THERMORECEPTION AND TEMPERATURE REGULATION pdf

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The study of thermal physiology in man includes the investigation of temperature sensation and thermal comfort, recording of afferent impulses from thermoreceptors as well as the study of autonomic temperature regulation and thermoregulatory behavior.

Environmental Ergonomics addresses the problems of maintaining human comfort, activity and health in stressful environments. Its subject areas include thermal environments, illumination, noise and hypo- and hyperbaric environments. The book concentrates fundamentally on the way the thermal environment has affected human comfort, health and performance from the age of cave-dwellings to our age of skyscrapers. Selected papers from the 10th International Conference on Environmental Ergonomics held in Japan, September They have been revised and peer-reviewed. Papers included in this text have been widely recognised as the catalyst for the recent advances witnessed in Environmental Ergonomics in Asia. Add this volume to your copy of the Elsevier Ergonomics Book Series. Since the first English edition of this book appeared three years ago, the authors have received many useful comments from readers. In preparing this amended edition we have carefully examined each chapter, improving and expanding the text where necessary; in the process, we have been greatly helped by their remarks. Further commentary on this edition will be much appreciated. Again, I should like to express the gratitude of all the authors to the staff of Springer-Verlag for expediting the publication of the book. SCHMIDT Preface to the First Edition In the field of sensory physiology we are concerned with what our sense organs and the associated central nervous structures - can do and how that perform ance is achieved. Research here is not limited to description of the physi cochemical reactions taking place in these structures; the conditions under which sensations and perceptions arise and the rules that govern them are also of fundamental interest. Sensory physiology thus demands the attention of everyone who wishes to - or must - delve into the potentialities and limitations of human experience. The Fifth Edition is thoroughly revised and updated, and includes new chapters on the physiology of incubation and growth. Chapters on the nervous system and sensory organs have been greatly expanded due to the many recent advances in the field. The text also covers the physiology of flight, reproduction in both male and female birds, and the immunophysiology of birds. The Fifth Edition, like the earlier editions, is a must for anyone interested in comparative physiology, poultry science, veterinary medicine, and related fields. This volume establishes the standard for those who need the latest and best information on the physiology of birds. Thoroughly updated and revised Coverage of both domestic and wild birds New larger format Only comprehensive, single volume devoted to birds.

2: Skin temperature: its role in thermoregulation

1. Monogr Physiol Soc. ; Thermoreception and temperature regulation. Hensel H. PMID: [PubMed - indexed for MEDLINE] MeSH Terms.

