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Glossary of terms for thermal physiology[1]

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PREFACE

THE PURPOSE of the Glossary is to improve precision of meaning and uniformity in the usage of technical terms in thermal physiology. Two circumstances in particular make this desirable: 1) the increasing use of English as the principal language for international scientific communication, and 2) the use of computers for rapid information processing and retrieval. The following paragraphs explain the use of the Glossary.

Units

Units used in the Glossary are based on the Systeme Internationale (SI). Where such units would be inconveniently small or large SI convention permits increases or decreases by multiples of 10^3, e.g., m to mm ($m \times 10^{-3}$) or to nm ($m \times 10^{-9}$), but not to cm ($m \times 10^{-2}$). The basic, supplementary, and derived SI units used in the Glossary are given in APPENDIX 1.

Symbols

The symbols used in the Glossary are listed in APPENDIX 2. These symbols conform generally to those specified in the "Proposed Standard System of Symbols for Thermal Physiology" (*J. Appl. Physiol.* 27: 439–446, 1969). Minor changes have been suggested. In the BODY HEAT BALANCE EQUATION, the symbol M is now used to denote METABOLIC FREE ENERGY PRODUCTION; METABOLIC HEAT PRODUCTION is identified by the symbol H. The symbol ϵ (epsilon) is now used for EMISSIVITY and not for EMITTANCE, and the term EXITANCE has replaced EMITTANCE (see American National Standards Institute, *Nomenclature and Definitions for Illuminating Engineering*, RP-16, 1967, p. 32 (UDC 653.104.8: 621.32)).

Order of Presentation of Terms

To bring similar or related terms closer together in the Glossary, the common term is given first followed by the

[1] The Glossary for Thermal Physiology follows the IUPS-approved "Proposed Standard System of Symbols for Thermal Physiology," published in the *Journal of Applied Physiology* 27: 439–446, 1969. Copies of both documents can be obtained by writing to Executive Editor, American Physiological Society, 9650 Rockville Pike, Bethesda, Md. 20014.

descriptive term, e.g., EMISSIVITY, HEMISPHERICAL. In use the order is reversed: HEMISPHERICAL EMISSIVITY. To avoid confusion such entries have a cross-reference, e.g., HEMISPHERICAL EMISSIVITY: *see* EMISSIVITY, HEMISPHERICAL.

Use of Capitals in Text

The use of capital letters in the definitions, explanatory notes, and list of symbols (APPENDIX 2) indicates that the term in capitals is defined elsewhere in the Glossary.

Abbreviations

cf.	compare	
e.g.	for example	
Fr.	French	
Gk.	Greek	
i.e.	that is	
L.	Latin	
OED	Oxford English Dictionary	
Ref	Reference	
SD	Standard Deviation	
SOED	Shorter OED	
( )	Symbols	
[ ]	Units	

Multiple Definitions

Where more than one definition of a term is given, they are listed in order of preference.

General References to Physical Terms, Units, and Symbols

American National Standard Institute, *Nomenclature and Definitions for Illuminating Engineering*, RP-16, 1967, UDC 653.014.8: 621.32.

Proposed Standard System of Symbols for Thermal Physiology. *J. Appl. Physiol.* 27: 439–446, 1969.

Quantities, Units and Symbols. London: The Royal Society, 1971.

Electrical Units and Standards. National Physical Laboratory. London: Her Majesty's Stationery Office, 1970.

Revision of the Glossary would seem to be desirable after about five years. For this to be effective, suggestions and criticisms are required from both users and nonusers of the Glossary. Communications concerning the Glossary may be sent to the Chairman of the International Commission for Thermal Physiology, c/o Executive Editor, American Physiological Society, 9650 Rockville Pike, Bethesda, Md. 20014.

ACKNOWLEDGMENTS

The editors have been greatly aided in their task by the contributions and constructive criticisms of an international panel of consultants which included the members of the IUPS Thermal Physiology Commission. The names of those who have helped are listed in APPENDIX 3. To these people and to any others whose contributions we have failed to acknowledge, we express our thanks. We are particularly grateful to Professor J. L. Monteith of Nottingham University, England, and Professor A. Pharo Gagge of Yale University, USA, for their painstaking scrutinies of the definitions of some of the physical units.

11 April 1972

John Bligh
K. G. Johnson

Glossary

ABSOLUTE HUMIDITY. *See* HUMIDITY, ABSOLUTE.

ABSORPTANCE, TOTAL RADIANT. *See* RADIANT ABSORPTANCE, TOTAL.

ACCLIMATION: A physiological change, occurring within the lifetime of an organism, which reduces the strain caused by experimentally induced stressful changes in particular climatic factors.

NOTE: The terms ACCLIMATION and ACCLIMATIZATION are etymologically indistinguishable. Both words have been assigned several and different meanings (Greenleaf & Greenleaf, 1970), and at present there can be no certainty as to what is meant when either term is used. The most useful of the assigned meanings, adopted here, would seem to be those of Hart (1957) and Eagan (1963) who use the term ACCLIMATION to describe the adaptive changes which occur within the lifetime of an organism in response to experimentally induced changes in *particular climatic factors* such as ambient temperature in a controlled environment, and the term ACCLIMATIZATION to describe the adaptive changes which occur within the lifetime of an organism in response to changes in the natural climate. Refs: EAGAN, C. J., *Federation Proc.* 22: 930, 1963; GREENLEAF, J. E., & C. J. GREENLEAF, *NASA Tech. Mem.* X-62, 008, 1970; HART, J. S., *Rev. Can. Biol.* 16: 133, 1957.

ACCLIMATIZATION: A physiological change occurring within the lifetime of an organism which reduces the strain caused by stressful changes in the natural climate (e.g., seasonal or geographical). *See* ACCLIMATION.

ADAPTATION: A change which reduces the physiological strain produced by a stressful component of the TOTAL ENVIRONMENT. This change may occur within the lifetime of an organism (phenotypic) or be the result of genetic selection in a species or subspecies (genotypic).

NOTE: ACCLIMATION and ACCLIMATIZATION, as defined in this Glossary, relate to phenotypic adaptations to climatic components of the TOTAL ENVIRONMENT. There are no distinct terms which relate to genotypic adaptations to the climate or to particular components of climate. All such genetically fixed attributes of a species or subspecies are covered by the general term GENOTYPIC ADAPTATION.

ADAPTATION, GENETIC. *See* ADAPTATION, GENOTYPIC.

ADAPTATION, GENOTYPIC: A genetically fixed condition of a species or subspecies, or its evolution, which favors survival in a particular TOTAL ENVIRONMENT. *See* ADAPTATION.

ADAPTATION, NONGENETIC. *See* ADAPTATION, PHENOTYPIC.

ADAPTATION, PHENOTYPIC: A change which reduces the physiological strain produced by a stressful component of the TOTAL ENVIRONMENT and occurring within the lifetime of the organism. Synonym: ADAPTATION, NONGENETIC.

NOTE: ACCLIMATION and ACCLIMATIZATION relate to PHENOTYPIC ADAPTATIONS to climatic components of the TOTAL ENVIRONMENT.

AESTIVATION. *See* ESTIVATION.

ALLIESTHESIA (general): The changed sensation for a given peripheral stimulus resulting from the stimulation of internal sensors; (in thermal physiology): the dependence of thermal sensation on both skin and core temperatures. (Gk. *alloioo*—to alter; *aisthesia*—sensation.)

NOTE: Positive ALLIESTHESIA indicates a change to a more pleasurable sensation, negative ALLIESTHESIA a change to a less pleasurable one.

AMBIENT TEMPERATURE. *See* TEMPERATURE, AMBIENT.

ANAEROBIC METABOLISM. *See* METABOLISM, ANAEROBIC.

AREA, DUBOIS (A_D): The total surface area in square meters of a nude human as estimated by the formula of DuBois based on the height, H[m], and weight, W[kg].

$$A_D = 0.202\ W^{0.425}\ H^{0.725} \qquad [m^2]$$

AREA, EFFECTIVE RADIATING (A_r): The surface area of a body that exchanges radiant energy with the environment through a solid angle of 4π steradians. [m^2]

AREA, PROJECTED (A_p): The area of a body (or surface) projected on a plane perpendicular to the direction of a collimated beam of radiation. [m^2]

AREA, SOLAR RADIATION (A_s): The area of a body projected normally to the sun's rays. [m^2]

AREA, TOTAL BODY (A_b): The area of the outer surface of a body, assumed smooth. [m^2]

NOTE: Direct measurements of surface area are difficult and subject to appreciable error. Surface area is usually estimated from a formula such as that of Meeh (1879) which relates TOTAL BODY AREA (A_b) to body weight (W): $A_b = k \cdot W^{2/3}$. This is a particular case of Huxley's allometric law. Estimates of the value of k vary widely between and within species but are generally between 0.07 and 0.11 when A_b is in m^2 and W is in kg (Spector, 1956). The DuBois formula (*see* AREA, DUBOIS), used in the estimation of the total body area of man, relates total body area to both weight and height. Estimates of total body area made with either Meeh's formula or the DuBois formula have limited accuracy, and reference should be made to the original direct measurements of total body area from which they were calculated. Refs: HUXLEY, J. S., *Problems of Relative Growth*, London: Methuen, 1932; MEEH, K., *Z. Biol.* 15: 425, 1879; SPECTOR, W. S., *Handbook of Biological Data*, Philadelphia, Pa.: Saunders, 1956.

AREA, WETTED (A_w): The area of skin which, if covered with sweat, would provide the observed rate of evaporation under the prevailing condition. [m^2] *See also* WETTEDNESS, SKIN.

AUTONOMIC TEMPERATURE REGULATION. *See* TEMPERATURE REGULATION, AUTONOMIC.

AUTONOMIC THERMOREGULATION. *See* TEMPERATURE REGULATION, AUTONOMIC.

BACTERIAL PYROGEN. *See* PYROGEN, BACTERIAL.

BASAL METABOLIC RATE. *See* METABOLIC RATE, BASAL.

BEHAVIORAL TEMPERATURE REGULATION. *See* TEMPERATURE REGULATION, BEHAVIORAL.

BEHAVIORAL THERMOREGULATION. *See* TEMPERATURE REGULATION, BEHAVIORAL.

BLACKBODY. *See* RADIATOR, FULL.

BODY HEAT BALANCE: The steady-state relation in which heat production in the body equals heat loss to the environment.

