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Rhythm!

To horses, as for men, the passing of time has an impact on many conscious or automatic activities. When it comes to men, in particular athletes, we talk about "biorhythm", i.e. the effect that longer or shorter cycles can have on performance. But what about our adventure buddy?

Chronobiology

Chronobiology, from the Greek "chronos" (time) and "biologia" (study of life), is a field of science that examines periodic (cyclic) phenomena in living organisms and their adaptation to solar and lunar related rhythms.

Chronobiological studies include but are not limited to comparative anatomy, physiology, genetics, molecular biology and behavior of organisms within biological rhythms mechanics.

The variations of the timing and duration of biological activity in living organisms occur for many essential biological processes. These occur in animals (eating, sleeping, mating – particularly for horses, which are only fertile in spring! -, hibernating, migration, cellular regeneration, etc.), and in plants (leaf movements, photosynthetic reactions, etc.).

Chronobiology is an interdisciplinary field of investigation. It interacts with medical and other research fields such as jetlag, sleep disorders, endocrinology, geriatrics, sports medicine, space medicine and photoperiodism.

The unsubstantiated theory of biorhythms, which is said to describe a set of cyclic variations in human behavior based on physiological and emotional cycles, is not a part of chronobiology.

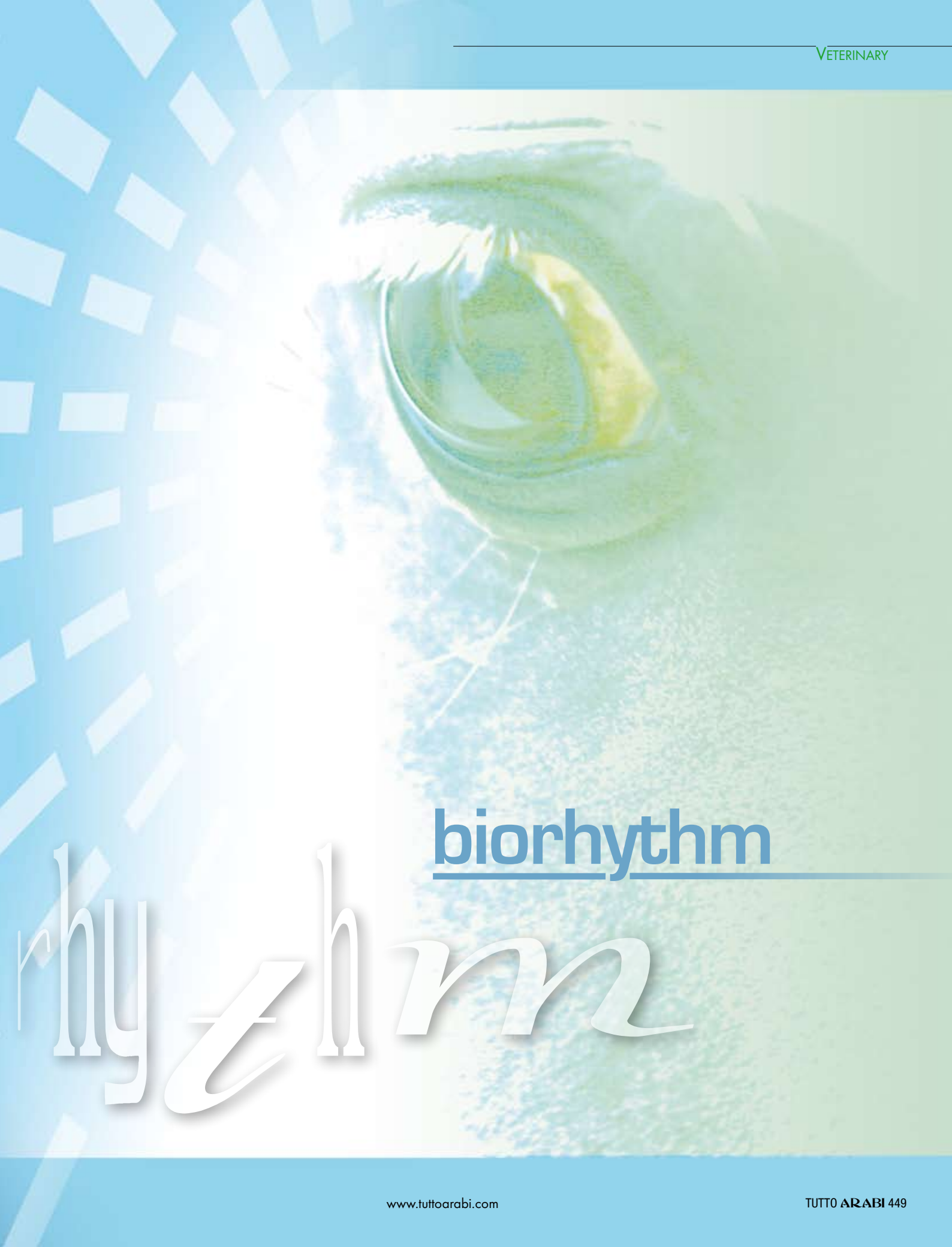
The various rhythms

The most important rhythm in chronobiology is:

- *the circadian rhythm, a roughly 24-hour cycle shown by physiological processes in plants and animals.*

Many other important cycles are also studied, including:

- *infradian rhythms, which are long-term cycles, such as the annual migration or reproduction cycles found in certain animals or the human menstrual cycle.*
- *ultradian rhythms, which are short cycles, such as the 90-minute REM cycle, the 4-hour nasal cycle, or the 3-hour cycle of growth hormone production. They have periods of less than 24 hours.*
- *tidal rhythms, commonly observed in marine life, which follow the (roughly) 12-hour transition from high to low tide and back.*



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history

A circadian cycle was initially discovered, in the 1700s, in the movement of plant leaves by the French scientist Jean-Jacques d'Ortous de Mairan. In 1751 Swedish botanist and naturalist Carolus Linnaeus (Carl von Linné) designed a floral clock using certain diurnal species of flowering plants. By arranging the selected species in a circular pattern, he designed a clock that indicated the time of day by observing which flowers were open and which ones were closed. For example, he discovered that the hawk's beard plant opened its flowers at 6:30 am, whereas another species, the hawkbit, did not open its flowers until 7 am.

In 1924 Alexander Chizhevsky, graduate of Medical School at Moscow University, published interdisciplinary works: "Physical factors behind the process of history" and "Epidemiological catastrophes and periodic activity of the Sun" studying cycles in living organisms in connections with solar cycle and cycle of lunar phases. Chizhevsky developed a new discipline, Heliobiology, a branch of Astrobiology. In 1939 Chizhevsky was elected Honorary President of the International Congress in Biological Physics for his 1936 publication "The Terrestrial Echo of Solar Storms". However, soon Chizhevsky was arrested by the Soviet government and exiled to Siberia under the dictatorship of Joseph Stalin. Chizhevsky's publications were censored and his 1930s research of blood and electromagnetic parameters of erythrocytes in connection with cycles in human circadian system was banned; it was published in 1973, 40 years later. Chizhevsky's 1928 publication "Influence of Cosmos on human psychoses" was censored in the Soviet Union, albeit in 2003 this work was referenced in Journal of Circadian Rhythms article.

The 1960 symposium at Cold Spring Harbor Laboratory seems to define the moment when researchers from widely different fields discovered that they all were studying the same phenomenon. That well-attended meeting lay the groundwork for the field of chronobiology.

It was also in 1960 that Patricia DeCoursey invented the phase response curve, a time graph showing the effect of a treatment designed to affect circadian rhythms (e.g. the sleep-wake cycle throughout the day).

Franz Halberg of the University of Minnesota, who coined the word circadian, is widely considered the father of American chronobiology. However, it was Colin Pittendrigh and not Halberg who was elected to lead the Society for Research in Biological Rhythms in the 1970s. Halberg wanted more emphasis on the human and medical issues while Pittendrigh had his background more in evolution and ecology. With Pittendrigh as leader, the Society members did basic research on all types of organisms, plants as well as animals.

More recently, light therapy and melatonin administration have been explored by Dr. Alfred J. Lewy and other researchers as a means to reset animal and human circadian rhythms.Humans can be morning people or evening people; these variations are called chronotypes for which there are various assessment tools and biological markers.

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Hormones and physical performance

As everyone knows, physical performance is, among other things, under the control of hormones that determine higher or lesser fitness. These hormones can be produced continually or, more often than not, can be mero present at certain times (peak or acrophase) and then decrease. Let's see which hormones are involved and what are the best moments for successful training.

