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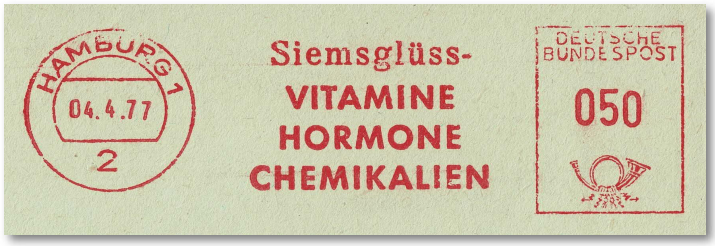
REDAKTIONSSCHLUSS HEFT 211: 15. Nov. 2023

Chemical structures of hormones on stamps

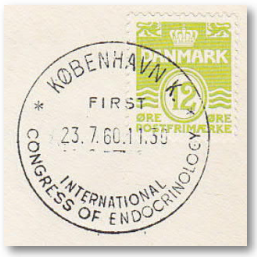
Johan Diesveld / Ulrich Treutlein / Daniela M. Vogt Weisenhorn



What are hormones? Hormones are messenger substances that are produced by special cells (in the so-called endocrine glands or cell tissues) and released into the body (via the bloodstream) as endogenous active substances. These signaling or messenger substances trigger specific effects or regulatory functions in specific cells of the target organs. This classic definition is still valid today but has been modified and expanded many times. For example, some researchers now regard various vitamins as hormones, although this does not apply in the strict sense, since they are not endogenous substances.

Word History: The word hormone was first introduced in 1905/1906 by Ernest Starling and William Maddock Bayliss for the active ingredient of internal secretory glands/tissues as an explanation of their functions and is derived from the Greek word horman, which translates as 'to set in motion', 'to drive', 'to excite'. The classical concept of hormone dates from this time.

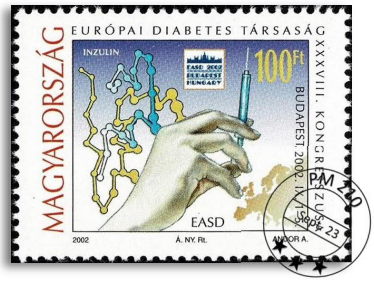
Which science deals with hormones? The special science that studies hormones is called endocrinology and deals with their effects, but also with changes/diseases in hormonal metabolism in animals and humans.



Hormones not only in humans: By analogy, in arthropods and mollusks, messenger substances are considered hormones that reach their destination via the hemolymph. The pheromones found in animals are also messenger substances, but act between individuals and are not bound to the organism where they are produced, but can signal over a long distance and become effective (locusts use 4-vinylanisole as a pheromone to signal swarming (structural formula shown on the stamp from China 2021)). The hormones found in plants are called phytohormones. They have in common with animal hormones that they trigger signaling effects - albeit over a greater distance - and are effective in low concentrations, such as the growth hormones auxin and gibberellin (Chinese postal stationery - promotional postcard for gibberellin).

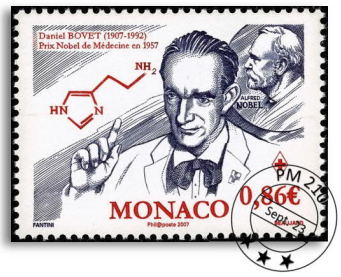
Biochemical properties: A distinction is made here between water-soluble and lipophilic hormones. Water-soluble hormones cannot cross the cell membrane barrier due to their lipid insolubility. Instead, they bind to specific membrane-bound receptors of the target cells. Together with a receptor, these form the so-called hormone-receptor complex. This activated receptor then functions inside the cell as an enzyme that indirectly triggers various biochemical reactions. Water-soluble hormones are mostly polypeptides. They consist of long chains of 8 to 100 amino acids. They include, for example, hormones of the hypothalamus and the pituitary gland (e.g. vasopressin, somatotropin) but also of the pancreas such as insulin and glucagon. Lipid-soluble hormones can cross the cell membrane without receptors. The hormone binds to intracellular receptors in the cytoplasm and forms a hormone-protein complex. This complex is capable of passing through the cell membrane to DNA. An important class within the lipid-soluble hormones are the steroid hormones, all of which

are formed by cholesterol as the basic body. They include, for example, all sex hormones, aldosterone and cortisol. The thyroid hormones, which are nevertheless lipid-soluble, are not derived from cholesterol.