BODY HEAT BALANCE EQUATION: A mathematical expression that describes the net rate at which a body generates and exchanges heat with its environment (First Law of Thermodynamics):

$$S = M \pm E - (\pm W) \pm R \pm C \pm K \qquad [W] \text{ or } [W \cdot m^{-2}]$$

in which

S = rate of STORAGE OF BODY HEAT (+ for net gain by body)
M = METABOLIC FREE ENERGY PRODUCTION (always +)
E = EVAPORATIVE HEAT TRANSFER (− for net loss)
W = WORK (+ for POSITIVE WORK against external forces)
R = RADIANT HEAT EXCHANGE (+ for net gain)
C = CONVECTIVE HEAT TRANSFER (+ for net gain)
K = CONDUCTIVE HEAT TRANSFER (+ for net gain)

NOTE: EVAPORATIVE HEAT TRANSFER most frequently occurs by vaporization of water from the body and is EVAPORATIVE HEAT LOSS ($-E$):

in some circumstances vapor can condense on the body causing EVAPORATIVE HEAT GAIN ($+E$). In terms of body heat balance, POSITIVE WORK ($+W$) is the transfer of energy from the body to an external system and is therefore a loss of energy, represented in the equation as $-(+W)$ or a loss W; conversely NEGATIVE WORK ($-W$) is the transfer of energy from an external system to the body and is therefore a gain of energy, represented in the equation as $-(-W)$ or a gain W.

BODY HEAT CONTENT. *See* HEAT CONTENT, BODY.

BODY HEAT STORAGE. *See* STORAGE OF BODY HEAT and HEAT STORAGE.

BRADYMETABOLISM: The low levels of basal metabolism of reptiles and other nonavian and nonmammalian animals relative to those of birds and mammals of the same body size and at the same tissue temperature. (Gk. *bradus*—slow, sluggish; *metabole*—change.) Antonym: TACHYMETABOLISM.

NOTE: As a synonym COLD-BLOODEDness is unsatisfactory and is falling into disuse. This relatively low level of basal metabolism is sometimes described as POIKILOTHERMY, which is incorrect since poikilothermy signifies conformity of body and ambient temperatures and not all bradymetabolic species are TEMPERATURE CONFORMERS: some are ECTOTHERMIC TEMPERATURE REGULATORS.

CALORIMETRY: The measurement of heat. In thermal physiology, the measurement of the heat transfer between a tissue, an organ, or an organism and its environment. (L. *calor*—heat; Gk. *metria*—act of measuring.) *See* CALORIMETRY, DIRECT and CALORIMETRY, INDIRECT.

CALORIMETRY, DIRECT: The direct physical measurement of heat, usually the rate of transfer of heat between a tissue, an organ, or an organism and its environment.

CALORIMETRY, INDIRECT: The measurement of the rate of transfer of a material involved in the transformation of chemical energy into heat between a tissue, an organ, or an organism and its environment. The process requires the calculation of the heat transfer from an empirically established relation between the material transfer and the heat transfer.

NOTE: The most common method of INDIRECT CALORIMETRY is to measure the uptake of oxygen and/or the elimination of carbon dioxide, and to convert these values to an equivalent quantity of heat.

CALORIMETRY, PARTITIONAL: The estimation of any single term in the BODY HEAT BALANCE EQUATION from direct measurements of all other terms in the equation during the steady state. Ref: WINSLOW, C.-E. A., L. P. HERRINGTON, & A. P. GAGGE, *Am. J. Physiol.* 116: 641, 1936.

CENOTHERMY: The condition of a temperature-regulating organism when within ± 1 SD of the mean core temperature of the species measured under resting conditions in a thermoneutral environment. (Gk. *koinos*—common, shared, *therme*—heat.) Synonym: EUTHERMY, NORMOTHERMY.

NOTE: *Ceno* (common) seems a more appropriate prefix than *eu* (well, good).

CHANGE IN HEAT STORAGE. *See* HEAT STORAGE, CHANGE IN.

CHEMICAL TEMPERATURE REGULATION. *See* TEMPERATURE REGULATION, CHEMICAL.

CIRCADIAN: Relating to the approximate 24-h periodicity of a free-running biological rhythm, or to the exact 24-h periodicity of an environmentally synchronized biological rhythm which persists with an approximate 24-h periodicity when not environmentally synchronized. (L. *circa*—about, approximately; *dies*—day.)

CLO: A unit to express the relative thermal insulation values of various clothing assemblies.

$$1 \text{ clo} = 0.18\,^{\circ}\text{C}\cdot\text{m}^2\cdot\text{h}\cdot\text{kcal}^{-1} = 0.155\,^{\circ}\text{C}\cdot\text{m}^2\cdot\text{W}^{-1}$$

NOTE: The CLO is a unit developed to express thermal insulation in practical terms and represents the insulation provided by the normal indoor clothing of a sedentary worker in comfortable indoor surroundings (Ref: GAGGE, A. P., A. C. BURTON, & H. C. BAZETT, *Science* 94: 428, 1941). The term is used in heating and ventilation engineering in the determination of environmental conditions for human comfort.

COLD-BLOODED: The thermal state of an animal in which core temperature remains close to ambient temperature when subjected to a low ambient temperature. Synonym: BRADYMETABOLIC, POIKILOTHERMIC. Antonym: WARM-BLOODED.

NOTE: The existence of only a small temperature gradient between the organism and its environment results from the low rate of metabolic heat production (BRADYMETABOLISM) of cold-blooded animals relative to the high rate of heat production (TACHYMETABOLISM) of warm-blooded animals. Thus the terms BRADYMETABOLIC and TACHYMETABOLIC are preferred to the terms COLD-BLOODED and WARM-BLOODED, because the first pair of terms relates to a more basic physiological distinction and because the second pair of terms has been used with various meanings not all of which are entirely consistent with the definitions given here. Since their core temperatures follow ambient temperature, all cold-blooded animals are POIKILOTHERMIC (i.e., many temperatured). Thus COLD-BLOODED, POIKILOTHERMIC, and BRADYMETABOLIC are descriptions of related phenomena. The same cannot be said of WARM-BLOODED, HOMEOTHERMIC, and TACHYMETABOLIC (*see* WARM-BLOODED).

COMBINED NONEVAPORATIVE HEAT TRANSFER COEFFICIENT. *See* HEAT TRANSFER COEFFICIENT, COMBINED NONEVAPORATIVE.

COMFORT. *See* THERMAL COMFORT.

CONDUCTANCE, THERMAL. *See* THERMAL CONDUCTANCE.

CONDUCTIVE HEAT TRANSFER (K): The net rate of heat transfer by conduction between an organism and its environment, usually expressed in terms of unit area of the total body surface. The quantity K in the BODY HEAT BALANCE EQUATION in which $+K$ = heat gain, and $-K$ = heat loss. [$W \cdot m^{-2}$] or [W]

CONDUCTIVE HEAT TRANSFER COEFFICIENT. *See* HEAT TRANSFER COEFFICIENT, CONDUCTIVE.

CONDUCTIVITY, THERMAL. *See* THERMAL CONDUCTIVITY.

CONTROLLED TEMPERATURE LABILITY. *See* TEMPERATURE LABILITY, CONTROLLED.

CONVECTION, FORCED: Fluid movement along pressure gradients induced by forces such as wind, fans, and blowers.

CONVECTION, NATURAL: Movement in a fluid medium induced by gravitational forces caused by differences of density associated with changes in temperature of the medium.

CONVECTIVE HEAT TRANSFER (C): The net rate of heat transfer by convection between an organism and its environment, usually expressed in terms of unit area of the total body surface. The quantity C in the BODY HEAT BALANCE EQUATION in which $+C$ = heat gain and $-C$ = heat loss. [$W \cdot m^{-2}$] or [W]

CONVECTIVE HEAT TRANSFER COEFFICIENT. *See* HEAT TRANSFER COEFFICIENT, CONVECTIVE.

CONVECTIVE MASS TRANSFER. *See* MASS TRANSFER, CONVECTIVE.

CORE TEMPERATURE. *See* TEMPERATURE, CORE.

CRITICAL TEMPERATURE FOR EVAPORATIVE HEAT LOSS. *See* CRITICAL TEMPERATURE, UPPER.

CRITICAL TEMPERATURE FOR HEAT PRODUCTION. *See* CRITICAL TEMPERATURE, LOWER.

CRITICAL TEMPERATURE, LOWER: The ambient temperature below which the rate of metabolic heat production of a resting thermoregulating animal increases by shivering and/or nonshivering thermogenic processes to maintain thermal balance. Synonym: CRITICAL TEMPERATURE FOR HEAT PRODUCTION. [°C]

CRITICAL TEMPERATURE, UPPER: 1. The ambient temperature above which thermoregulatory evaporative heat loss processes (e.g., THERMAL TACHYPNEA, SWEATING) of a resting thermoregulating animal are recruited (preferred usage). Synonym: CRITICAL TEMPERATURE FOR EVAPORATIVE HEAT LOSS. 2. The ambient temperature above which there is an increase in metabolic rate due to a rise in the core temperature of a resting thermoregulating animal. [°C]

CRYOTHERMY: The thermal status of a supercooled organism (i.e., with the temperature of the body mass below the freezing point of the tissue). (Gk. *kruos*—cold; *therme*—heat.)

CUTANEOUS WATER EXCHANGE, PASSIVE. *See* PASSIVE CUTANEOUS WATER EXCHANGE.

CUTANEOUS WATER VAPOR EXCHANGE, PASSIVE. *See* PASSIVE CUTANEOUS WATER VAPOR EXCHANGE.

DEEP BODY TEMPERATURE. *See* TEMPERATURE, CORE

DENSITY (ρ): The ratio of the mass to the volume of a substance. [$kg \cdot m^{-3}$]

DEW-POINT TEMPERATURE. *See* TEMPERATURE, DEW-POINT.

DIFFUSIVITY, MASS (D): The constant of proportionality relating the rate of diffusion of a gas to the gradient of its concentration in another gas, e.g., water vapor in air. If the rate of diffusion of mass is $\dot{m}$ [$kg \cdot s^{-1}$] in a direction specified by a coordinate y [m] and if the concentration over a plane at a given value of y is ρ [$kg \cdot m^{-3}$], the flux through an area A is given by the Fickian equation, $\dot{m} = -DA(\delta\rho/\delta y)$, where D is the MASS DIFFUSIVITY or diffusion coefficient and $\delta\rho/\delta y$ is the appropriate concentration gradient. More complex equations are needed to describe diffusion in two or three directions simultaneously. [$m^2 \cdot s^{-1}$]

DIFFUSIVITY, THERMAL (α): The thermal conductivity of a substance divided by its density (ρ) and specific heat at constant pressure (c_p). [$m^2 \cdot s^{-1}$]

DIRECT CALORIMETRY. *See* CALORIMETRY, DIRECT.