Temperature Regulation Photo by: Rido Humans and other mammals are homeothermic, able to maintain a relatively constant body temperature despite widely ranging environmental temperatures. Although the average human body temperature is Temperature regulation, or thermoregulation, is the balance between A pit bull panting. Thermoregulation is the balance between heat production mechanisms and heat loss mechanisms that occur to maintain a constant body temperature. Heat flows from higher temperature to lower temperature. Conduction is the transfer of heat between objects that are in direct contact with each other. For instance, if a person sits on the cold ground, heat moves from the body to the cold ground. Convection is the transfer of heat by the movement of air or liquid moving past the body. This explains why a breeze across the skin may cool one down, whereas trapping air inside clothing keeps the body warm. A lizard sunning itself on a rock on a warm summer day illustrates radiation: Whereas conduction, convection, and radiation can cause both heat loss and heat gain to the body, evaporation is a mechanism of heat loss only, in which a liquid is converted to a gas. Perspiration evaporating off the skin is an example of this heat loss mechanism. When the body is too hot, it decreases heat production and increases heat loss. One way of increasing heat loss is through peripheral vasodilation, the dilation of blood vessels in the skin. When these vessels dilate, large quantities of warmed blood from the core of the body are carried to the skin, where heat loss may occur via radiation, convection, and conduction. Evaporation of fluids from the body also causes heat loss. Humans constantly lose fluids from the skin and in exhaled air. The unconscious loss of fluid is called insensible perspiration. Although the body has no active control over insensible perspiration, the sympathetic nervous system controls the process of sweating and can stimulate secretion up to 4 liters 4. In order for the sweat to evaporate and cool the body, the environmental air must have a relatively low humidity. When the body is too cold, it increases heat production and decreases heat loss. Vasoconstriction, the constriction of the vessels of the skin, helps prevent heat loss. Shivering, which is a rhythmic contraction of skeletal muscles, produces heat. Heat can also be produced by nonshivering thermogenesis, an increase in metabolic heat production. Hormones such as epinephrine, norepinephrine, and thyroid hormone increase the metabolic rate by stimulating the breakdown of fat. Humans also change posture, activity, clothing, or shelter to adjust for fluctuations in temperature. The goose bumps that arise on the skin in the cold are another sign the body is trying to prevent heat loss. They are due to piloerection, the erection of the hair follicles on the skin. This is a vestige of the time when humans were covered in hair: Body temperature is regulated by a system of sensors and controllers across the body. The brain receives signals regarding body temperature from the nerves in the skin and the blood. These signals go to the hypothalamus, which coordinates thermoregulation in the body. Signals from the hypothalamus control the sympathetic nervous system, which affects vasoconstriction, metabolism , shivering, sweating, and hormonal controls over temperature. In general, the posterior hypothalamus controls responses to cold, and the anterior hypothalamus controls responses to heat. Hypothermia, or low body temperature, is a result of prolonged exposure to cold. With a decrease in body temperature, all metabolic processes begin to slow. Hypothermia can be life-threatening. Hyperthermia describes a body temperature that is higher than normal. One example of hyperthermia is fever. A fever is generally considered to be a body temperature over 38 degrees Celsius Fevers may even make the immune system work more effectively. Heat exhaustion and heatstroke are other examples of hyperthermia. These occur when heat production exceeds the evaporative capabilities of the environment. Heatstroke may be fatal if untreated. Rosenthal Bibliography Marieb, Elaine. A Human Perspective, 2nd ed. West Publishing Company, Other articles you might like:

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Fish Many species of modern bony fish teleosts are sensitive to very small temperature changes of the water in which they live. Various marine teleosts such as the Atlantic cod Gadus morhua have been trained to swim half out of water up a long sloping trough in response to changes of as little as 0. Further studies have indicated that thermoregulation is particularly important in G. Thermoregulation is particularly important in the Atlantic cod Gadus morhua. Studies have indicated that these fish respond to water temperature changes as small as 0. Temperature sensitivity persists in these animals when the nerve supplying the lateral line is cut; however, temperature sensitivity is abolished after transection of the spinal cord. Goldfish Carassius auratus have been trained to discriminate between warm and cold metal rods placed in their tanks. Practically the whole surface of the fish, including the fins, is thermosensitive. This mode of temperature discrimination need not be ascribed to the function of specific thermoreceptors; it could depend on skin receptors that are sensitive to combined mechanical and thermal stimulation. Indeed, electrophysiological recordings from nerve fibres originating in the skin of fish support the latter view. Changes in the electrical activity of these fibres are elicited only when the skin is touched by some solid object; yet the frequency of this mechanically elicited neural discharge is heavily influenced by the temperature of the object used in touching the fish. Goldfish Carassius auratus are very thermosensitive, and their behaviour is readily influenced by water temperature. Lerdsuwa Elasmobranchs, such as rays and sharks , have distinctive sense organs, called ampullae of Lorenzini , that are highly sensitive to cooling. The capsules and the canals are filled with a jellylike substance, and the sensory-receptor cells are situated within each capsule. Rapid cooling causes transient increases in discharge frequency, whereas rapid warming produces transient discharge inhibition. However, it remains unknown whether the ampullae of Lorenzini are to be called specific thermoreceptors, since they also respond to mechanical stimuli and to weak electrical currents. Researchers suspect there is a protein homologue of TRPV in fish. However, evolutionary investigations of thermoregulatory members of the TRP superfamily have indicated that these proteins differ significantly between mammals and fish. Other than this, very little is known about the molecular details of thermoregulation in fish. Reptiles and amphibians Rattlesnakes and pit vipers in the subfamily Crotalinae have a pair of facial pitsâ€”sense organs on the head lying below and in front of the eyes that function as highly sensitive thermoreceptors. True boas in the family Boidae also have pits, though they are slightly different in structure from those of the crotalinids. The pit organs act as directional distance receptors and make it possible for the reptile to strike at warm prey. Each pit is a cavity about 1â€”5 mm 0. A direct connection between the air space beneath the membrane and the open air maintains equal pressure on both sides of the membrane. Warm-sensitive receptors distributed over the membrane consist of treelike structures of bare unmyelinated nerve fibre endings. Radiation heat energy reaches the membrane from an external source through the narrow opening of the pit, permitting the snake not only to detect heat but also to localize coarsely the position of the stimulus. The fields of direction cones of reception from which each pit can receive radiation from the environment extend to the front and sides of the head, with a narrow zone of overlap in the middle. Top Partially dissected head of rattlesnake showing heat-sensitive membrane inside pit organ. Bottom Cones of reception, and directions from which heat energy can be detected. Under resting conditions, there is an irregular, steady discharge of nerve impulses from the pit organ. Infrared energy calculated to produce a change of as little as 0. Sensitivity to rapid temperature changes is enhanced by the very limited heat capacity of the thin receptive membrane. As cold-blooded animals, reptiles have practically no internal metabolic mechanisms for maintaining their body temperature within physiologically safe limits. Nevertheless, reptiles, such as snakes and lizards , are able to keep their body temperature near these safe levels through behavioral regulation i. For example, through behavioral heating strategies the body temperature of the lizard Sceloporus magister was maintained at However, further studies discovered the ideal body temperature of C. The desert