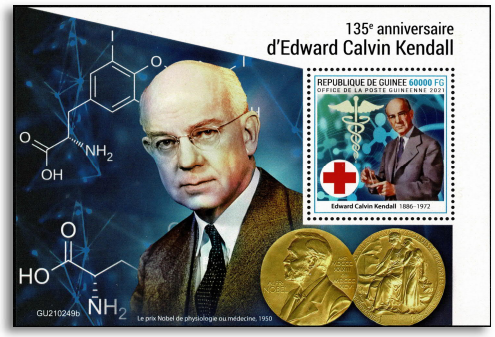


Due to the importance of hormones for human health, the chemical structure of some of them has also found its way into philately and are depicted on stamps.

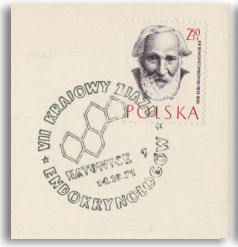
The chemical structure respectively crystal structure of *insulin* can be found on at least 6 stamps (Dane-mark 1990, Switzerland 2021, Brazil 2021, Belgium 1971, and Romania 1999 - see also article on page 10, Hungary 2002).



Histamine an amine derived from an amino acid; plays a role in the gastrointestinal tract and in the regulation of blood vessels. Its structural formula can be found on a stamp of Monaco brand from 2007.

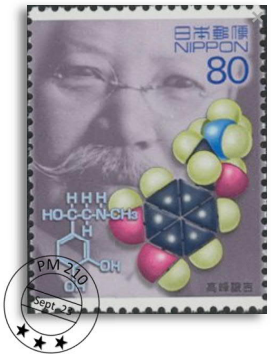


In the upper left corner of a block from Guinea (2021) one finds the structural formula of an *L-thyroxine* molecule with iodine-atmones (=I) bound to it. L-thyroxine is a thyroid hormone and is first converted into the actually active triiodothyronine. This increases the energy metabolism, stimulates heat production and has an influence on muscles, fat loss, liver and heart.



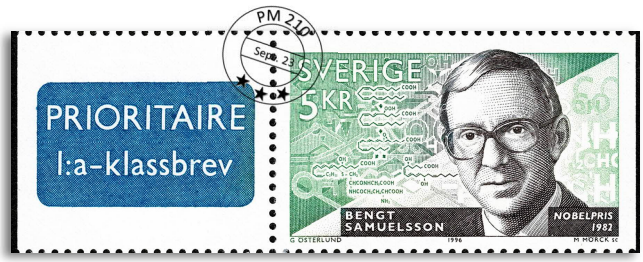
Steroid hormones are a diverse group of substances with different functions. The special stamp from Poland shows the general basic structure of a steroid: four interconnected carbon rings. These can also be seen as a green structure in front of drugs and ampoules on the British stamp from 1977. An important steroid hormone is *cortisol or corticosterone*. The structural formula of this so-called "stress hormone" is shown on the Canadian stamp from 2000, together with a photograph of Hans Selye, the "father of stress research".

Another stress hormone is adrenaline, which belongs to the group of *catecholamines*. Stress hormones ensure that in a stress situation, i.e. a situation in which one would like to run away, the body briefly becomes stronger and more powerful and temporarily switches off unnecessary activities such as digestion. The structural formula as well as a calotte model of adrenalin are shown together with Takamine Jokichi (isolated adrenalin in 1901 from the adrenal gland) on a Japanese stamp from 2004.



The *sex hormones* (e.g. testosterone, estrogens and progesterone) in turn belong to the steroid hormones. They play an important role in the development of the contraceptive pill, the history of which is discussed in more detail in the article starting on page 14.