DIRECTIONAL EMISSIVITY. *See* EMISSIVITY, DIRECTIONAL.

DIURNAL: 1. Occurring during the day, as distinct from the night. Antonym: NOCTURNAL. 2. Occurring daily (during each 24-h period). (L. *diurnus* adj < *dies*—day.)

DRY BULB TEMPERATURE. *See* TEMPERATURE, DRY BULB.

DRY HEAT LOSS. *See* HEAT LOSS, NONEVAPORATIVE.

DUBOIS AREA. *See* AREA, DUBOIS.

ECCRITIC BODY TEMPERATURE. *See* PREFERRED BODY TEMPERATURE.

ECTOTHERMY: The pattern of thermoregulation in which the body temperature depends on the behav-

iorally and autonomically regulated uptake of heat from the environment. (Gk. *ektos*—outside; *therme*—heat.) Antonym: ENDOTHERMY.

EFFECTIVE RADIANT FIELD. *See* RADIANT FLUX, EFFECTIVE.

EFFECTIVE RADIANT FLUX. *See* RADIANT FLUX, EFFECTIVE.

EFFECTIVE RADIATING AREA. *See* AREA, EFFECTIVE RADIATING.

EFFECTIVE TEMPERATURE. *See* TEMPERATURE, EFFECTIVE.

EMISSIVITY (ϵ): The ratio of the total RADIANT ENERGY emitted by a body to the energy emitted by a FULL RADIATOR at the same temperature.

EMISSIVITY, DIRECTIONAL ($\epsilon_{(\theta,\phi)}$): The ratio of the THERMAL RADIANCE ($L_{e,th}$) of a body in a given direction to that of a FULL RADIATOR ($L_{e,(\epsilon=1)}$) at the same temperature.

$$\epsilon_{(\theta,\phi)} = L_{e,th}(\theta,\phi)/L_{e,(\epsilon=1)}$$

in which θ and ϕ are the angular coordinates defining the given direction.

EMISSIVITY, HEMISPHERICAL (ϵ_h): The ratio of the total RADIANT ENERGY emitted by an element of a surface into a hemisphere to the energy emitted by a similar element on the surface of a FULL RADIATOR. The element forms the center of the equatorial plane of the hemisphere, but it is not necessary to define its radius.

EMISSIVITY, SPECTRAL (ϵ_λ): The ratio of the RADIANT FLUX emitted by an element of surface per unit wavelength interval to the flux emitted by a FULL RADIATOR at the same temperature and in the same waveband.

EMISSIVITY, WINDOW (ϵ_w): The ratio of the RADIANT ENERGY emitted by an element of surface between wavelengths λ_1 and λ_2 to the flux emitted by a FULL RADIATOR at the same temperature and in the same waveband. The quantity is a special type of SPECTRAL EMISSIVITY and is used because some biological materials have a low emissivity in parts of the infrared or visible spectrum. These parts are known as windows.

EMITTANCE. *See* RADIANT EXITANCE.

ENDOGENOUS PYROGEN. *See* PYROGEN, ENDOGENOUS.

ENDOTHERMY: The pattern of thermoregulation in which the body temperature depends on a high (TACHYMETABOLIC) and controlled rate of heat production. (Gk. *endo*—inside; *therme*—heat.) Antonym: ECTOTHERMY.

NOTE: The use of endothermy to denote the production of heat within an organ or organism is etymologically correct but may be found confusing as the same term is used in chemistry to mean the *uptake* of heat during a chemical reaction.

ENDOTOXIC PYROGEN. *See* ENDOTOXIN.

ENDOTOXIN: A heat-stable PYROGEN derived from the cell walls of gram-negative bacteria.

NOTE: Chemically, all ENDOTOXINS so far examined contain lipopolysaccharides of high molecular weight.

ENERGY METABOLISM. *See* METABOLISM, ENERGY.

ENVIRONMENT. *See* TOTAL ENVIRONMENT.

ESTIVATION: A state of summer lethargy with a reduction in body temperature and metabolism demonstrated by some animals which are TEMPERATURE REGULATORS when active. (L. *aestivus* adj < *aestas*—summer.)

EURYTHERMY: The tolerance by organisms of a wide range of environmental temperatures, or the accommodation to substantial changes in the thermal environment. (Gk. *eurus*—wide; *therme*—heat.) Antonym: STENOTHERMY.

EUTHERMY. *See* CENOTHERMY.

EVAPORATIVE HEAT GAIN ($+E$): The rate of total heat gain due to condensation of vapor on the skin and/or the surfaces of the respiratory tract, expressed in terms of unit area of total body surface. The quantity $+E$ in the BODY HEAT BALANCE EQUATION. [$W \cdot m^{-2}$] or [W]

NOTE: EVAPORATIVE HEAT TRANSFER most frequently occurs by vaporization of water from the body and is EVAPORATIVE HEAT LOSS ($-E$); in some circumstances vapor can condense on the body causing EVAPORATIVE HEAT GAIN ($+E$).

EVAPORATIVE HEAT LOSS ($-E$): The rate of total heat loss by evaporation of water from the skin and the surfaces of the respiratory tract, usually expressed in terms of unit area of total body surface. The quantity $-E$ in the BODY HEAT BALANCE EQUATION. [$W \cdot m^{-2}$] or [W]

EVAPORATIVE HEAT LOSS COEFFICIENT. *See* HEAT LOSS COEFFICIENT, EVAPORATIVE.

EVAPORATIVE HEAT TRANSFER (E): The rate of heat transfer by evaporation from or condensation on the skin and the surfaces of the respiratory tract, usually expressed in terms of unit area of total body surface. In the BODY HEAT BALANCE EQUATION, evaporation and heat loss from the body are indicated by ($-E$), condensation and heat gain to the body by ($+E$). [$W \cdot m^{-2}$] or [W]

EXITANCE. *See* RADIANT EXITANCE.

FEVER: A pathological condition in which there is an abnormal rise in core temperature. The extent of the rise is variable. The temperature rise in an individual may be considered as fever when it is greater than the

mean SD for the species in basal conditions. FEVER is distinct from HYPERTHERMIA in that all thermoregulatory responses indicate a defense of the feverish level of core temperature. There is no evidence that fever, due to the elevation of body temperature alone, can be lethal. Pathological, malignant HYPERTHERMIAs of endogenous origin may be fatal in susceptible patients given anesthetics such as halothane. These HYPERTHERMIAs are characterized by very rapid, uncontrolled rises in core temperature.

FORCED CONVECTION. *See* CONVECTION, FORCED.

FULL RADIATOR. *See* RADIATOR, FULL.

GENETIC ADAPTATION. *See* ADAPTATION, GENOTYPIC.

GENOTYPIC ADAPTATION. *See* ADAPTATION, GENOTYPIC.

GLOBE TEMPERATURE. *See* TEMPERATURE, GLOBE.

GULAR FLUTTERING: The rapid oscillations of the hyoid apparatus and hence of the gular region of some birds during exposure to high ambient temperature, by which means air is moved across the moist surfaces of the upper respiratory tract.

HABITUATION: Reduction of responses to or perception of repeated stimulation.

HEAT BALANCE EQUATION. *See* BODY HEAT BALANCE EQUATION.

HEAT CAPACITY: The product of the mass of an object and its SPECIFIC HEAT. [$J \cdot °C^{-1}$]

HEAT CONTENT, BODY: The product of the body mass, its average SPECIFIC HEAT, and the absolute MEAN BODY TEMPERATURE. [J]

NOTE: The actual value of this term is seldom calculated. It is used only in the determination of HEAT STORAGE. *See also* STORAGE OF BODY HEAT.

HEAT CRAMPS: Painful spasms of voluntary muscles related to salt deficiency caused by profuse sweating in response to prolonged heat stress.

HEAT EXHAUSTION: Muscular weakness, fatigue, and distress, with reduced sweating, resulting from prolonged exposure to heat. This condition is aggravated by muscular exertion and by water or salt deficiency.

HEAT FLOW: The rate of thermal energy transmission from a region of higher to one of lower temperature. [W]

HEAT FLUX DENSITY: Thermal energy passing through unit area of a given surface in unit time. [$W \cdot m^{-2}$]

HEAT LOSS: The rate of heat transfer from an organism to the environment, or from one part of an organism to another, by conduction, convection, radiation, evaporation, or a combination of these.

HEAT LOSS COEFFICIENT, EVAPORATIVE. *See* HEAT TRANSFER COEFFICIENT, EVAPORATIVE.

HEAT LOSS, DRY. *See* HEAT LOSS, NONEVAPORATIVE.

HEAT LOSS, NEWTONIAN. *See* HEAT LOSS, NONEVAPORATIVE.

HEAT LOSS, NONEVAPORATIVE: The sum of heat losses by radiation, convection, and conduction per unit area of body surface in unit time. [$W \cdot m^{-2}$] Synonyms: HEAT LOSS, DRY; HEAT LOSS, SENSIBLE; HEAT LOSS, NEWTONIAN.

NOTE: In meteorological literature, SENSIBLE HEAT LOSS refers to convection only and does not include other nonevaporative forms of heat transfer.

HEAT LOSS, SENSIBLE. *See* HEAT LOSS, NONEVAPORATIVE.

HEAT, SPECIFIC. *See* SPECIFIC HEAT.

HEAT STORAGE, CHANGE IN: The gain or loss of heat associated with change in body temperature or body mass. Rate [W], Level [$W \cdot s$] or [J] *See also* STORAGE OF BODY HEAT.

HEAT STROKE: A condition caused by an excessive rise in body temperature as the result of overloading or failure of the thermoregulatory system during exposure to heat stress. It is characterized by a sudden and sustained loss of consciousness and may be preceded by vertigo, nausea, headache, muscular cramps, and cessation of sweating.

HEAT SYNCOPE: Collapse, usually with loss of consciousness, during exposure to heat. The symptoms are similar to those of the vasovagal syndrome (fainting).

