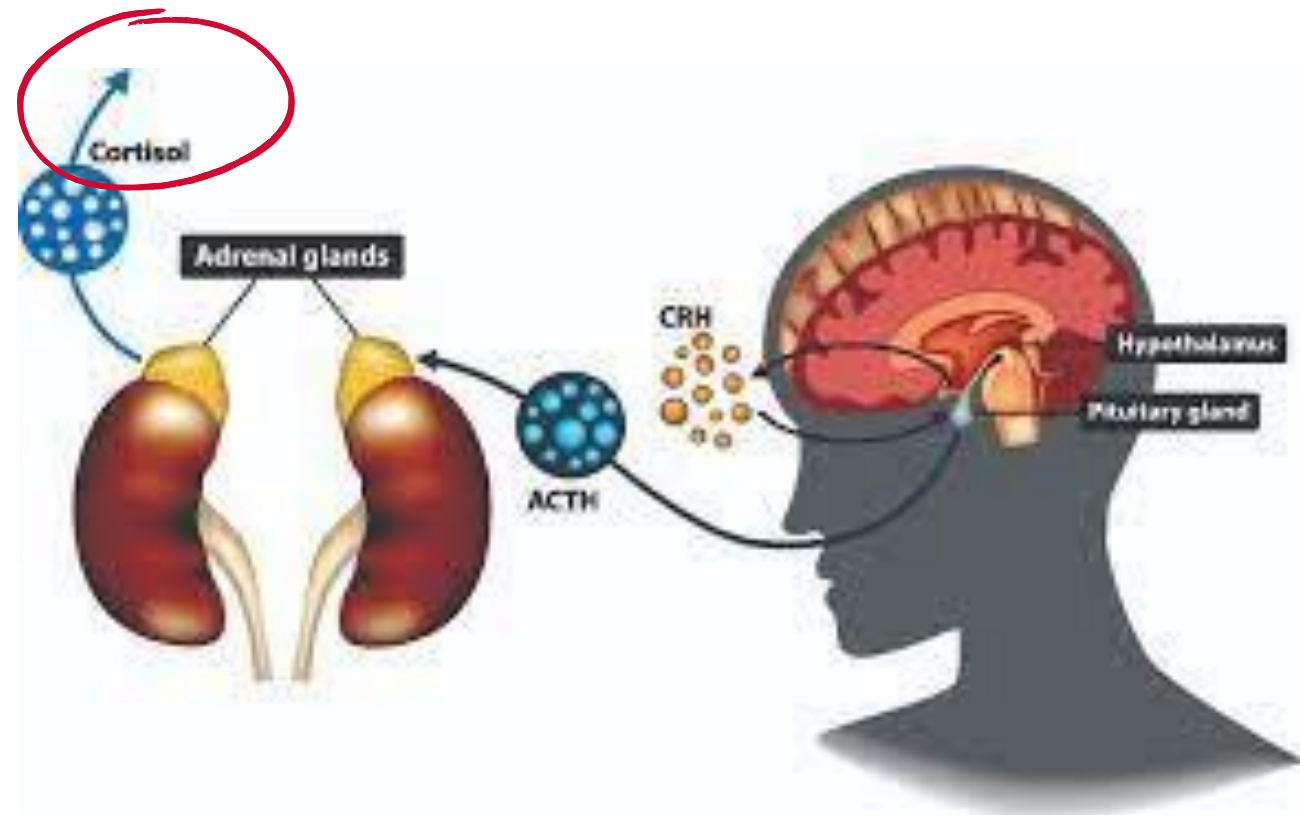
# Hormonal response to exercise

## Sympathetic Nervous System

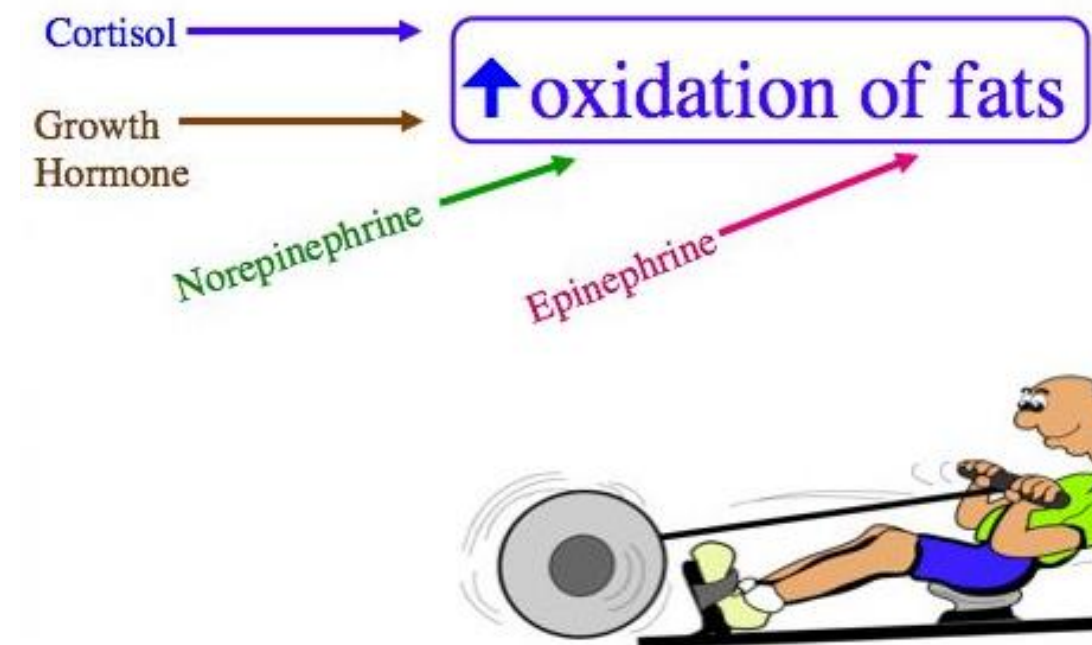


**Catecholamines:**  
**Epinefrine**  
**Norepinephrine**

Increase of blood flow, bpm, breathing



## Hormone Regulation of Fat Metabolism



# Hormonal response to exercise

## **Growth Hormone (GH)**

Tissue growth and metabolism (muscle cells activated during the exercise - importance of training specificity).

## **Testosterone**

Aerobic and resistance exercise.

Role: increase the activation of muscle fibers. Increase protein synthesis - hypertrophy. Recovery and muscle repair.

'Hormone release adapts to meet the demands of the exercise'



## **Cortisol**

Energy production - generate energy. to ensure your muscles get the energy they need.