Prostaglandins, like vitamins, are not hormones in the strict sense of the term, since they are not produced by glands but in the tissues. They are therefore local hormones. They play a role in local pain mediation, as well as in integrative functions such as the development of fever in inflammatory processes. The synthesis pathway for this chemical substance class is shown on the Swedish stamp from 1996, together with a portrait of Bengt Samuelsson, who received the Nobel Prize for his work on prostaglandins.



Hormones and the long memory of water

Ulrich Treutlein

Sewage plants – Kambodscha 1996

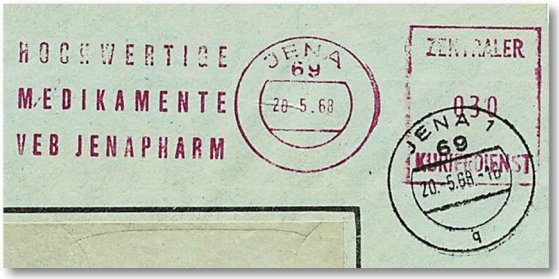
Synthetically produced hormones (and their degradation products), e.g. for contraceptives (birth control pills), are excreted in the urine but not removed from the wastewater liquor in sewage treatment plants. Studies of wastewater samples have shown that ethinylestradiol, a synthetic component of the contraceptive pill, is highly biologically effective. Even very low concentrations of only a few nanograms per liter are sufficient to reduce the fertilization rates of some fish species and snails in the case of prolonged exposure. Such levels of active ingredients are actually measurable in some surface waters or near wastewater treatment plants. Female aquatic snails even produce additional male reproductive organs at slightly higher concentrations of ethinyl estradiol. Other drugs - such as the painkiller diclofenac - are also increasingly found in our waters and have, for example, already brought vulture species in India to the brink of extinction, as the drug leads to an agonizing death by kidney failure.

Water snails are endangered by estrogens; Yugoslavia 1976

Indian vulture - almost wiped out by use of dic-lofenac in veterinary medicine; Mozambique 2012

Unfortunately, filtering out active ingredients such as ethinylestradiol from wastewater is problematic; conventional wastewater treatment plants are overtaxed, especially in the case of water-soluble substances. Additional purification, for example by nanofiltration, ozonation or the use of activated carbon, can remove the drugs from the water, but in turn causes problematic waste or waste products, or it is expensive. For a sensible use of these technologies, it is therefore necessary to separate highly contaminated wastewater at the point of origin, for example, by means of appropriate sewers at old people's homes (elderly people no longer take pille, but have an increased need for other medicines (e.g. diclofenac see above)), in order to clean them effectively. However, if the fact is added that more than 180 of the 3,000 active substances approved in Germany can be detected in German waters today, the magnitude of the tasks for wastewater treatment is made quite clear. Among them is almost everything that can be found in the medicine cabinet: Hormones, lipid-lowering agents, painkillers, antibiotics, and even X-ray contrast media - all of which are not freely available and require a prescription.