HEAT TRANSFER COEFFICIENT, COMBINED NONEVAPORATIVE (h): The ratio of total rate of heat transfer per unit area by radiation, convection, and conduction to the temperature difference between the surface and operative temperature of the environment.

$$h = h_r + h_c + h_k \qquad [W \cdot m^{-2} \cdot °C^{-1}]$$

HEAT TRANSFER COEFFICIENT, CONDUCTIVE (h_k): The net rate of heat transfer by conduction per unit area between a surface and a solid or stationary fluid in contact with the surface per unit temperature difference (ΔT) between the surface and the substance with which it is in contact.

$$h_k = K\Delta T^{-1} \qquad [W \cdot m^{-2} \cdot °C^{-1}]$$

HEAT TRANSFER COEFFICIENT, CONVECTIVE (h_c): The net rate of heat transfer per unit area between a surface and a moving fluid per unit temperature difference (ΔT) between the surface and the fluid.

$$h_c = C\Delta T^{-1} \qquad [W \cdot m^{-2} \cdot °C^{-1}]$$

HEAT TRANSFER COEFFICIENT, EVAPORATIVE

(h_e). The rate of heat exchange per unit vapor pressure gradient caused by the evaporation of water from a unit area of wet surface or by the condensation of water vapor on a unit area of body surface. The driving force is the VAPOR PRESSURE gradient from P_{ws} (on the surface) to P_{wa} (of the ambient gas). Thus

$$h_e = -E(P_{ws} - P_{wa})^{-1} \text{ or } +E(P_{wa} - P_{ws})^{-1}$$

$$[W \cdot m^{-2} \cdot Pa^{-1}] \text{ or } [W \cdot m^{-2} \cdot Torr^{-1}]$$

In terms of the LATENT HEAT (λ) of water, the gas constant for water vapor (R_w), the mean temperature (T) of the medium in °K and the MASS TRANSFER COEFFICIENT (h_D)

$$h_e = h_D \lambda R_w^{-1} T^{-1}$$

NOTE: In most physiological applications the VAPOR PRESSURE gradient instead of the concentration gradient can be considered as the driving potential for the evaporative process since the temperature difference between the evaporating surface and the ambient air is small in relation to the average temperature of the surface-water vapor medium.

HEAT TRANSFER COEFFICIENT, RADIATIVE: The net rate of heat transfer per unit area by the exchange of thermal radiation between two surfaces, per unit temperature difference between the surfaces. $[W \cdot m^{-2} \cdot °C^{-1}]$

HEAT TRANSFER COEFFICIENT, RADIATIVE (LINEAR) (h_r): According to the Stefan-Boltzmann Law, the exchange of radiation between two black surfaces at temperatures T_1 and T_2 [°K] is proportional to σT^4, where σ is the Stefan-Boltzmann constant. When the ratio $(T_1 - T_2)/T$ is small, where $T = (T_1 + T_2)/2$, $\sigma(T_1^4 - T_2^4) \leqq 4\sigma T^3 \cdot (T_1 - T_2)$ and the term $4\sigma T^3$ can be treated as a linear heat transfer coefficient. $[W \cdot m^{-2} \cdot °C^{-1}]$

HELIOTHERMY: The regulation of the core temperature of an ectothermic animal by behavioral variation in exposure to solar radiation. (Gk. *helios*—the sun; *therme*—heat.)

HEMISPHERICAL EMISSIVITY. *See* EMISSIVITY, HEMISPHERICAL.

HETEROTHERMY: The pattern of temperature regulation in a TACHYMETABOLIC species in which the variation in core temperature, either nychthemerally or seasonally, exceeds that which defines HOMEOTHERMY. (Gk. *hetero*—different; *therme*—heat.)

NOTE: This is an arbitrary term in two senses: i) because *hetero* = a difference from (i.e., a difference between two) rather than a wide range, and ii) because the distinction that is being made between thermostable and rather less thermally stable species depends on an arbitrary division. *See*: 1. POIKILOTHERMY (diversified temperatures) although etymologically satisfactory has already been given a more restricted meaning. 2. STENOTHERMY (narrow temperature range) and EURYTHERMY (wide temperature range) would have suited the circumstance well, but these terms are already in use to describe the patterns of thermoregulation of animals which occur in narrow ranges and wide ranges of ambient temperature.

HIBERNATION: The state of winter lethargy with a reduction in body temperature and metabolism of some animals that are TEMPERATURE REGULATORS when active. (L. *hibernare*—to pass the winter.)

HOMEOTHERMY: The pattern of temperature regulation in a TACHYMETABOLIC species in which the cyclic variation in core temperature, either nychthemerally or seasonally, is maintained within arbitrarily defined limits (±2°C) despite much larger variations in ambient temperature. (Gk. *homoio*—like, resembling; *therme*—heat.) Synonym: HOMOIOTHERMY.

HOMOIOTHERMY. *See* HOMEOTHERMY.

HUMIDITY, ABSOLUTE (γ): Mass of water vapor in air per unit volume of air/water vapor mixture. $[kg \cdot m^{-3}]$

HUMIDITY, RELATIVE (ϕ): The ratio of the mol fraction of water vapor present in a volume of air to the mol fraction present in saturated air, both at the same temperature and pressure; in thermal physiology, the ratio of the saturated vapor pressure at the dew-point temperature ($P_{s,dp}$) of the enclosure to the saturated vapor pressure at its dry bulb temperature ($P_{s,db}$). [ND] When the RELATIVE HUMIDITY is expressed as a percentage, the symbol is (rh).

HYPERPNEA, THERMAL. *See* THERMAL HYPERPNEA.

HYPERTHERMIA: The condition of a temperature-regulating animal when the core temperature is more than one standard deviation (1 SD) above the mean core temperature of the species in resting conditions in a thermoneutral environment. (Gk. *hyper*—over; *therme*—heat.)

NOTE: HYPERTHERMIA need not be a febrile state, e.g., the hyperthermia of exercise, but FEVER is a hyperthermic state. In nonpathological hyperthermia, the regulatory centers might be functioning normally but the heat load may be too great to be compensated by equal heat loss without a rise in core temperature of more than 1 SD above the mean for the species.

HYPOTHERMIA: The condition of a temperature-regulating animal when the core temperature is more than one standard deviation (1 SD) below the mean core temperature of the species in resting conditions in a thermoneutral environment. (Gk. *hypo*—under, beneath; *therme*—heat.)

INDIRECT CALORIMETRY. *See* CALORIMETRY, INDIRECT.

INSENSIBLE PERSPIRATION: The mass of water passing through the skin by diffusion per unit area in unit time. $[kg \cdot m^{-2} \cdot s^{-1}]$ Synonym: PASSIVE CUTANEOUS WATER VAPOR EXCHANGE.

NOTE: Hitherto, rates of insensible perspiration and of sweating have been expressed most commonly in [$g \cdot m^{-2} \cdot h^{-1}$], but this does not conform with SI conventions. The most convenient SI term appears to be [$mg \cdot m^{-2} \cdot s^{-1}$] (3.6 $g \cdot m^{-2} \cdot h^{-1}$ = 1 $mg \cdot m^{-2} \cdot s^{-1}$).

INSENSIBLE WATER LOSS: The sum of the water lost by diffusion through the skin and water lost in breathing, and excluding any water excreted (e.g., in sweat, urine, feces). [$kg \cdot s^{-1}$] or [$kg \cdot m^{-2} \cdot s^{-1}$]

INSULATION. *See* THERMAL RESISTANCE.

IRRADIANCE (E): The RADIANT FLUX incident on or passing through unit area of a surface. [$W \cdot m^{-2}$]

LATENT HEAT OF VAPORIZATION (λ): The quantity of heat released (or absorbed) in the reversible process of evaporation (or condensation) of unit mass of liquid (or vapor) under isobaric and isothermal equilibrium conditions. [$J \cdot kg^{-1}$]

LEAST OBSERVED METABOLIC RATE. *See* METABOLIC RATE, LEAST OBSERVED.

LEUKOCYTIC PYROGEN. *See* PYROGEN, LEUKOCYTIC.

LOWER CRITICAL TEMPERATURE. *See* CRITICAL TEMPERATURE, LOWER.

LOWER TEMPERATURE SURVIVAL LIMIT. *See* TEMPERATURE SURVIVAL LIMIT, LOWER.

MASS DIFFUSIVITY. *See* DIFFUSIVITY, MASS.

MASS TRANSFER COEFFICIENT (DIFFUSION) (h_D): The rate of mass transfer ($\dot{m}$) from a vaporizing liquid (usually water) to a moving gas (usually air) in contact with it, per unit area (A) of the liquid surface and per unit difference between the vapor density (saturated) at the surface (ρ_{wa}) and the vapor density of the ambient gas (ρ_{wa}), expressed in the equation

$$h_D = \dot{m}A^{-1}(\rho_{ws} - \rho_{wa})^{-1} \qquad [m \cdot s^{-1}]$$

See HEAT TRANSFER COEFFICIENT, EVAPORATIVE.

MASS TRANSFER, CONVECTIVE: The transport by convection of one component of a nonreactive mixture (usually air-water) across an interface caused by a concentration gradient often accompanied by a transformation of phase and by a simultaneous transfer of heat.

MASS TRANSFER RATE ($\dot{m}$): The rate of transfer of mass. [$kg \cdot s^{-1}$]

MAXIMUM METABOLIC RATE. *See* METABOLIC RATE, MAXIMUM.

MAXIMUM OXYGEN CONSUMPTION. *See* OXYGEN CONSUMPTION, MAXIMUM.

MEAN BODY TEMPERATURE. *See* TEMPERATURE, MEAN BODY.

MEAN RADIANT TEMPERATURE. *See* TEMPERATURE, MEAN RADIANT.

MEAN SKIN TEMPERATURE. *See* TEMPERATURE, MEAN SKIN.

MET: An assigned unit of measurement to designate "sitting-resting" metabolic rate of man.

$$1 \text{ met} = 58.15 \text{ W} \cdot \text{m}^{-2} = 50 \text{ kcal} \cdot \text{h}^{-1} \cdot \text{m}^{-2}$$

It is an empirical unit of measurement to express the metabolic rate of a man whose clothing has an insulative value of 1 CLO when he is sitting at rest in comfortable indoor surroundings (21°C).

METABOLICALLY EFFECTIVE BODY WEIGHT: *See* METABOLIC BODY SIZE (preferred synonym).

NOTE: The term METABOLICALLY EFFECTIVE BODY WEIGHT may be wrongly understood to be that part of the body weight which is metabolically active in contrast to a part that is metabolically inert. Its use is better avoided.

METABOLIC BODY SIZE: The function of an animal's body size to which STANDARD (or BASAL) METABOLIC RATE is directly proportional. Synonym: METABOLICALLY EFFECTIVE BODY WEIGHT.