## **Insulin-Like Growth Factors (IGF)**

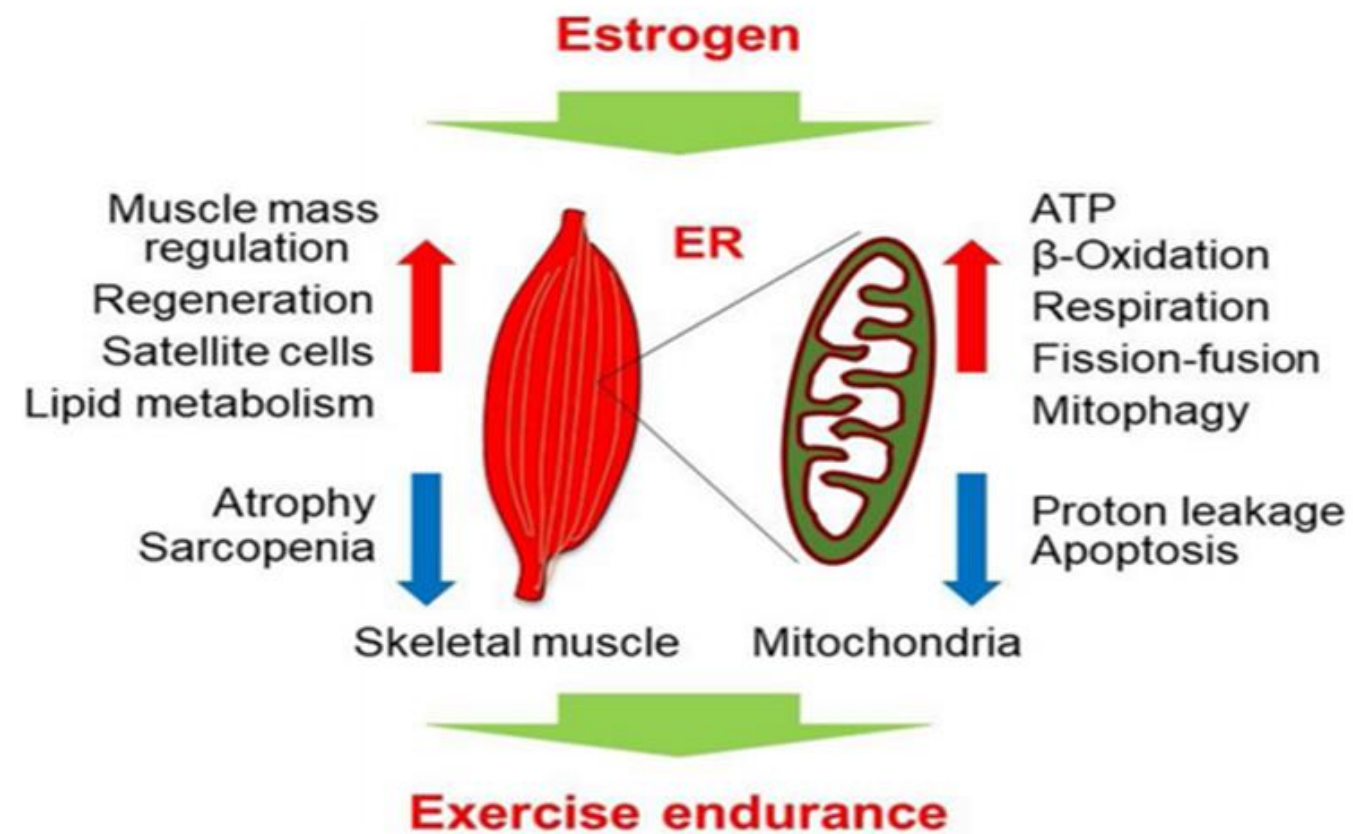
Training adaptations in repair and remodeling bone and skeletal muscle