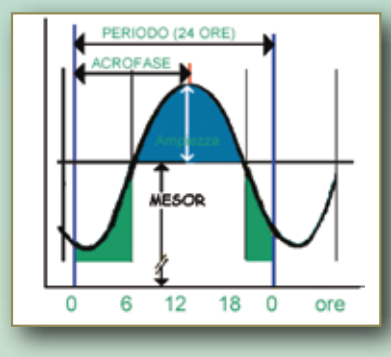
- *Cortisol secretion is constant over the 24 hours, with a peak (acrophase) recorded around the early hours of the morning (3-4am) and a minimum coinciding with the early hours of the night rest (10 pm -12 am).*
- *The plasma concentration of GH or somatotropine reaches its acrophase around 12 am with its minimum value recorded from 8 am to 8 pm.*
- *Testosterone has its peak around 2-3 am, whereas its basal level is around 6 pm.*
- *TSH, the main hormone regulating thyroid functions, has a pattern that looks exactly like that of testosterone.*

The peak of cortisol causes the body to have a stronger predisposition to use the fatty acids as energy substrate. Therefore for endurance horses it is best to train in the morning. But beware! Any food intake prior to the morning training session involves a reduction in the levels of cortisol, its positive effects on lipolysis. A light meal is acceptable.
Constantly high levels of cortisol (such as in cases of stress) encourages the accumulation of fat, reducing at the same time the muscle mass and triggering a process affecting predominantly the muscles.
The hormonal profile that sets in around the evening hours stimulates the synthesis of glycogen (the sugar that gets stored in muscles) preparing the body to the storing of energy.
In the first hours of the night, conversely, there is a predisposition to storing proteins, which encourages muscular anabolism. This explains why bodybuilders are often advised to take a casein-based supplement before going to bed (casein is a particular milk protein).
Anabolic hormones are stimulated during the first few minutes of physical activity, especially when training at a particularly high pace, with hyperproduction and consequent accumulation of lactic acid. Catabolic hormones start to be activated after 45 minutes of exertion. Lymphocytes (the main constituents of the immune system) also decrease after too intense training in proportion to the increased secretion of cortisol and its immunosuppression activity. In this cases we talk about immulogical stress reaction.
An inadequate and/or excessive training program not only increases the risk of accidents but most of all causes a long-term depletion in the immune defense system, making the body more susceptible to the risk of infections.

Chronobiology, hormones and circadian rhythms: what is the best time for training?

As already mentioned, the plasma concentrations of the main body hormones follow a sinusoidal trend, marked by subsequent phases of:

- *Increase phase*
- *Peak (acrophase)*
- *Decrease phase*
- *Minimum peak*



The sequence of these stages can occur or be analysed over one day (circadian rhythms), one week (circasettian rhythms), one month (circatrigintan rhythms), one moon cycle (circalunar rhythms), one year (circannual rhythms) and so on.
Athletic performance too follows a circadian rhythm.
When is it best to train? In the morning, afternoon or eve-

biorhythm

ning? It is obvious that in most cases the choice is dictated by all the other commitments (generally work commitments) which we must honor. However, when you can choose, what is the most appropriate solution? In the morning, when you have a light stomach and you have rested? In the afternoon, when the body has been refueled with some food energy and the post-sleep sluggishness? Or in the evening, when the wish to relax makes physical exercise more enjoyable?

The choice must be based on your own characteristics and sensations. It is normal for everyone of us to feel better and fitter in certain hours of the day rather than others. Some people fuel only in the afternoon (for example, those suffering from low blood pressure), others have their best part of the day in the morning (usually those with hypertension). There are some who prefer to have a lie-in in the morning and be up until late at night (night owls) and those with the opposite preference (early birds).

Also in sports you can feel the influence of the variation in physical and psychological efficiency, so some people prefer to play sport at certain times of the day rather than others – except those who cannot choose, obviously.

Tests have shown, however, that the highest peaks in body temperature are recorded in late afternoon and early evening (4-6 pm). This increase in temperature is associated with an improvement in reactivity, explosive force, maximum strength and highest level of oxygen consumption (maximum aerobic ability). If we consider that body hyperthermia improves the speed with which nervous stimuli are transmitted and the metabolism increases, thus enabling the production of energy, we can easily understand why the sports performance is improved as a result.

What about the competition?

Having established that training can be moved to the time of the day in which fitness is at its best, we also need to take into account the moment in which it is necessary to perform. If a competition is scheduled for the morning, the horse can be "prepared" for this type of energy consumption by training in the morning. Obviously, in the case of competition horses the timetable can vary a lot, so you can choose the training moment regardless of this.

In order to prepare the horse for the most important event in the season, you will also have to take into account that during training, their effectiveness follows an undulating trend, increasing and decreasing, resulting from the influence of the day, the moon, the season and so on. The secret, however, is planning to have the horse in top form during the peak in effectiveness within the best season period and near the time of the most important event. The rest is down to a bit of luck, which never does do any harm.