NOTE: Metabolic body size is often calculated using body weight raised to a power as in the expression $M = aW^b$, where W^b is the METABOLIC BODY SIZE. That the metabolic rate of adult animals (both TACHYMETABOLIC and BRADYMETABOLIC) changes in proportion to the $\frac{3}{4}$ power of body weight is an empirically established fact, and the use of $W^{3/4}$ as the METABOLIC BODY SIZE permits comparisons to be made between the metabolic levels of different animals. When $W^{2/3}$ is used, this implies proportionality of metabolic body size to the animal's surface area (*see* SURFACE RULE). The relation between metabolic rate and body size ($M = aW^{3/4}$) is a particular case of the general allometric equation ($y = ax^b$) which says that if a biological variable, y, is plotted logarithmically against another biological variable, x, a straight line with slope b results. Ref: VON BERTALANFFY, L., *Helgolaender Wiss. Meeresuntersuch.* 9: 5, 1964.

METABOLIC ENERGY PRODUCTION. *See* METABOLIC FREE ENERGY PRODUCTION.

METABOLIC FREE ENERGY PRODUCTION (M): The rate of transformation of chemical energy into heat *and* mechanical work by aerobic and anaerobic metabolic activities within an organism, usually expressed in terms of unit area of the total body surface. The quantity M in the BODY HEAT BALANCE EQUATION. [$W \cdot m^{-2}$] or [W]

NOTE: Metabolic free energy production may not all result from aerobic metabolic activities and may therefore exceed that indicated by the rate of oxygen consumption. Part of the metabolic free energy production may be used to do work on an external system, and therefore the rate of heat production may be less than the metabolic free energy production.

METABOLIC HEAT PRODUCTION (H): Rate of transformation of chemical energy into heat in an

organism, usually expressed in terms of unit area of the total body surface. The quantity $M - (+W)$ in the BODY HEAT BALANCE EQUATION. [$W \cdot m^{-2}$] or [W]

Note: During POSITIVE WORK or in the absence of both POSITIVE WORK and NEGATIVE WORK, METABOLIC HEAT PRODUCTION equals TOTAL HEAT PRODUCTION, but when work is being done on the body by an external source (NEGATIVE WORK), TOTAL HEAT PRODUCTION is the sum of the METABOLIC FREE ENERGY PRODUCTION and the heat liberated within the body due to negative work, i.e., the quantity $M - (-W)$ in BODY HEAT BALANCE EQUATION.

METABOLIC LEVEL: The heat production measured under standard* conditions during a 24-h period divided by the METABOLIC BODY SIZE. [$kJ \cdot kg^{-3/4} \cdot (24\ h)^{-1}$]†

Note: **See* METABOLIC RATE, STANDARD. † $kJ \cdot kg^{-3/4} \cdot (24\ h)^{-1} = 0.2388\ kcal \cdot kg^{-3/4} \cdot (24\ h)^{-1}$. METABOLIC LEVELS are approximately constant within phylogenetic groups but may vary between groups. For example, mammalian and avian (TACHYMETABOLISM) species have higher METABOLIC LEVELS than other species (BRADYMETABOLISM), while the METABOLIC LEVELS of birds are apparently higher than those of mammals, and those of prototherian (monotreme) and metatherian (marsupial) mammals are lower than those of eutherian (placental) mammals (Poczopko, 1971). Ref: Poczopko, P., *Acta Theoriologica* 16: 1, 1971.

METABOLIC RATE (MR): *See* METABOLIC FREE ENERGY PRODUCTION. [W], [$W \cdot m^{-2}$], [$W \cdot kg^{-1}$], [$W \cdot kg^{-3/4}$]

Note: Terms in the BODY HEAT BALANCE EQUATION are usually expressed as quantities of energy per unit surface area and per unit time [$W \cdot m^{-2}$], because heat exchange is a function of area. METABOLIC RATE may also be given as the total free energy production in the organism in unit time [W] or as the free energy production per unit mass of tissue in unit time [$W \cdot kg^{-1}$]. For comparison of metabolic rates of animals of different body sizes, METABOLIC RATE is usually related to (body weight) $^{3/4}$ (*see* METABOLIC BODY SIZE).

METABOLIC RATE, BASAL (BMR): The rate of METABOLIC FREE ENERGY PRODUCTION* calculated from measurements of heat production or oxygen consumption in an organism in a rested, awake, fasting,† and thermoneutral state (a particular case of STANDARD METABOLIC RATE). [W], [$W \cdot m^{-2}$], [$W \cdot kg^{-1}$], [$W \cdot kg^{-3/4}$]

Note: *In these conditions, when the amount of work being done on an external system is negligible, the rate of heat production is equal to the rate of metabolism (METABOLIC FREE ENERGY PRODUCTION). † The period of fasting needs to be specified as this may be for days in large animals, and for much shorter periods for very small mammals and birds.

METABOLIC RATE, LEAST OBSERVED (LOMR): The lowest rate of metabolism during specified periods of minimum activity. [W], [$W \cdot m^{-2}$], [$W \cdot kg^{-1}$], [$W \cdot kg^{-3/4}$] *See* METABOLIC RATE, MINIMUM OBSERVED. The rationale and objective of LOMR and MOMR are identical: to measure the metabolic rates of small and wild animals during periods of minimal activity as the nearest that can be made to a measurement of a STANDARD METABOLIC RATE. There may be small but significant differences in technique: MOMR is the *average* metabolic rate during periods of minimum activity; LOMR is the *lowest* recorded metabolic rate during periods of minimum activity. Such brief low values may be influenced by physical characteristics of the system of measurement.

METABOLIC RATE, MAXIMUM (MMR): The highest metabolic rate during a specified period of work compatible with sustained aerobic metabolism (i.e., when there is no progressive accumulation of lactic acid in the blood). [W], [$W \cdot m^{-2}$], [$W \cdot kg^{-1}$], [$W \cdot kg^{-3/4}$].

Note: There may be some confusion between MAXIMUM and PEAK METABOLIC RATES. Both terms indicate maximum rates; the distinction is in usage. MAXIMUM relates to work; PEAK relates to cold exposure. The terms should also be distinguished from MAXIMUM OXYGEN CONSUMPTION.

METABOLIC RATE, MINIMUM OBSERVED (MOMR): Averaged metabolic rates during specified periods of minimum activity. [W], [$W \cdot m^{-2}$], [$W \cdot kg^{-1}$], [$W \cdot kg^{-3/4}$]

Note: The metabolic rate of small animals in particular, but also of larger wild animals, cannot be measured under basal or other standard conditions (*see* METABOLIC RATE, BASAL and METABOLIC RATE, STANDARD). A practical solution to the problem is to measure metabolic rate continuously and accept the average metabolic rate during periods of minimum activity as the best possible estimation of a STANDARD METABOLIC RATE.

METABOLIC RATE, PEAK (PMR): The highest metabolic rate that can be induced in a resting animal by any cold environment. [W], [$W \cdot m^{-2}$], [$W \cdot kg^{-1}$], [$W \cdot kg^{-3/4}$] Synonym SUMMIT METABOLIC RATE. *See also* METABOLIC RATE, MAXIMUM. Although SUMMIT METABOLIC RATE (SMR) is now an accepted term, PEAK METABOLIC RATE (PMR) is preferable because the abbreviation SMR is indistinguishable from that for STANDARD METABOLIC RATE.

METABOLIC RATE, RESTING (RMR): The metabolic rate of an animal which is resting in a thermoneutral environment but not in the postabsorptive state. [W], [$W \cdot m^{-2}$], [$W \cdot kg^{-1}$], [$W \cdot kg^{-3/4}$]

Note: A particular case of STANDARD META-

BOLIC RATE used when the subject cannot be brought to a fasting condition, e.g., ruminant animals. The period of food deprivation should be stated.

METABOLIC RATE, STANDARD (SMR): The rate of METABOLIC FREE ENERGY PRODUCTION* calculated from measurements of heat production or oxygen consumption in an organism under specified standard conditions.† [W], [$W \cdot m^{-2}$], [$W \cdot kg^{-1}$], [$W \cdot kg^{-3/4}$]

NOTE: * The conditions are usually such that the amount of work being done on an external system is negligible. The rate of heat production is then an acceptable index of the rate of metabolism (METABOLIC FREE ENERGY PRODUCTION).

†The specified standard conditions are usually that the organism is rested (or as near to rested as is possible), fasting (if possible), awake, and in a thermoneutral environment. The extent to which standard conditions can be achieved varies with species. *See* METABOLIC RATE, MINIMUM OBSERVED.

METABOLIC RATE, SUMMIT. *See* METABOLIC RATE, PEAK.

METABOLISM: *See* METABOLISM, ENERGY. (Gk. *metabole*—change.)

NOTE: METABOLISM is a general term which relates to chemical and physical changes occurring in living organisms. In thermal physiology METABOLISM invariably relates to the transformation of chemical energy into free energy, but in other divisions of physiology the term is used in relation to other changes in state, e.g., calcium metabolism.

METABOLISM, ANAEROBIC: Transformation of matter and energy without uptake of oxygen.

METABOLISM, ENERGY: The sum of the chemical changes in living matter in which energy is transformed. (Gk. *metabole*—change.) *See* METABOLISM.

MINIMUM OBSERVED METABOLIC RATE. *See* METABOLIC RATE, MINIMUM OBSERVED.

NATURAL CONVECTION. *See* CONVECTION, NATURAL.

NEGATIVE WORK. *See* WORK, NEGATIVE.

NOCTURNAL: Occurring during the nighttime, as distinctfrom daytime. (L *nocturnus* adj < *nox*—night.) ANTONYM: DIURNAL

NONEVAPORATIVE HEAT LOSS. *See* HEAT LOSS, NONEVAPORATIVE.

NONGENETIC ADAPTATION. *See* ADAPTATION, PHENOTYPIC.

NONSHIVERING THERMOGENESIS. *See* THERMOGENESIS, NONSHIVERING.

NONSHIVERING THERMOGENESIS TOPOGRAPHY: The distribution of the sites of NONSHIVERING THERMOGENESIS.

NONTHERMAL SWEATING. *See* SWEATING, NONTHERMAL.

NORMOTHERMY. *See* CENOTHERMY.

NYCHTHEMERAL: Relating to an exact period of 24 h. (Gk. *nux*—night; *hemera*—day.)

NYCHTHEMERON: A period of 24 h, consisting of a day and a night (SOED).

OPERATIVE TEMPERATURE. *See* TEMPERATURE, OPERATIVE.

OXYGEN CONSUMPTION, MAXIMUM ($\dot{V}O_{2max}$): The maximum rate at which the lungs can take up oxygen. [$ml \cdot s^{-1}$]

NOTE: Determination of this parameter requires very high motivation of the subject and can probably be done only on man. Criteria used to show that a man has reached the $\dot{V}O_{2max}$, although not as yet agreed upon, include an indication of no further increase in oxygen uptake during further increase in work load. Tests showing levels of blood lactate concentration exceeding 0.7–0.8 mg/ml have been suggested to control the variability of motivation.