## **BDNF- brain-derived neurotrophic factor**

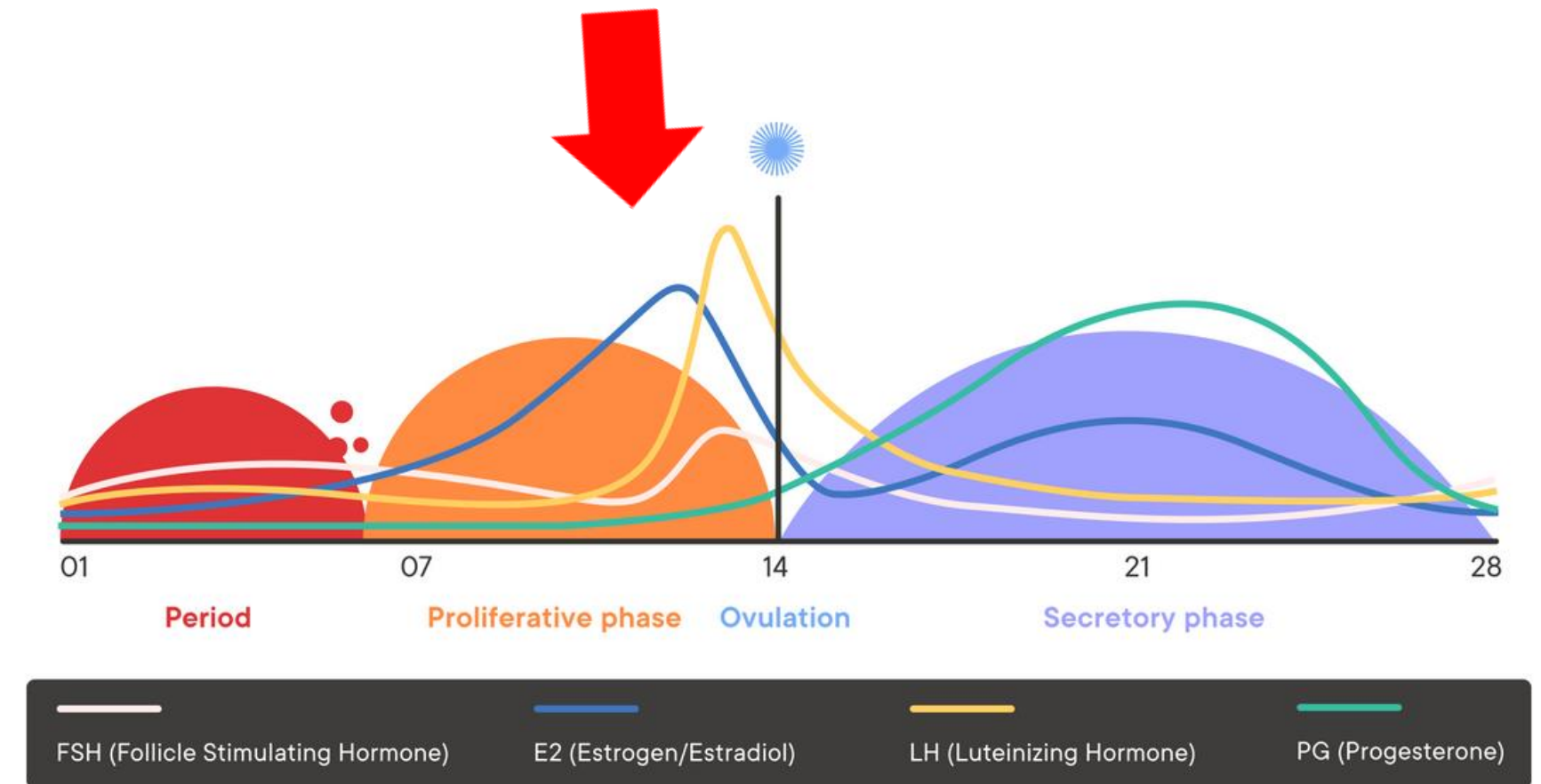
improvements in cognitive function

# Menstrual cycle and hormone concentration

*Journal of Steroid Biochemistry and Molecular Biology 191 (2019) 105375*



**Fig. 1.** Model of estrogen functions in exercise endurance, focusing on skeletal muscle and mitochondrial regulation.



**No consensus about performance and menstrual cycle phase**

# Recovery and Sleep



***Overtraining*** - an imbalance of training dose-responses

Increase production, receptors  
and muscle growth

**Hypoactivity of HPG axis**



Testosterone  
Concentration

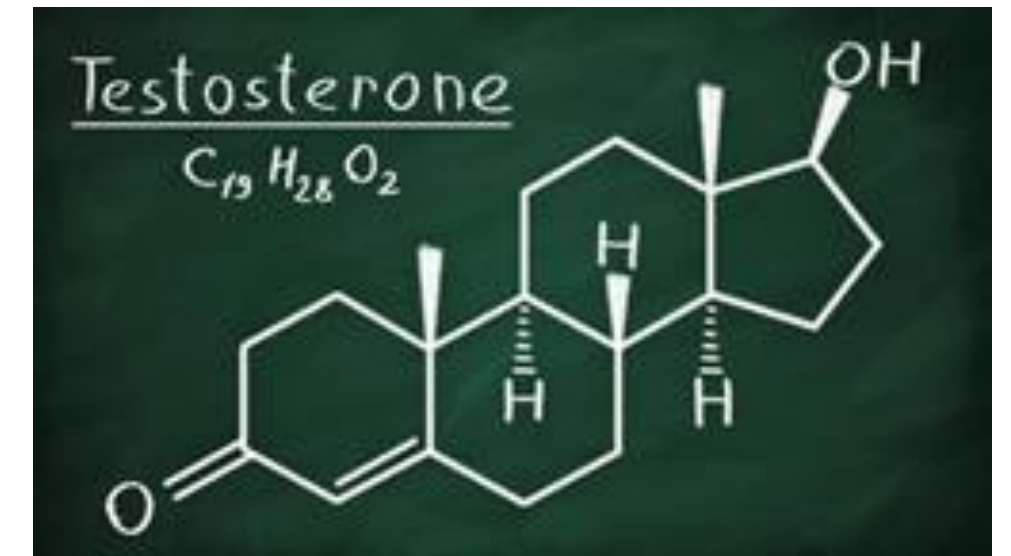
# Hormone and Behavioral Responses

## During Exercise



muscle hypertrophy, power, strength

T concentrations related to better performance



## Behaviors

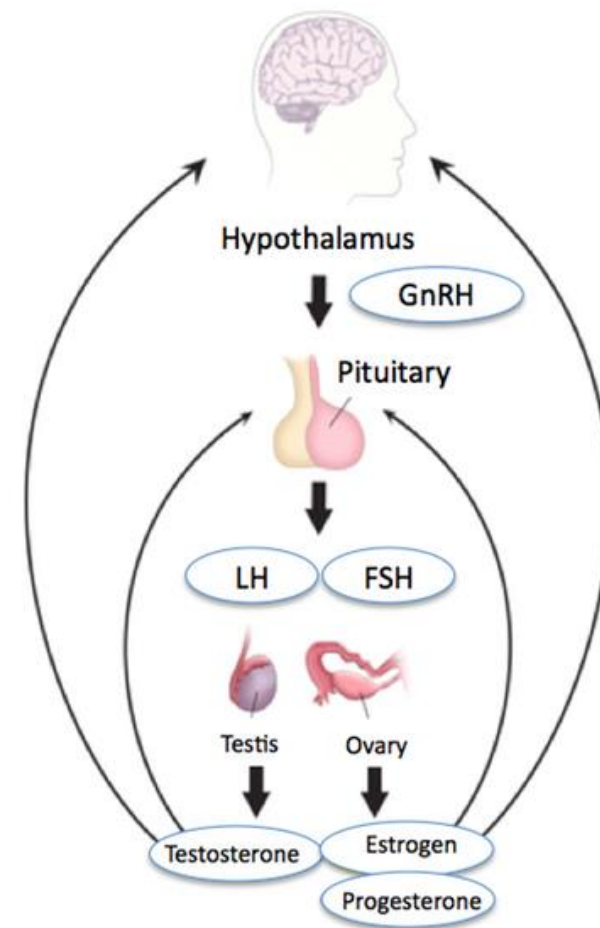


Aggressive

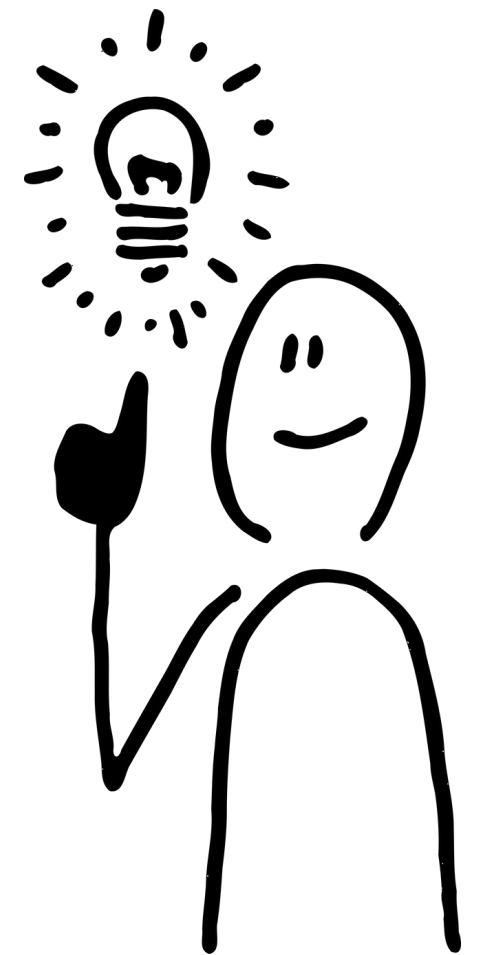
Vigor

Angry

Dominant



Some behaviors can **increase T concentration**; a major concentration of T during a game/exercise can **improve performance**



# Hormone and Behavioral Responses

## Pre-competition hormonal and psychological levels of elite hockey players: Relationship to the 'home advantage'

Justin Carré<sup>a</sup>, Cameron Muir<sup>a,b</sup>, Joey Belanger<sup>c</sup>, Susan K. Putnam<sup>\*</sup>