iguana , Dipsosaurus dorsalis, regulates its body temperature largely by behavioral mechanisms to achieve and hold body temperatures near Thermal adjustments by iguanas include postural orientation to solar radiation both inside and outside burrows and altered thermal contact of the body surface with the soil. There is some electrophysiological evidence of thermal sensitivity among amphibians ; however, these organisms appear to respond only to relatively large temperature changes. The lateral-line organs in the platanna frog , Xenopus laevis, are sensitive to minute water turbulence but also respond to static temperatures and to temperature changes. However, it is not clear whether the lateral-line organ is important for thermoreception; it may function solely in rheotaxis movement in response to currents in air or water. In the reptilian brain the hypothalamus appears to be the most important thermoregulatory structure, acting as a central processing station for thermal information received from internal and peripheral thermoreceptors. Molecular studies have identified the presence of heat-sensing TRPV channels in some reptiles, including frogs of the genus Xenopus, the estuarine saltwater crocodile Crocodylus porosus the scincid lizard Pseudemoia entrecasteauxii, and the jacky lizard, Amphibolurus muricatus. Investigations exploring the reptilian pineal gland , which controls melatonin secretion, have revealed the complexity of thermoregulation in reptiles. For example, melatonin levels are known to affect body temperature selection in reptiles. Studies into the existence of TRP channels and other cellular thermoreception mechanisms in amphibians are ongoing. In birds severe cooling induces shivering in particular muscles and causes cardiovascular and metabolic changes. In fact, there is little evidence of nonshivering thermogenesis metabolic heat production in adult birds, since birds do not have the heat-generating brown adipose tissue found in mammals. Birds such as the Arctic tern Sterna paradisaea migrate largely in response to thermal changes in their environments. Furthermore, different skin areas of birds appear to have varying thermosensitivity. For example, in pigeons skin on the back is more sensitive to the detection of warmth than skin on the wings and breast. In addition, nonfeathered skin areas, such as the legs and feet, have little sensitivity to cold or warm stimuli. Many species of birds have a high degree of cold sensitivity, and thus, these species migrate to warm climates for the winter. In contrast, species that are cold-tolerant may migrate to avoid climates that become too warm. Many cold-tolerant birds adjust their basal metabolic rates to avoid hypothermy. In the pigeon Columba livia different skin areas have varying thermosensitivity. For example, the skin on the back is more sensitive to warmth than the skin on the wings and breast, and nonfeathered skin areas, such as the legs and feet, have little sensitivity to warm or cold stimuli. Wilson Investigations of thermoreception and thermoregulation in birds indicate that thermosensors exist not only in the skin on the body but also in the skin around the face, the thoracic brood patch the area used for egg incubation , and the beak. Thermoreceptors also exist in the spinal cord and brainstem though apparently not in the hypothalamus. Early studies employing microelectrodes provided evidence of cold-sensitive thermoreceptors in the tongues of chickens. As indicated above, there is electrophysiological evidence of cold and warm thermoreceptors in the skin of pigeons. There is also evidence that cold and warm thermoreceptors are present in the beaks of geese and ducks ; some of these receptors may also be mechanoreceptive. There is direct physiological and behavioral evidence for thermoreceptors in the brood patch of hens. Such thermoreceptors are important for controlling incubating behaviour and for regulating blood flow in the brood patch. For example, in response to the temperature of the eggs, hens remain on the eggs for an appropriate length of time, and, by regulating blood flow, they can maintain the temperature of their brood patch, keeping this region warm and optimizing the development of the embryos in the incubating eggs. It is particularly striking that hens have impaired or absent incubation behaviour when the nerves to the brood patch have been cut; this suggests a critical role for thermoreceptors in incubation behaviour. Megapodes , large-footed birds such as the Australian mallee fowl genus Leipoa and the brush turkey, have unique incubation behaviour that appears to rely heavily on thermoreception. They bury their eggs in mounds where heat is generated through the fermentation