PANTING, THERMAL. *See* THERMAL PANTING.

PARTITIONAL CALORIMETRY. *See* CALORIMETRY, PARTITIONAL.

PASSIVE CUTANEOUS WATER EXCHANGE: The passage through the skin in either direction of water down an osmotic gradient per unit area in unit time. [$kg \cdot m^{-2} \cdot s^{-1}$], also [$mg \cdot m^{-2} \cdot s^{-1}$]

NOTE: Passive cutaneous *water* exchange occurs only when the skin is covered with water or an aqueous solution.

PASSIVE CUTANEOUS WATER VAPOR EXCHANGE: The passage through the skin in either direction of water vapor down a water vapor pressure gradient per unit area in unit time. [$kg \cdot m^{-2} \cdot s^{-1}$], also [$mg \cdot m^{-2} \cdot s^{-1}$] Synonym: INSENSIBLE PERSPIRATION.

PASSIVE TEMPERATURE LABILITY. *See* TEMPERATURE LABILITY, PASSIVE.

PHENOTYPIC ADAPTATION. *See* ADAPTATION, PHENOTYPIC.

PHYSICAL TEMPERATURE REGULATION. *See* TEMPERATURE REGULATION, PHYSICAL

PHYSICAL THERMOREGULATION. *See* TEMPERATURE REGULATION, PHYSICAL.

PHYSIOLOGICAL TEMPERATURE REGULATION. *See* TEMPERATURE REGULATION, PHYSIOLOGICAL.

PHYSIOLOGICAL THERMOREGULATION. *See* TEMPERATURE REGULATION, PHYSIOLOGICAL.

POIKILOTHERMY: The pattern of thermoregulation of a species exhibiting a large variability of core tem-

perature as a proportional function of ambient temperature. (Gk. *poikilos*—changeful, diversified; *therme*—heat.) Synonym: TEMPERATURE CONFORMITY (preferred). Antonyms: HOMEOTHERMY, TEMPERATURE REGULATION (preferred).

NOTE: An animal with this pattern of thermoregulation is better described as a TEMPERATURE CONFORMER. *Poikilo* is inconsistent with other uses of this root in biology. It should, perhaps, be *poecilo* or *pecilo*; cf., poeciloblast, poecilocyte (OED).

POLYPNEA, THERMAL. *See* THERMAL POLYPNEA.

POSITIVE WORK. *See* WORK, POSITIVE.

PREFERRED AMBIENT TEMPERATURE: The range of ambient temperature, associated with specified radiation intensity, humidity, and air movement, from which an unrestrained animal does not seek to move to a warmer or colder environment. [°C]

PREFERRED BODY TEMPERATURE: The range of core temperature within which an ectothermic animal seeks to maintain itself by behavioral means. [°C]

PRESSURE (P): The force exerted by a homogenous liquid or gas, per unit area, normal to the walls of its container. [Pa, bar, Torr]

NOTE: The SI-derived unit of pressure is the pascal (Pa), which is defined as a newton per square meter ($N \cdot m^{-2}$). An alternate SI-derived unit of pressure is the bar (bar) defined as 10^5 Pa. The unit of pressure currently approved by the International Commission of the IUPS for Respiratory Physiology is the torr (Torr), which is synonymous with the pressure unit mmHg (an obsolescent unit). One torr is equal to 1.33322 millibars.

PRESSURE, ATMOSPHERIC (P): The pressure due to the weight of the atmosphere as indicated by a barometer. STANDARD ATMOSPHERIC PRESSURE is the pressure 760 Torr (or the weight of a 760 mm column of mercury at 0°C with density $13.5951 \times 10^3 kg \cdot m^{-3}$ under standard gravity of $9.80665\ m \cdot s^{-2}$) and is equivalent to 1,013.25 millibars or to 101.325 kilopascals (kPa).

PRESSURE, WATER VAPOR (P_w): The pressure exerted by water vapor. If water vapor is confined over its liquid so that the vapor comes into equilibrium with the liquid, and the ambient temperature T_a of the medium is held constant, the vapor pressure approaches a maximum value called the SATURATED VAPOR PRESSURE (P_{s, T_a}) or P_{sa}. The term VAPOR PRESSURE (WATER) is always synonymous with a SATURATED VAPOR PRESSURE at a temperature T. [Pa, millibar, Torr]

NOTE: The water vapor pressure of an enclosure is calculated usually from the observed WET BULB and DRY BULB TEMPERATURES and the atmospheric pressure, by using standard steam or meteorological tables and formulas (Ref: CHAMBERS, A. B., A psychrometric chart for physiological research, *J. Appl. Physiol.* 29: 406–412, 1970). The water vapor pressure in an enclosure is equal to the SATURATED VAPOR PRESSURE at its DEW-POINT TEMPERATURE ($P_{s, T_{dp}}$ or $P_{s, dp}$) or to the product of the RELATIVE HUMIDITY and the SATURATED VAPOR PRESSURE at its DRY BULB TEMPERATURE ($\phi \cdot P_{s, db}$).

PROJECTED AREA. *See* AREA, PROJECTED.

PYRETOGEN: *See* PYROGEN. (Gk. *pureto*—fever; <*gen*—become.)

PYROGEN: The generic term for any substance whether exogenous or endogenous which causes a FEVER when introduced into or released in the body. (Gk. *pur*—fire; <*gen*—become.)

PYROGEN, BACTERIAL: Any PYROGEN derived from bacteria.

NOTE: All ENDOTOXINS are bacterial pyrogens.

PYROGEN, ENDOGENOUS: A heat-labile substance formed in body tissues and which, when released, causes FEVER by an action upon the central nervous system.

NOTE: Endogenous pyrogens can be produced and released by cells exposed to ENDOTOXIN.

PYROGEN, ENDOTOXIC. *See* ENDOTOXIN.

PYROGEN, LEUKOCYTIC: An ENDOGENOUS PYROGEN formed in and released from leukocytes under experimental conditions.

Q_{10}: The ratio of the rate of a physiological process at a particular temperature to the rate at a temperature 10°C lower, when the logarithm of the rate is an approximately linear function of temperature.

RADIANCE (L_e): Radiance at a surface element (dA) of a source or receiver is the RADIANT INTENSITY (dI) from direction θ divided by the orthogonal projection of this surface element ($dA \cdot \cos \theta$) on a plane perpendicular to the direction θ. θ is the angle between the normal to the element (dA) of the source or receiver and the direction of the observation. [$W \cdot sr^{-1} \cdot m^{-2}$]

RADIANCE, THERMAL ($L_{e, th}$): RADIANCE due to thermal radiation. [$W \cdot sr^{-1} \cdot m^{-2}$]

RADIANT ABSORPTANCE, TOTAL (α): The ratio of total RADIANT FLUX absorbed by a body to the total incident flux.

RADIANT EMITTANCE. *See* RADIANT EXITANCE.

RADIANT ENERGY (Q): Energy traveling in the form of electromagnetic waves. [J]

NOTE: This term should be distinguished from the RADIANT HEAT EXCHANGE (R) of the environment with the body. That part of the electromagnetic spectrum of significance in thermal physiology is divided for convenience into the wavebands:

Ultraviolet	0.25 – 0.38 μm
Visible	0.38 – 0.78 μm
Infrared	0.78 – 100 μm
Microwave	1 – 100 mm

RADIANT ENERGY, SPECTRAL (Q_λ): The radiant energy per unit wave length interval at wavelength λ. [$J \cdot nm^{-1}$]

RADIANT EXITANCE (M_e): The RADIANT FLUX leaving an element of a surface divided by the area of that element. This quantity includes radiation emitted, reflected, and transmitted by the surface.

$$M_e = d\Phi_e/dA = \int L_e \cdot \cos\theta \cdot d\Omega \qquad [W \cdot m^{-2}]$$

NOTE: The name RADIANT EMITTANCE previously given to this quantity is abandoned because it has given rise to confusion. Thus the term emittance is used to designate either the flux per unit area leaving a surface whatever the origin (emitted, reflected, or transmitted), or the flux per unit area emitted by a surface (originating in the surface), or a quantity without dimensions similar to emissivity but applicable only to a specimen.

RADIANT EXITANCE, SELF ($M_{e,s}$): The RADIANT FLUX emitted by an element of a surface divided by the area of that element. The flux considered does not include reflected or transmitted flux.

RADIANT EXITANCE, THERMAL ($M_{e,th}$): The RADIANT FLUX emitted as thermal radiation by an element of a surface divided by the area of that element.

NOTE: In the case of a FULL RADIATOR, the RADIANCE (L_e) is uniform in all directions. In consequence, when the solid angle is measured in steradians, the RADIANT EXITANCE has the numerical value $M_e = 4\pi L_e$.

RADIANT FIELD, EFFECTIVE. *See* RADIANT FLUX, EFFECTIVE.

RADIANT FLUX (Φ): The rate of flow of RADIANT ENERGY. [W]

RADIANT FLUX DENSITY ($d\Phi/dA$): The RADIANT FLUX per unit area. [$W \cdot m^{-2}$]

NOTE: The radiant flux density emitted by a surface is the THERMAL RADIANT EXITANCE. The radiant flux density incident on or passing through an area is the IRRADIANCE.

RADIANT FLUX, EFFECTIVE (H_r): The net radiant energy exchanged in unit time with all enclosing surfaces and with any intense directional heat sources and sinks (if present) by a man or man-shaped object whose surface temperature is hypothetically at ambient temperature. [$W \cdot m^{-2}$]

RADIANT FLUX, SPECTRAL (Φ^λ): The RADIANT FLUX per unit wavelength interval at wavelength λ. [$W \cdot nm^{-1}$]

RADIANT HEAT EXCHANGE (R): The net rate of heat exchange by radiation between an organism and its environment, usually expressed in terms of unit area of the total body surface. The quantity R in the BODY HEAT BALANCE EQUATION where $+R$ = heat gain and $-R$ = heat loss. [$W \cdot m^{-2}$] or [W]

RADIANT INTENSITY (I): The RADIANT FLUX proceeding from a source per unit solid angle in the direction considered. [$W \cdot sr^{-1}$]

RADIANT INTENSITY, SPECTRAL (I_λ): The RADIANT INTENSITY per unit wavelength interval. [$W \cdot sr^{-1} \cdot nm^{-1}$]

RADIATION REFLECTANCE. *See* REFLECTANCE, RADIATION.