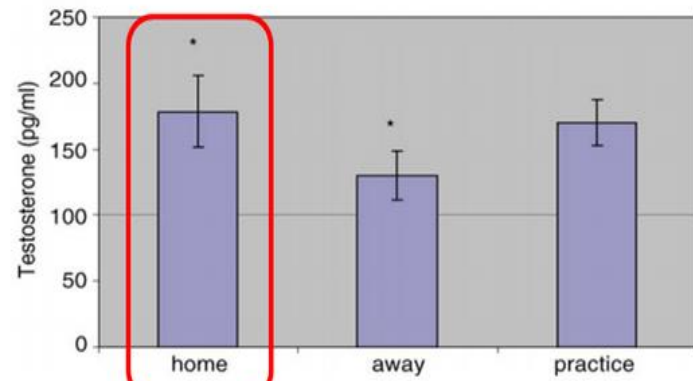
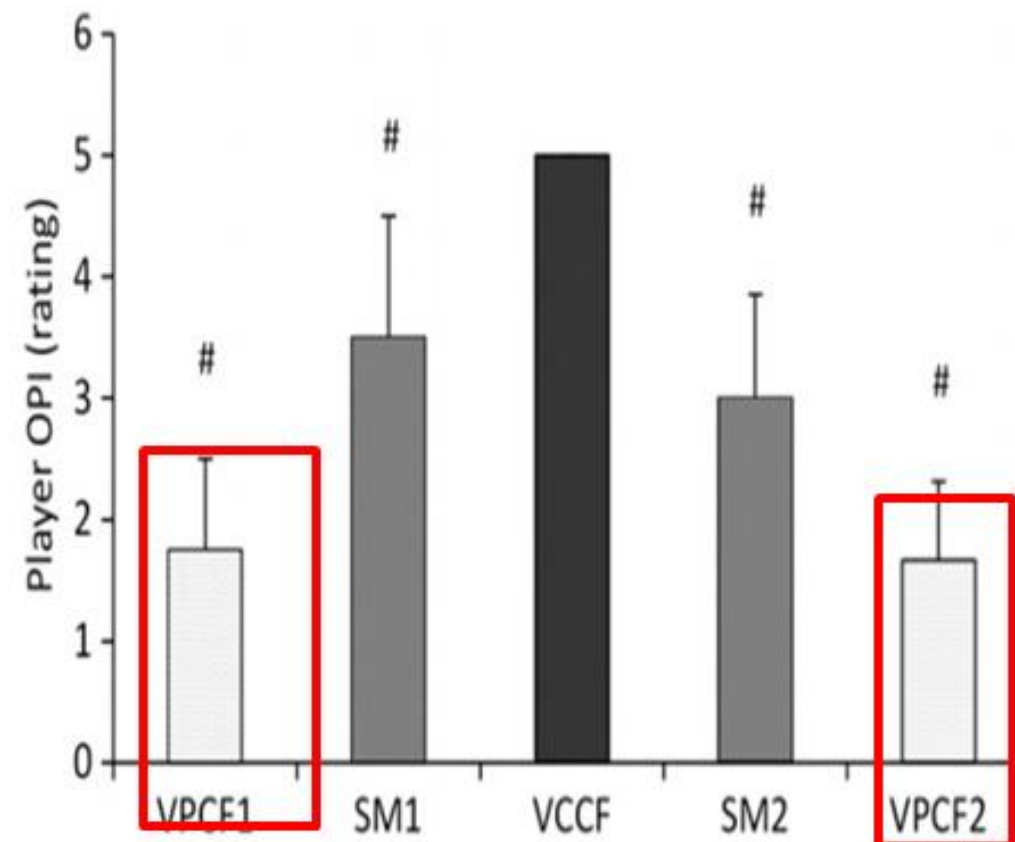


Fig. 1. Mean (±S.E.) pre-game and practice salivary testosterone levels in 14 elite Junior 'A' hockey players. Players showed significantly higher pre-game salivary testosterone levels when playing in their home arena as compared to their opponents' arena (paired *t*-tests, two-tailed). \**p*=0.04.

## The effects of different pre-game motivational interventions on athlete free hormonal state and subsequent performance in professional rugby union matches

Christian J. Cook<sup>a,b,c,d</sup>, Blair T. Crewther<sup>b,d,\*</sup>



## Changes in salivary testosterone concentrations and subsequent voluntary squat performance following the presentation of short video clips

Christian J. Cook<sup>a,b,c</sup>, Blair T. Crewther<sup>b,\*</sup>

<sup>a</sup> United Kingdom Sport Council, London, UK

<sup>b</sup> Hamlyn Centre, Imperial College, London, UK

<sup>c</sup> Sport, Health and Exercise Science, Department for Health, University of Bath, Bath, UK



**Table 1**

Salivary testosterone concentrations in response to the pre-game motivational interventions (mean ± SD).

| Testosterone             |    | VPCF1               | SM1                | VCCF  | SM2                | VPCF2               |
|--------------------------|----|---------------------|--------------------|-------|--------------------|---------------------|
| Pre-intervention (pg/ml) | M  | 140.5               | 152.6              | 147.4 | 144.1              | 147.2               |
|                          | SD | 19.4                | 30.1               | 34.6  | 25.6               | 19.2                |
| Pre-game (pg/ml)         | M  | 157.5               | 160.3              | 146.3 | 151.0              | 164.0               |
|                          | SD | 18.5                | 29.2               | 35.4  | 25.1               | 17.6                |
| % change                 | M  | 12.5 <sup>*,α</sup> | 5.4 <sup>*,#</sup> | -0.7  | 5.0 <sup>*,#</sup> | 11.8 <sup>*,α</sup> |
|                          | SD | 5.9                 | 3.7                | 4.7   | 2.4                | 4.8                 |

VPCF = video with positive coach feedback, SM = self-motivate, VCCF = video with cautionary coach feedback.