of rotting vegetation and by irradiation from the Sun. This behaviour depends on thermoreceptors in and around their mouths and face to guide the success of their efforts. Mammals Thermoreceptive elements Mammals have thermoreceptive elements sensitive to warming or cooling within their brains , particularly in the spinal cord and the hypothalamus , a region at the base of the forebrain. Physiological investigations of peripheral nerve fibres and of neurons in the spinal cord and forebrain in mammals have provided information on the characteristics of thermoreceptive activity. In addition, molecular studies of mammalian cells have revealed the existence of several different thermoreceptor proteins, including TRPM and TRPV channels. Cold receptors such as those found in the skin of cats may be innervated by fast-conducting myelinated A-fibres or slow-conducting unmyelinated C-fibres. The cold and warm thermoreceptors of mammals show dynamic as well as static excitatory or inhibitory discharge responses. These responses represent the magnitude and rate of change of cold and warm stimuli. The thermoreceptors have spotlike receptive fields in the skin, and cold receptors are more numerous than warm receptors in the skin. Warm receptors are found primarily in deep tissues e. Skin thermoreceptors are concentrated in orofacial regions around the mouth, tongue , nose , lips, eyes , and ears , as well as in regions on the hands and feet paws in quadrupeds. While both cold and warm receptors are innervated by unmyelinated C-fibres that conduct discharge activity very slowly, cold receptors are predominantly served by thinly myelinated A-fibres that conduct impulses more rapidly than C-fibres. Thus, a blockade of peripheral nerve conduction by maintained pressure will first interrupt touch, then cold, then finally sensations of warmth and pain , whereas blockade with a local anesthetic agent such as lidocaine will interrupt these sensations in the reverse order. Thermoreceptors are infrequently excited by mechanical deformation of the skin. However, some mechanoreceptors are sensitive to thermal changes. In addition, certain heat-sensing thermoreceptors are sensitive to painful stimuli and thus have a dual function as nociceptors pain receptors. The tips of these branches are embedded in small concavities on the lower surface of the basal cells of the epidermis. In contrast, the sharp biting sensation elicited by touching an object at deep cold temperatures such as dry ice is due to the abrupt activation of nociceptors by rapid ice crystal formation in the skin. The thermal grill demonstrates that there is a central neural mechanism for the cold inhibition of pain. The simultaneous warm and cool temperatures summate in the brain to reduce normal thermoreceptive activity, and this reduction unmasks disinhibits the cold-evoked polymodal nociceptive activity that is normally inhibited centrally by the thermoreceptive activity. The dermis of the skin is innervated by a myelinated nerve fibre that divides into several unmyelinated branches beneath the skin surface. These nerves detect thermal changes in the environment and relay thermal information to nerve tracts in the spinal cord that extend into the brain. Cold or warm packs are used therapeutically to reduce pain, and the thermal grill illusion shows that these thermal stimuli have a centralâ€”not just peripheralâ€”interaction with pain sensation. The central integration of thermosensory and pain activity in the brain is important for the thermoregulatory control of blood flow to the skin and deep tissues. The association of the central neural mechanisms controlling the thermoregulation of blood flow and pain explains the intense burning experienced when lukewarm water is applied to feet that are numb from cold. Neural thermoreceptive pathways The processing of thermoreceptive information in the central nervous system of mammals begins in the dorsal horn of the spinal cord , where specialized neurons receive convergent input selectively from cold or warm thermoreceptors. Both warm- and cool-sensitive cells summate input from a large number of peripheral thermoreceptors over broad areas of skin. This summation is fundamental for overcoming ambiguous temperature responses received from individual thermoreceptors. In humans the brainstem midbrain, pons, and medulla oblongata and thalamus process information from spinal thermoreceptive neurons. The activity of these regions in the brain lead to thermal sensation. This activity is inhibited by warming but is stimulated by cooling, increasing in a linear fashion as temperature drops. In an inverse manner warm-sensitive spinal neurons have ongoing discharge that is inhibited by cooling.