RADIATION SHAPE FACTOR (F_{ij}): A dimensionless quantity expressing the fraction of the diffuse energy emitted by a surface (or a source), denoted by the subscript i, that is received by another surface, denoted by the subscript j, visible by it and in known geometric relation with it. Synonym: RADIATION VIEW FACTOR.

RADIATION TRANSMITTANCE. *See* TRANSMITTANCE, RADIATION.

RADIATION VIEW FACTOR. *See* RADIATION SHAPE FACTOR.

RADIATIVE HEAT TRANSFER COEFFICIENT. *See* HEAT TRANSFER COEFFICIENT, RADIATIVE.

RADIATIVE (LINEAR) HEAT TRANSFER COEFFICIENT. *See* HEAT TRANSFER COEFFICIENT, RADIATIVE (LINEAR).

RADIATOR: An emitter of RADIANT ENERGY.

RADIATOR, FULL: A RADIATOR of uniform surface temperature whose RADIANT EXITANCE in all parts of the spectrum is the maximum obtainable. The EMISSIVITY of a full radiator is unity for all wavelengths. Synonym: BLACKBODY.

RADIATOR, GRAYBODY: A RADIATOR whose SPECTRAL EMISSIVITY is less than unity, at least in the waveband for thermal radiation (3–30 μm), but is the same at all wavelengths.

RADIATOR, SELECTIVE: A RADIATOR with a SPECTRAL EMISSIVITY less than unity which varies with wavelength.

NOTE: Human and animal skins have high EMISSIVITIES in the waveband 3–30 μm but not between 0.7 and 3 μm.

REFLECTANCE, RADIATION (ρ): The ratio of the RADIANT FLUX reflected by a surface or medium to the incident flux.

NOTE: Measured values of reflectance depend upon the angles of incidence and view and the spectral character of the incident flux; these factors should be specified.

RELATIVE HUMIDITY. *See* HUMIDITY, RELATIVE.

RESISTANCE, THERMAL. *See* THERMAL RESISTANCE.

RESTING METABOLIC RATE. *See* METABOLIC RATE, RESTING.

SALIVA SPREADING: The spreading of saliva on the body surface, often a deliberate behavioral action to cool the surface by evaporation.

SATURATED VAPOR PRESSURE. *See* PRESSURE, WATER VAPOR.

SENSIBLE HEAT LOSS. *See* HEAT LOSS, NONEVAPORATIVE.

SHAPE FACTOR, RADIATION. *See* RADIATION SHAPE FACTOR.

SHIVERING. *See* THERMOGENESIS, SHIVERING.

SHIVERING THERMOGENESIS TOPOGRAPHY: The distribution of thermoregulatory muscle tone, microvibrations, and shivering in skeletal muscles of tachymetabolic TEMPERATURE REGULATORS during cold exposure.

SKIN WETTEDNESS. *See* WETTEDNESS, SKIN.

SOLAR RADIATION AREA *See* AREA, SOLAR RADIATION.

SPECIFIC HEAT (c): The quantity of heat required to raise the temperature of unit mass of a substance by one degree Celsius. [$J \cdot kg^{-1} \cdot °C^{-1}$]

NOTE: For gases, it is necessary to specify whether the pressure (c_P) or the volume (c_V) is held constant during its determination. The specific heat of body tissue is usually taken to be 3.48 $kJ \cdot kg^{-1} \cdot °C^{-1}$ (i.e., 0.83 $kcal \cdot kg^{-1} \cdot °C^{-1}$). Ref: SCHAFER, E. A., *Textbook of Physiology*, London: Hodder & Stoughton, 1898, vol. 1, p. 838.

SPECIFIC HEAT, VOLUMETRIC: The product of the DENSITY of a material and its SPECIFIC HEAT. [$J \cdot °C^{-1} \cdot m^{-3}$]

SPECTRAL EMISSIVITY. *See* EMISSIVITY, SPECTRAL.

SPECTRAL RADIANT FLUX. *See* RADIANT FLUX, SPECTRAL.

STANDARD ATMOSPHERIC PRESSURE. *See* PRESSURE, ATMOSPHERIC.

STANDARD METABOLIC RATE. *See* METABOLIC RATE, STANDARD.

STEFAN-BOLTZMANN LAW: The THERMAL RADIANT EXITANCE of a FULL RADIATOR is proportional to the fourth power of its absolute temperature, $M_{e,th} = \sigma T^4$. The currently recommended value of the Stefan-Boltzmann constant (σ) is 5.6696×10^{-8} [$W \cdot m^{-2} \cdot K^{-4}$].

STENOTHERMY: The pattern of thermoregulation in organisms, which occur naturally in a narrow range of environmental temperatures and which, singly or collectively, are intolerant of or accommodate ineffectually to wide changes in their thermal environment. (Gk. *stenos*—narrow; *therme*—heat.) Antonym: EURYTHERMY.

STERADIAN (Ω): Unit of measurement of a solid (space) angle, i.e., the angle subtended at the center of a sphere of unit radius by unit area of the surface of the sphere. [sr]

STORAGE OF BODY HEAT (S): The rate of increase (+) or decrease (−) in the HEAT CONTENT of the body caused by an imbalance between heat production and heat loss, usually expressed in terms of unit area of total body surface. The quantity S in the BODY HEAT BALANCE EQUATION. [$W \cdot m^{-2}$] or [W]

SUMMIT METABOLIC RATE. *See* METABOLIC RATE, PEAK.

SURFACE AREA. *See* AREA, TOTAL BODY and AREA, DUBOIS (for man only).

SURFACE RULE: A statement that the BASAL METABOLIC RATE is proportional to the $\frac{2}{3}$ power of body weight.

NOTE: The rule is based on the proposition that BMR is related to surface area and that surface area varies with the $\frac{2}{3}$ power of body weight. However, this is not experimentally verifiable, for when BMR is expressed per $\frac{2}{3}$ power of body weight it increases systematically with body size (Kleiber, 1947). BMR is more nearly proportional to the $\frac{3}{4}$ power of body weight (*see* METABOLIC BODY SIZE). Ref: KLEIBER, M., *Physiol. Rev.* 27: 411, 1947.

SWEATING, NONTHERMAL: A response of the sweat glands to a nonthermal stimulus.

SWEATING, THERMAL: A response of the sweat glands to a thermal stimulus. Rate [$mg \cdot m^{-2} \cdot s^{-1}$]

Note: 1 $mg \cdot m^{-2} \cdot s^{-1} = 3.6\ g \cdot m^{-2} \cdot h^{-1}$.

TACHYMETABOLISM: The high level of basal metabolism of birds and mammals relative to those of reptiles and other nonavian and nonmammalian animals of the same body weight and at the same tissue temperature. (Gk. *takhus*—fast; *metabole*—change.) Synonym: WARM-BLOODED. Antonym: BRADYMETABOLISM, COLD-BLOODED

NOTE: This relatively high level of basal metabolism in mammals and birds is a precondition for the relative stability of core temperature during exposure to cold (WARM-BLOODED) and of endothermic HOMEOTHERMY and HETEROTHERMY.

TACHYPNEA, THERMAL. *See* THERMAL TACHYPNEA.

TEMPERATURE, AMBIENT (T_a): The average temperature of a gaseous or liquid environment (usually air or water) surrounding a body, as measured outside the thermal and hydrodynamic boundary layers that overlay the body. [°C] Synonym: TEMPERATURE, DRY BULB (in a gaseous environment).

TEMPERATURE CONFORMER: An organism, the core temperature of which varies as a proportional function of ambient temperature; an animal without effective temperature regulation by autonomic or behavioral means. Synonym: POIKILOTHERM. Antonym: TEMPERATURE REGULATOR.

TEMPERATURE CONFORMITY: The thermal relation between the environment and an organism, the core temperature of which varies as a proportional function of ambient temperature, i.e., an absence of effective temperature regulation by autonomic or behavioral means.

TEMPERATURE, CORE: The mean temperature of the tissues at a depth below that which is affected directly by a change in the temperature gradient through peripheral tissues. Mean core temperature cannot be measured accurately, and is generally represented by a specified core temperature, e.g., that of the rectum. [°C] Synonym: TEMPERATURE, DEEP BODY.

TEMPERATURE, DEEP BODY. *See* TEMPERATURE, CORE (preferred synonym).

TEMPERATURE, DEW-POINT (T_{dp}): The temperature at which condensation first occurs when an air-water vapor mixture is cooled at constant pressure. [°C]

TEMPERATURE, DRY BULB (T_{db}): The temperature of a gas or mixture of gases indicated by a thermometer shielded from radiation. [°C] Synonym: TEMPERATURE, AMBIENT.

TEMPERATURE, EFFECTIVE (T_{eff}): An arbitrary index which combines in a single value the effect of temperature, humidity, and air movement on the sensation of warmth or cold felt by human subjects. The numerical value is that of the temperature of "still" air saturated with water vapor which would induce an identical sensation. [°C]

TEMPERATURE, GLOBE (T_g): The temperature of a blackened hollow sphere of thin copper (usually 0.15-m diameter) as measured by a thermometer at its center; T_g approximately equals TEMPERATURE, OPERATIVE. [°C]

TEMPERATURE LABILITY, CONTROLLED: An expression of the extent of the daily and seasonal variations in the level at which core temperature is being controlled. Synonym: THERMOLABILITY, CONTROLLED.

TEMPERATURE LABILITY, PASSIVE: An expression of the extent to which core temperature fluctuates passively (i.e., without recruitment of temperature-regulatory mechanisms) when either the rate of heat production or the rate of heat exchange with the environment is varied. Synonym: THERMOLABILITY, PASSIVE.

TEMPERATURE, MEAN BODY ($\bar{T}_b$): The sum of the products of the heat capacity and temperature of all the tissues of the body divided by the total heat capacity of the organism.

$$\bar{T}_b = \Sigma(c_i \cdot T_i)/\Sigma\, c_i$$

NOTE: This heat capacity cannot be determined precisely in the living organism. Mean body temperature can be estimated approximately from measurements of skin and core temperature, e.g., for man in a warm environment, $\bar{T}_b \cong 0.9\ T_{ty} + 0.1\ \bar{T}_{sk}$, where T_{ty} is tympanic membrane temperature and $\bar{T}_{sk}$ is the mean skin temperature. In a cool environment, $\bar{T}_b \cong 0.67\ T_{ty} + 0.33\ \bar{T}_{sk}$. Many other formulas have been proposed but no one formula remains valid under all conditions and for all species. For discussion, *see* MINARD, D., In: *Physiological and Behavioral Temperature Regulation*, edited by J. D. Hardy, A. P. Gagge, & J. A. J. Stolwijk, Springfield, Thomas, Ill.: 1970.