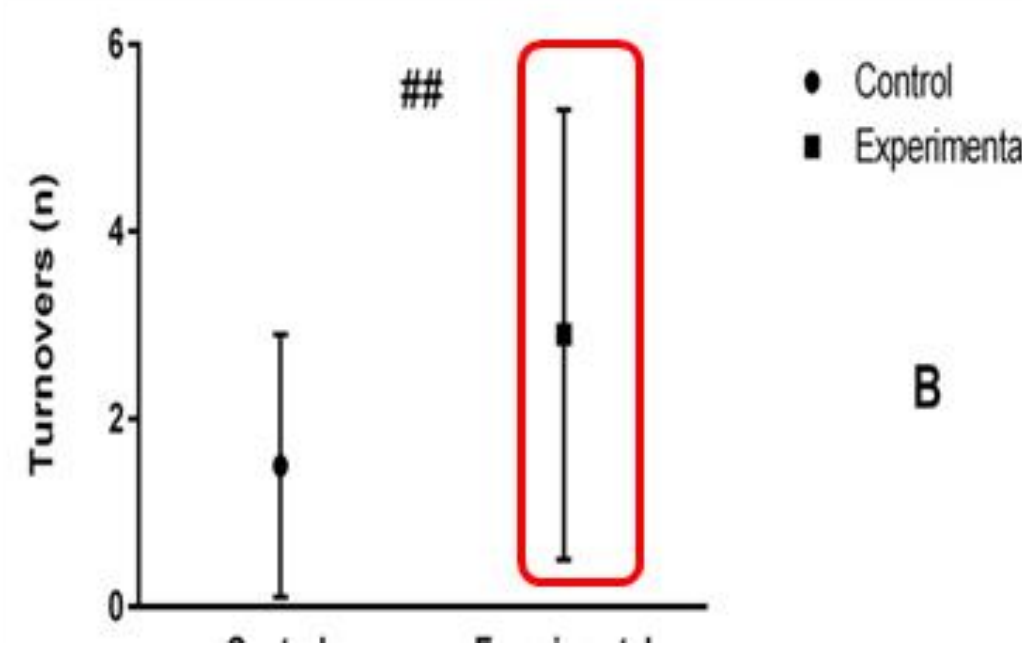
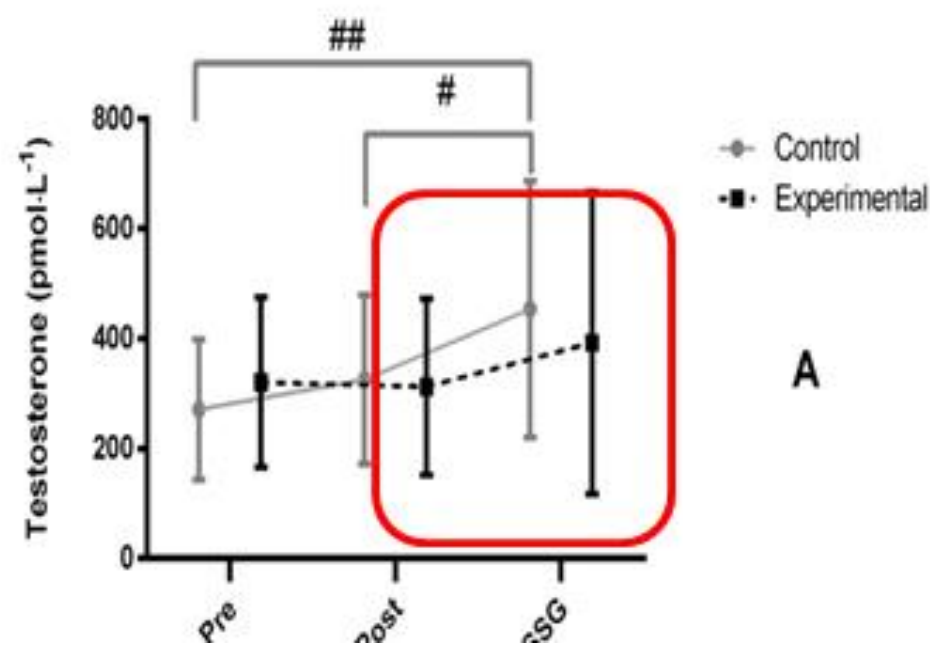


# Mental Fatigue and testosterone concentration



Mental fatigue impairs technical performance and alters neuroendocrine and autonomic responses in elite young basketball players

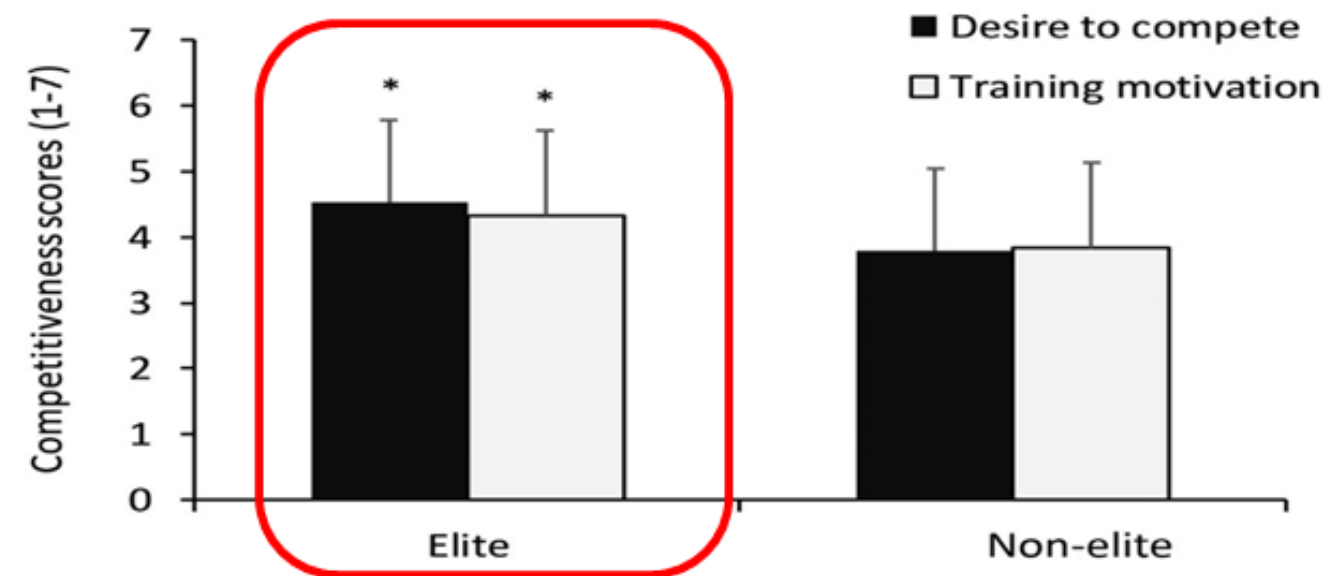
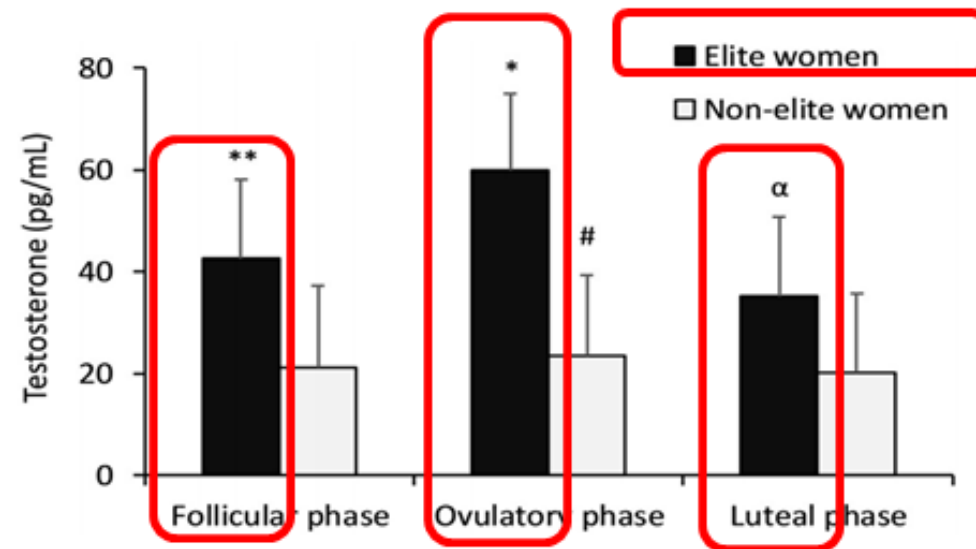
Alexandre Moreira<sup>a,\*</sup>, Marcelo Saldanha Aoki<sup>b</sup>, Emerson Franchini<sup>a</sup>, Daniel Gomes da Silva Machado<sup>c</sup>, Ana Carolina Paludo<sup>a</sup>, Alexandre Hideki Okano<sup>d</sup>