Waterpolution Turkey 1980

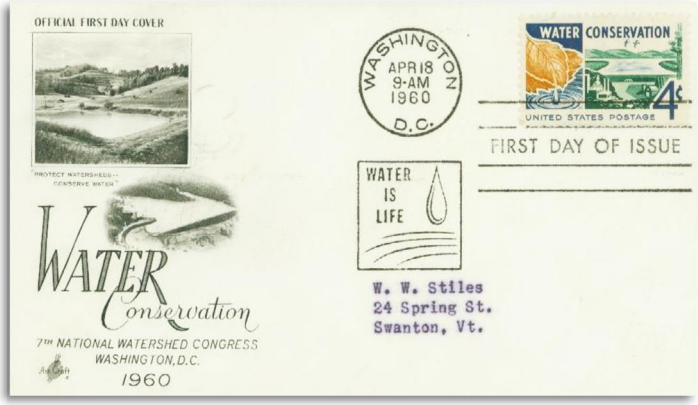


Further exacerbating the problem is the fact that while ecotoxicological studies are publicly available for non-pharmaceuticals such as industrial chemicals, herbicides and pesticides, they are not for pharmaceuticals. Such studies must be submitted to the regulatory authority - although extensive exceptions are granted - and this in turn may not then pass on the data to environmental authorities or the specialist public. All this is done on the grounds of business and trade secrets. There is now hope that - following a lawsuit - the ECJ could decide that the studies on the medicinal products must also be treated in accordance with environmental information law and thus be disclosed upon request. It could also come to a listing of drugs such as estradiol and diclofenac as so-called priority substances in the sense of the EU Water Framework Directive, which would have as a consequence that legally binding standards for these drugs in water bodies would have to be established. This is probably necessary because, for example, the measured average EU value for diclofenac is 0.4 micrograms per liter. In contrast, the value at which there are still no effects on an ecosystem is 0.04 micrograms per liter - i.e. 10 times lower. Admittedly, these are concentrations that are far from the therapeutically effective ones. However, the long-term effects not only on ecosystems but also on humans are still completely unclear.

Stamp embroidered from polyester yarn; motto protection of ecosystems; sun and seed; Vatican 2022

In Deutschland werden Medikamente durch das BfArM zugelassen

Sweden has already taken a different approach to tackle the problem. In Sweden, doctors are required to prescribe a drug that is more environmentally friendly and thus less harmful to wastewater if it has the same efficacy. For this purpose, corresponding lists are available that indicate the environmental risk of the drugs (which is known from the substance data collected) and a PTB index. The PTB index indicates a value between zero and nine, independent of the current exposure, which results from the stability of the drug (=persistence), the toxicity and the accumulation in the environment (=bioaccumulation). The higher the value, the worse the environmental compatibility. There are no plans to introduce a comparable system in Germany. Both the Europe-wide pharmaceutical legislation and the different organization of pharmacies - pharmacies are run by the state in Sweden - make it difficult to adapt this approach. What is certainly possible, however, is the conscientious use of prescribed medications, an obligatory return of medications that are no longer needed - and not the convenient and ill-considered route of flushing them down the toilet - by pharmacies and manufacturers, and educational campaigns by the Federal Environment Agency in Germany as well. **Because water has a long memory, we must protect it..**



Ungarn 2016
USA 1960
BRD 2014

Sources: Deutsches Ärzteblatt 24/2008, Wikipedia-Artikel: Hormon; https://www.geo.de/wissen/gesundheit/immer-mehr-arzneimittelrueckstaende-in-der-umwelt-33202740.html

Should you kiss red lips?

Clemens M. Brandstetter

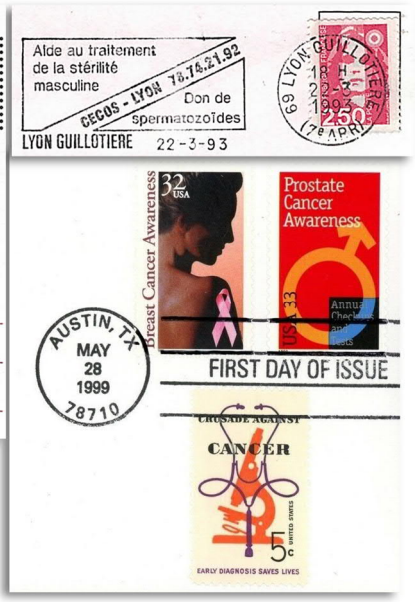
Plastic faith as economic miracle

Chemistry has secretly crept into everyday products. Actually, globally active corporations are behind it, which are reluctant to show their cards, i.e. recipes. It may be assumed that the mutual economic-political lobbying contributes to the clever and profit-oriented placement of chemicals in food (not food!) and other products [Bisphenol A is a good example of the importance of an independently financed risk assessment by the industry. For example, all the results of independent scientific studies in recent years pointed to a health hazard, whereas all the studies conducted by industry gave the all-clear].