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4: - Thermoreception and Temperature Regulation by BLIGH J. & VOIGT K

As indicated in the Preface, the contributions to this volume are based upon the papers presented at the symposium on Thermoreceptors and Temperature ReguläÂ- tion held in July at the Institute of Physiology of the University of Marburg (Federal Republic of Germany) to celebrate and commemorate.

In plants[edit] Thermogenesis occurs in the flowers of many plants in the Araceae family as well as in cycad cones. Heat is produced by breaking down the starch that was stored in their roots, [27] which requires the consumption of oxygen at a rate approaching that of a flying hummingbird. For example, the skunk cabbage is not frost-resistant, yet it begins to grow and flower when there is still snow on the ground. Desert lizards are ectotherms and so unable to metabolically control their temperature but can do this by altering their location. They may do this, in the morning only by raising their head from its burrow and then exposing their entire body. By basking in the sun, the lizard absorbs solar heat. It may also absorb heat by conduction from heated rocks that have stored radiant solar energy. To lower their temperature, lizards exhibit varied behaviors. Sand seas, or ergs , produce up to They also go to their burrows to avoid cooling when the sun goes down or the temperature falls. Aquatic animals can also regulate their temperature behaviorally by changing their position in the thermal gradient. In endotherms such as bats [31] and birds such as the mousebird [32] and emperor penguin [33] it allows the sharing of body heat particularly amongst juveniles. This allows the individuals to increase their thermal inertia as with gigantothermy and so reduce heat loss. Other animals exploit termite mounds. Their fur grows more densely to increase the amount of insulation. This minimizes heat loss through less insulated body parts, like the legs, feet or hooves , and nose. An ostrich can keep its body temperature relatively constant, even though the environment can be very hot during the day and cold at night. Hibernation, estivation and daily torpor[edit] To cope with limited food resources and low temperatures, some mammals hibernate during cold periods. To remain in "stasis" for long periods, these animals build up brown fat reserves and slow all body functions. Some bats are true hibernators and rely upon a rapid, non-shivering thermogenesis of their brown fat deposit to bring them out of hibernation. Estivation is similar to hibernation, however, it usually occurs in hot periods to allow animals to avoid high temperatures and desiccation. Both terrestrial and aquatic invertebrate and vertebrates enter into estivation. Examples include lady beetles Coccinellidae , [37] North American desert tortoises , crocodiles , salamanders , cane toads , [38] and the water-holding frog. Normal human temperature[edit] Main article: Normal human body temperature Previously, average oral temperature for healthy adults had been considered In Poland and Russia, the temperature had been measured axillary. Recent studies suggest that the average temperature for healthy adults is Variations one standard deviation from three other studies are: Monkeys also have a well-marked and regular diurnal variation of body temperature that follows periods of rest and activity, and is not dependent on the incidence of day and night; nocturnal monkeys reach their highest body temperature at night and lowest during the day. Sutherland Simpson and J. Galbraith observed that all nocturnal animals and birds â€” whose periods of rest and activity are naturally reversed through habit and not from outside interference â€” experience their highest temperature during the natural period of activity night and lowest during the period of rest day. Also, the curves obtained from rabbits, guinea pigs , and dogs were quite similar to those from man. Within 24 hours of ovulation, women experience an elevation of 0. The basal body temperature ranges between Variations due to fever[edit] Fever is a regulated elevation of the set point of core temperature in the hypothalamus , caused by circulating pyrogens produced by the immune system. To the subject, a rise in core temperature due to fever may result in feeling cold in an environment where people without fever do not. Variations due to biofeedback[edit] Some monks are known to practice Tummo , biofeedback meditation techniques, that allow them to raise their body temperatures substantially. In , it was reported that transgenic mice with a body temperature 0. This mechanism is due to overexpressing the uncoupling protein 2 in hypocretin neurons Hcrt-UCP2 , which elevated hypothalamic temperature, thus forcing the hypothalamus to lower body temperature. The mice were fed ad libitum. The effect of too extreme a cold is to decrease metabolism , and hence to lessen the production of heat. Both catabolic and anabolic pathways share in this metabolic depression, and, though less energy is used up, still less energy is generated. The effects of this diminished metabolism become telling on the central nervous system first, especially the brain and those parts concerning consciousness; [52] both heart rate and respiration rate decrease; judgment becomes impaired as drowsiness supervenes, becoming steadily deeper until the individual loses consciousness; without medical intervention, death by hypothermia quickly follows. Occasionally, however, convulsions may set in towards the end, and death is caused by asphyxia. Death appeared to be mainly due to asphyxia , and the only certain sign that it had taken place was the loss of knee-jerks. Blood that is too warm produces dyspnea by exhausting the metabolic capital of the respiratory centre;[citation needed] heart rate is increased; the beats then become arrhythmic and eventually cease. The central nervous system is also profoundly affected by hyperthermia and delirium , and convulsions may set in. Consciousness may also be lost, propelling the person into a comatose condition. These changes can sometimes also be observed in patients suffering from an acute fever. Vernon performed work on the death temperature and paralysis temperature temperature of heat rigor of various animals. He found that species of the same class showed very similar temperature values, those from the Amphibia examined being In higher animals, however, his experiments tend to show that there is greater variation in both the chemical and physical characteristics of the protoplasm and, hence, greater variation in the extreme temperature compatible with life. In addition, the mites are able to stop and change direction very quickly.

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6: Thermoreceptor - Wikipedia

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Thermoreception, sensory process by which different levels of heat energy (temperatures) in the environment and in the body are detected by animals.. Temperature has a profound influence upon living organisms.

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At older ages, the circadian rhythm of body temperature shows a decreased amplitude, an advanced phase, and decreased stability. The present review evaluates to what extent these changes may result from age-related deficiencies at several levels of the thermoregulatory system, including thermoreception, thermogenesis and conservation, heat loss, and central regulation.

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