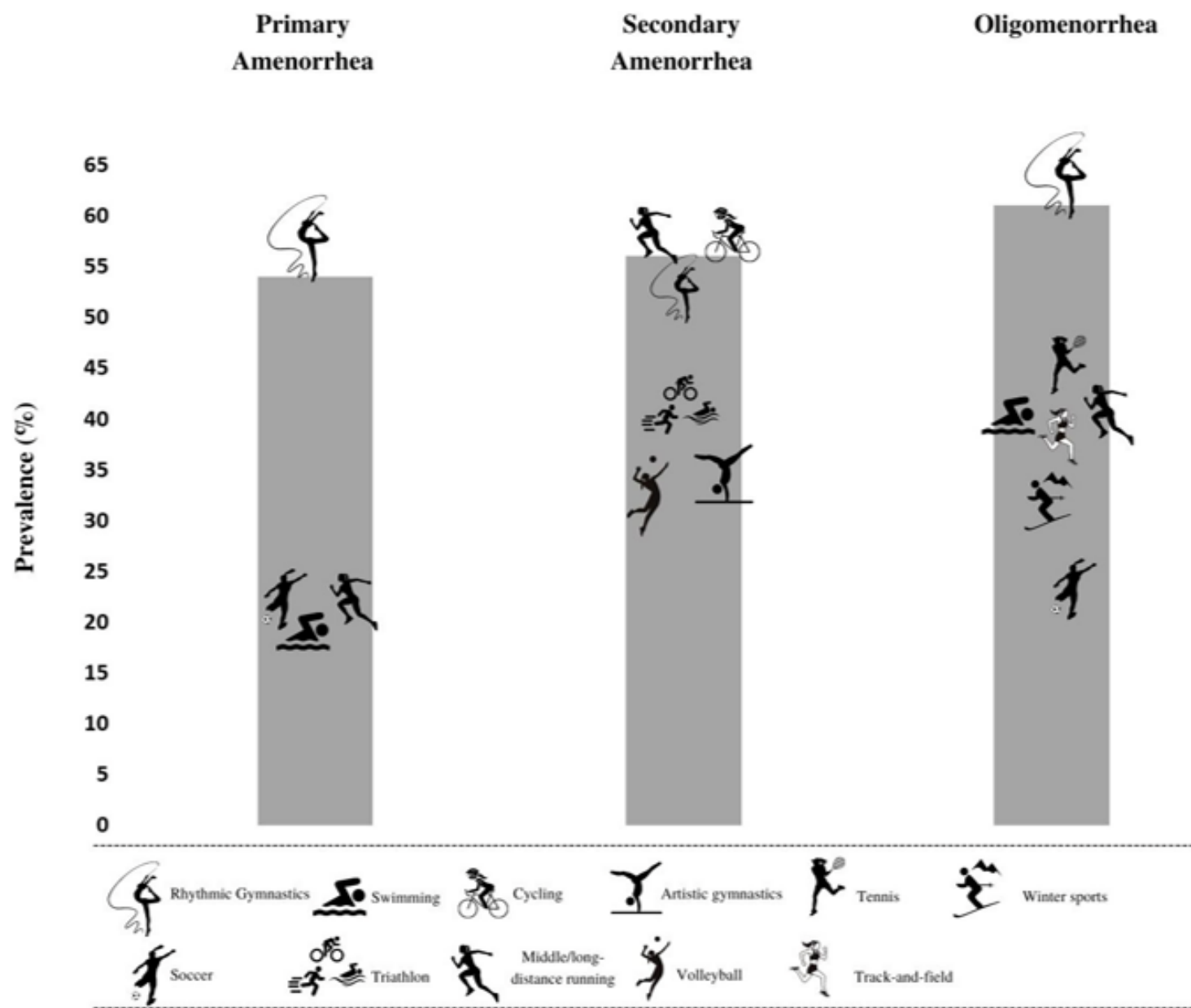
# Menstrual Cycle and Testosterone Concentration

A longitudinal analysis of salivary testosterone concentrations and competitiveness in elite and non-elite women athletes

Blair T. Crewther<sup>a,b,\*</sup>, Christian J. Cook<sup>b,c,d</sup>



# Menstrual Cycle and behavioural responses



Review

## The Prevalence of Menstrual Cycle Disorders in Female Athletes from Different Sports Disciplines: A Rapid Review

Marta [Gimunová](#)<sup>1,\*</sup>, Alexandra [Paulínyová](#)<sup>1</sup>, Martina [Bernaciková](#)<sup>1</sup> and Ana Carolina Paludo<sup>2</sup>

## The Effect of Menstrual Cycle on Perceptual Responses in Athletes: A Systematic Review With Meta-Analysis

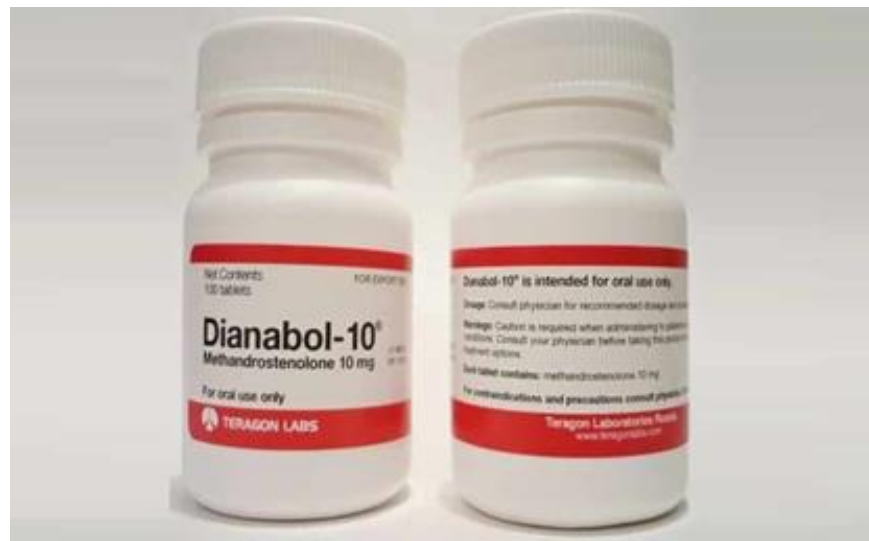
Ana Carolina Paludo<sup>1\*</sup>, Armin Paravlic<sup>1,2,3</sup>, Kristýna Dvořáková<sup>4</sup> and Marta Gimunová<sup>5\*</sup>

Figure 2. Sports disciplines with the highest prevalence of primary, secondary amenorrhea and oligomenorrhea.