Bund.net asks quite provocatively on its site: What do a tin can, an air mattress and a body cream (lipstick) have in common? These and many other everyday products can contain chemicals that act like hormones, so-called endocrine disruptors. Such substances include bisphenol A, plasticizers and parabens, which are found,

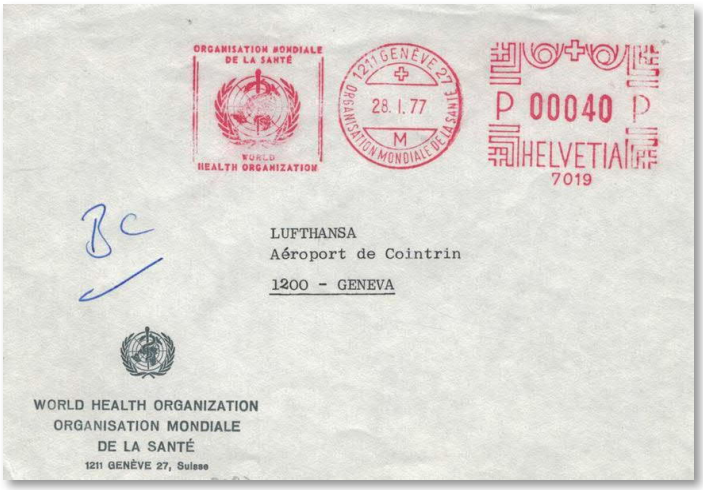
What do these three have in common? BRD 2012, F 2009, J

Among other things, the susceptibility of the unborn child to many harmful substances, e.g. the endocrine disruptors, may lead to secondary diseases such as infertility, but also to the development of breast and prostate cancer.



for example, in the inner coating of food cans, in air mattresses and in body creams and lipsticks.

I therefore intend to deal with these harmful substances. These substances mimic or expose natural (sexual) hormones and can promote male or female characteristics. They represent a considerable danger, especially for children, since the hormone system regulates physical and mental development. Thus, the prenatal phase can already be affected. In male adolescents and men, they could lead to malformations of the reproductive organs or even testicular cancer. The increase in non-functional sperm is also attributed to these pollutants. Girls could experience premature puberty and women could be at increased risk for breast cancer. There is also the possibility of increased incidence of allergies, diabetes, obesity, cardiovascular disease, behavioral disorders and even brain developmental impairments. The latter could also explain the results of some studies indicating a possible link between endocrine disruptors and cognitive development, including IQ. These could also explain the possibly continuous decrease in average IQ in the population, which is, however, highly controversial.



The WHO also has concerns

The adverse health effects have led to endocrine disruptors being considered a potential global threat by numerous experts and international organizations, including the World Health Organization (WHO) and the United Nations (UN). This is due to their global distribution, their harmful effects by entering water and soil, their long-term consequences (exposure in the womb may not cause problems until adulthood), their cumulative effects through lifelong accumulation in tissues, especially adipose tissue, and the challenge of regulating them. Their effects are often subtle and may not become apparent until long after exposure. This makes scientific proof of a causal link between these pollutants and the health problems they cause very difficult, if not impossible. Therefore, "only" statistical links between pollutant exposure and health problems exist so far, which are recognized by some (consumer advocates) but not accepted as sufficient evidence by others (industry) (see comment on bisphenol_A above).

Bund.net provides tips on how to avoid ingesting these pollutants: Tap water is preferable to water from plastic bottles. Avoid food packaged in plastic; also tin cans without "bisphenol_A-free" labeling. Food belongs in glass or stainless steel. Avoid microwave-safe plastic dishes. No clothing with processed plastic. Not using pressboard furniture. Use natural cosmetics and no perfumes. Use vinegar, lemon, natron instead of chemicals as cleaning agents. No toys made of soft plastic or cheap toys made of dark plastic. Give preference to labeled products (Blue Angel, ToxFox...).

Quelle: https://www.bund.net/themen/chemie/hormonelle-schadstoffe/

Simple rules of conduct can protect as always: no plastic - neither when eating and drinking (Publibel No. 2427) nor playing (China 1984) and pay attention to the "Blue Angel" label (Dialogpost).