# Hormonal Doping

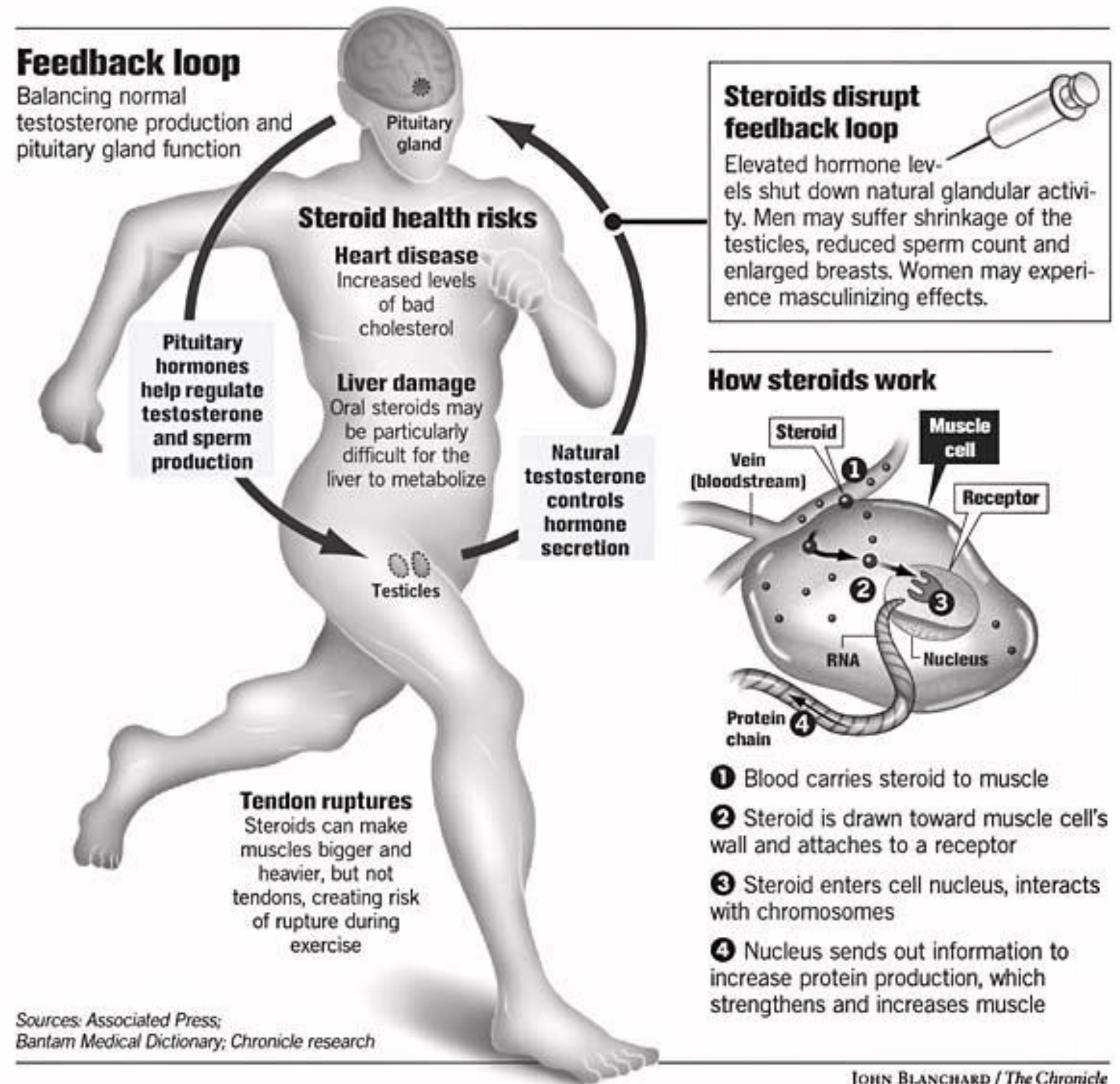
## Anabolic-Androgenic Steroids (AAS)

Synthetics derivatives of **testosterone**



Anabolic: muscle growth, major recovery, pain tolerance, aggression.

Androgenic: secondary sexual characteristics



# Hormonal Doping

## Side effect of AAS use

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12 November 2020

WADA statement on latest media report about the IWF

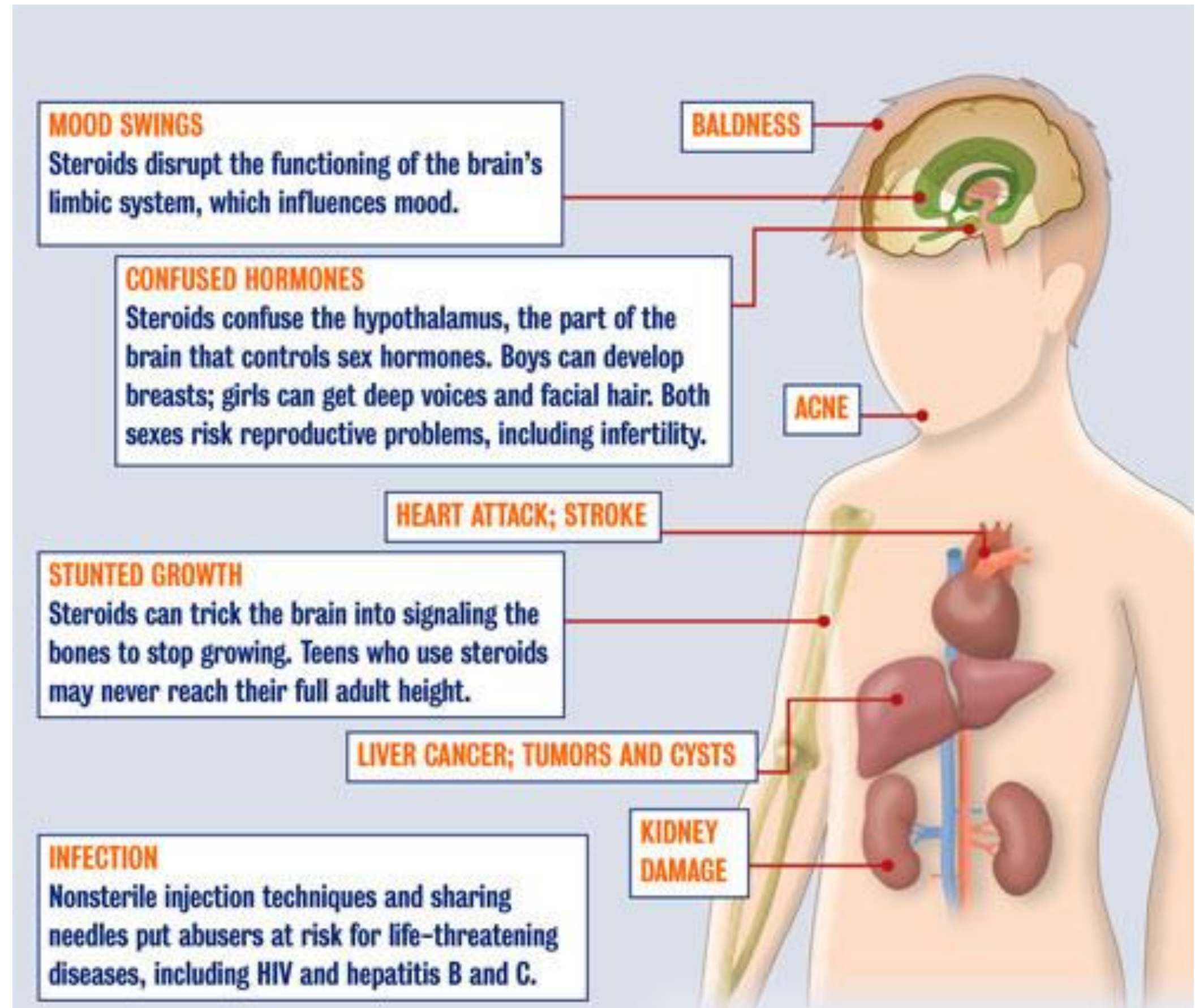
12 November 2020

WADA Executive Committee and Foundation Board expand upon Agency's governance reforms

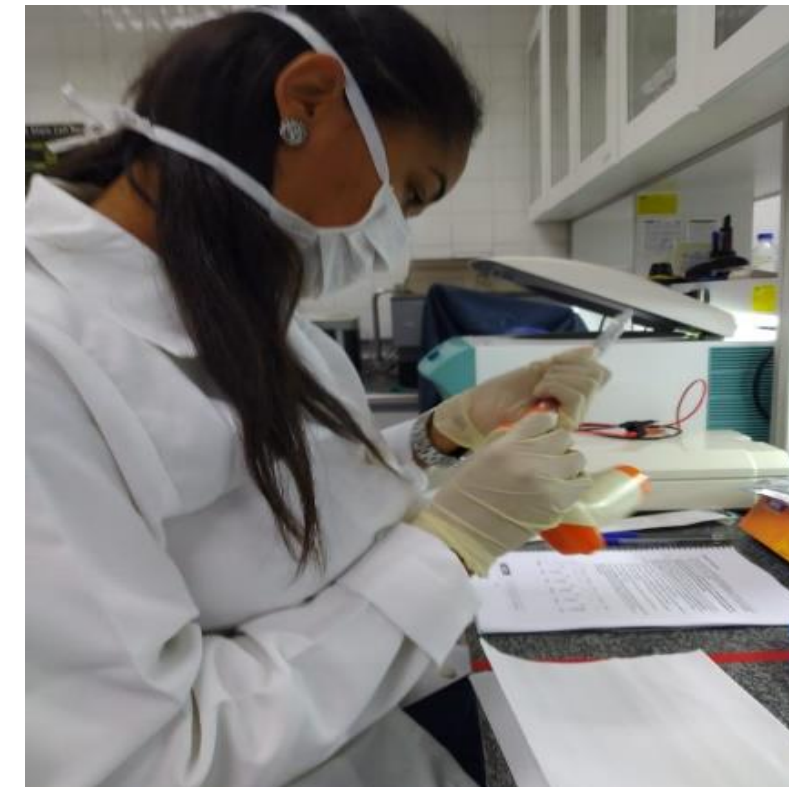
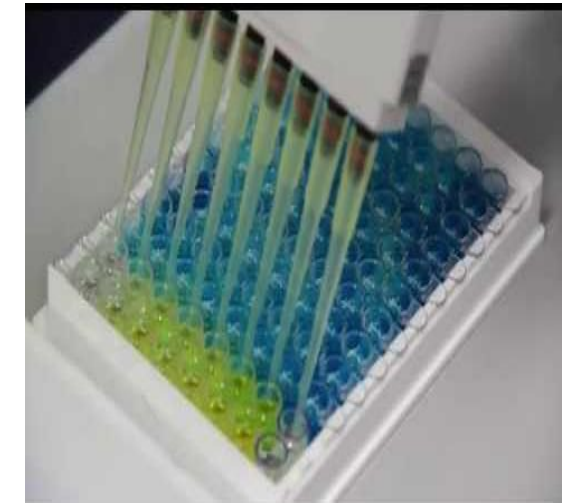
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Follow WADA's updates on COVID-19

speak up! REPORT DOPING

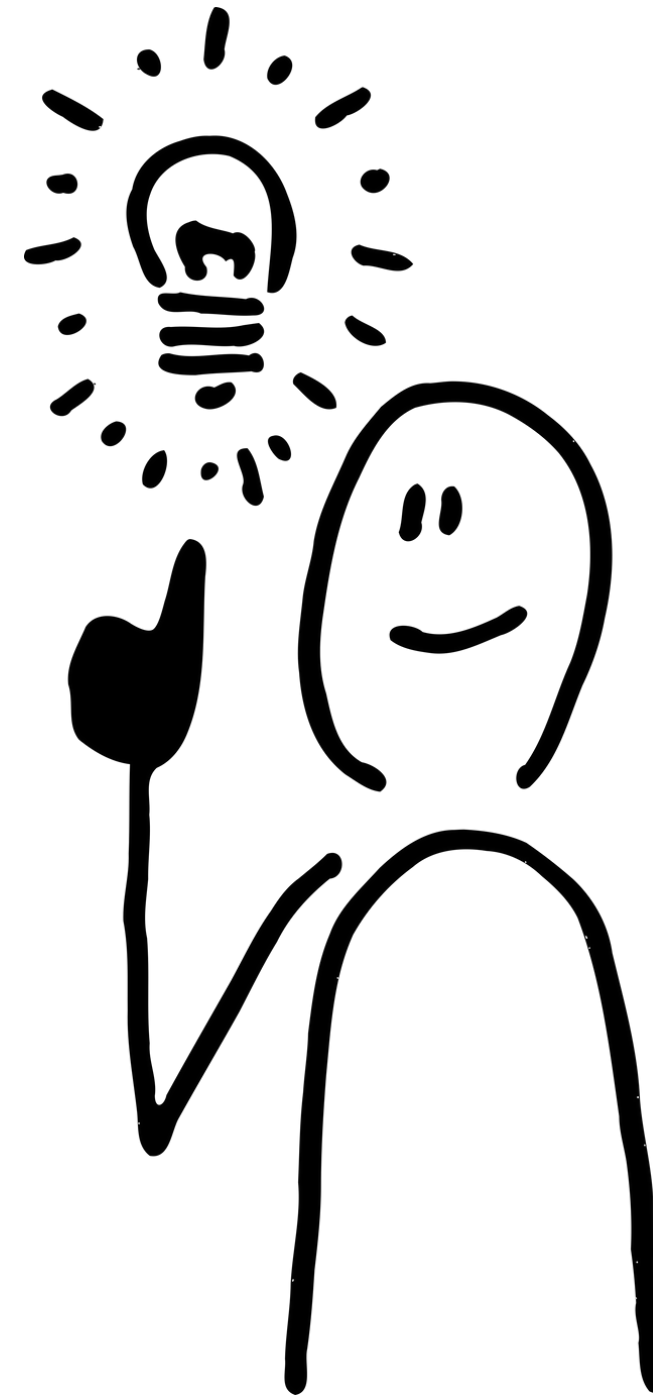


# Hormonal Evaluation



## Practical Application

**Task: search for an  
article about hormone  
and the sport modality  
that you like it**





Obrigada



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[Complementary material:](#)

Exercise associated hormonal signals as powerful determinants of an effective fat mass loss.

<https://pubmed.ncbi.nlm.nih.gov/26238498/>

Enhancement of hypothalamic-pituitary activity in male athletes: evidence of a novel hormonal mechanism of physical conditioning. <https://bmcendocrdisord.biomedcentral.com/articles/10.1186/s12902-019-0443-7>.

<https://www.youtube.com/watch?v=C0EcMJ7CZfY>