TEMPERATURE, MEAN RADIANT (T_r): The temperature of an imaginary isothermal "black" enclosure in which a solid body or occupant would exchange the same amount of heat by radiation as in the actual nonuniform enclosure. [°C]

TEMPERATURE, MEAN SKIN ($\bar{T}_{sk}$): The sum of the products of the area of each regional surface element (A_i) and its mean temperature ($\bar{T}_i$) divided by the total area of body surface.

$$\bar{T}_{sk} = (\Sigma A_i \cdot \bar{T}_i)/A_b \qquad [°C]$$

TEMPERATURE, OPERATIVE (T_o): The temperature of a uniform (isothermal) "black" enclosure in which a solid body or occupant would exchange the same amount of heat by radiation and convection as in the actual nonuniform environment. [°C]

TEMPERATURE REGULATION: The maintenance of the temperature or temperatures of a body within a restricted range under conditions involving variable internal and/or external heat loads. Biologically, the existence of some degree of body temperature regulation by autonomic or behavioral means. Antonym: TEMPERATURE CONFORMITY.

TEMPERATURE REGULATION, AUTONOMIC: The regulation of body temperature by autonomic (i.e., involuntary) responses to heat and cold which modify the rates of heat production and heat loss (i.e., by sweating, thermal tachypnea, shivering, and variations in peripheral vasomotor tone and basal metabolism). (Gk. *autos*—self; *nomos*—law, i.e., self-governing, SOED.)

NOTE: AUTONOMIC TEMPERATURE REGULATION is frequently described as PHYSIOLOGICAL TEMPERATURE REGULATION, a term which should be used for *all* physiological thermoregulatory processes (i.e., both autonomic and behavioral). Autonomic thermoregulatory responses are not necessarily associated with the conscious state and, in mammals, are unimpaired by the removal of the cerebral hemispheres.

TEMPERATURE REGULATION, BEHAVIORAL: The regulation of body temperature by complex patterns of responses of the skeletal musculature to heat and cold which modify the rates of heat production and/or heat loss (e.g., by exercise, change in body conformation, and in the thermal insulation of bedding and (in man) of clothing, and by the selection of an environment which reduces thermal stress).

NOTE: The distinction between BEHAVIORAL

TEMPERATURE REGULATION and THERMOTROPISM is ill-defined. A plant may exhibit thermotropism but is not considered to be thermoregulating behaviorally. Some aquatic unicellular organisms move to a PREFERRED AMBIENT TEMPERATURE, but whether this is THERMOTROPISM or BEHAVIORAL TEMPERATURE REGULATION may be disputed. In practice, behavioral temperature regulation relates to complex patterns of behavior dependent on the integrity of a central nervous system, and therefore excludes the thermotropic functions of organisms which lack an integrated nervous control over muscular activities.

TEMPERATURE REGULATION, CHEMICAL (obsolete): Body temperature regulation involving changes in heat production.

NOTE: This can be due to: 1. voluntary muscle movements; 2. involuntary muscle movements (e.g., shivering); 3. nonshivering thermogenesis; 4. increase or decrease in basal metabolic rate.

TEMPERATURE REGULATION, PHYSICAL (obsolete): Body temperature regulation involving control of the rate of heat flow into or out of an organism.

NOTE: The responses involved in such regulation consist of those autonomic and behavioral responses which vary the thermal conductance of peripheral tissues,* but not of those behavioral responses which involve alteration of the local environment. *For example: 1. changes in peripheral vasomotor tone; 2. piloerection; 3. evaporation of water from skin (following sweating, saliva spreading, wallowing) and from respiratory tract surfaces; 4. changes in body conformation.

TEMPERATURE REGULATION, PHYSIOLOGICAL: 1. Both autonomic and behavioral temperature regulation (preferred). 2. Synonym for AUTONOMIC TEMPERATURE REGULATION.

NOTE: Traditionally, mammalian thermoregulatory physiology has been concerned with those responses to heat or cold which do not depend on consciousness or the integrity of the cerebral cortex. These responses are autonomic (SOED—self-governing; Gk. *autos*—self, independently; *nomos*—law). Autonomic responses are generally referred to as physiological responses, but behavioral responses are also physiological (Physiology = the science of the normal functions and phenomena of living things, SOED). Thus physiological thermoregulatory responses properly consist of both AUTONOMIC and BEHAVIORAL responses. Although all thermoregulatory responses operating through the sympathetic and parasympathetic nervous pathways are AUTONOMIC, not all AUTONOMIC responses operate through the sympathetic and parasympathetic efferent nervous pathways.

TEMPERATURE REGULATOR: An organism, the core temperature of which is regulated to some extent by autonomic and/or behavioral processes. Antonym: TEMPERATURE CONFORMER.

NOTE: This term does not imply a *degree* of control of body temperature which needs to be defined. Both homeothermic and heterothermic animals are classified as TEMPERATURE REGULATORS, having different degrees of thermostability which are defined arbitrarily (*see* HOMEOTHERMY and HETEROTHERMY).

TEMPERATURE SENSOR: A neuronal structure which is differentially sensitive to temperature and which responds to a maintained temperature with a characteristic sustained impulse frequency. A temperature sensor may respond weakly to strong nonthermal stimuli. The presence of temperature sensors in a tissue may be inferred from the activation of thermoregulatory effector functions when the tissue is heated or cooled. Synonym: THERMORECEPTOR.

TEMPERATURE SURVIVAL LIMIT, LOWER: The environmental temperature below which thermal balance cannot be maintained for a long period and animals become progressively hypothermic. At this temperature PMR can be measured.

TEMPERATURE SURVIVAL LIMIT, UPPER: The environmental temperature above which thermal balance cannot be maintained for a long period and animals become progressively hyperthermic.

TEMPERATURE, TOLERATED AMBIENT RANGE. *See* TOLERATED AMBIENT TEMPERATURE RANGE.

TEMPERATURE, WET BULB (T_{wb}): The thermodynamic wet bulb temperature of a sample of air is the lowest temperature to which it can be cooled by evaporating water adiabatically. [°C]

NOTE: The term is usually applied to the temperature recorded by an aspirated thermometer covered with a wet sleeve that is approximately equal to the thermodynamic wet bulb temperature when the bulb is shielded from radiation.

THERMAL COMFORT: Subjective satisfaction with the thermal environment.

THERMAL COMFORT, ZONE OF: The range of ambient temperatures, associated with specified mean radiant temperature, humidity, and air movement, within which a human in specified clothing expresses satisfaction with his thermal environment for an indefinite period. [°C]

THERMAL CONDUCTANCE (C): The rate at which heat is conducted between unit area of two parallel surfaces in a medium when unit temperature difference is maintained between them. [$W \cdot m^{-2} \cdot °C^{-1}$].

THERMAL CONDUCTANCE, TISSUE: The rate of heat transfer per unit area during steady state when a temperature difference of 1°C is maintained across a layer of tissue. [$W \cdot m^{-2} \cdot °C^{-1}$]

NOTE: This term relates to the heat transfer down a temperature gradient from any tissue to its immediate environment, e.g., from a tissue to circulating blood, as well as from the body core through peripheral tissues to the body surface. In practice TISSUE THERMAL CONDUCTANCE of living tissues

within the organism is not amenable to direct measurement. Calculated values are usually based on several assumptions, e.g., mean tissue temperature, mean blood temperature, and the surface areas of blood vessel walls.

THERMAL CONDUCTIVITY (k): A property of a material defined by the flow of heat by conduction through unit thickness of the material per unit area and per unit temperature difference maintained at right angles to the direction of heat flow. [$W \cdot m^{-1} \cdot °C^{-1}$]

THERMAL CONTACT COEFFICIENT. *See* THERMAL INERTIA FOR RADIANT HEAT.

THERMAL DIFFUSIVITY. *See* DIFFUSIVITY, THERMAL.

THERMAL EXPANSION COEFFICIENT OF VOLUME (β): The change in volume at constant pressure of a substance (solid or fluid) per unit volume, per degree change in temperature.

$$\beta = V^{-1} \cdot dV/dT \text{ (gases only)} \qquad [K^{-1}]$$

THERMAL HYPERPNEA: An increase in tidal volume associated with an increase in alveolar ventilation occurring during severe heat stress which has caused a large rise in core temperature. (Gk. *hyper*—above, over; *pnoia*—breath.)

THERMAL INDIFFERENCE, ZONE OF: The range of ambient temperatures, associated with specified water vapor pressure, air velocity, and radiant exchange, within which 80% of active people do not complain of the thermal environment. [°C]

THERMAL INERTIA FOR RADIANT HEAT ($\sqrt{k\rho c}$): One of the properties of a material which determines the rate of increase of surface temperature during an exposure to IRRADIANCE (E). For nonpenetrating radiation incident upon a semi-infinite solid with uniform properties, the value of the thermal inertia for the surface can be determined in appropriate units by

$$\sqrt{k\rho c} = 2\pi^{-1/2} \cdot t^{1/2} \cdot E \cdot \Delta T^{-1}$$

in which ΔT is the rise in surface temperature at time, t.

THERMAL INSULATION. *See* THERMAL RESISTANCE.

THERMAL INSULATION, CLOTHING (I_{cl}): The intrinsic insulation of a clothing assembly. The effective insulation of clothing is ($I_{cl} + I_a$) where I_a is the reciprocal of the thermal conductance of the ambient environment. ($I_{cl} + I_a$) is usually measured as the temperature gradient from the surface of a heated man-sized manikin to the ambient air divided by the heat production per unit area of manikin surface. [$°C \cdot m^2 \cdot W^{-1}$] The value is sometimes expressed in CLO units.

THERMAL PANTING: Open-mouthed THERMAL TACHYPNEA.

THERMAL POLYPNEA. *See* THERMAL TACHYPNEA.

NOTE: Although POLYPNEA is more commonly used, TACHYPNEA is etymologically more correct.

THERMAL RADIANCE. *See* RADIANCE, THERMAL.

THERMAL RADIANT EXITANCE. *See* RADIANT EXITANCE, THERMAL.

THERMAL RESISTANCE (R): The reciprocal of thermal conductance. [$°C \cdot m^2 \cdot W^{-1}$]
Synonym: THERMAL INSULATION.

THERMAL STRAIN: Any change in the physiological state of an organism caused by THERMAL STRESS.

THERMAL STRESS: Any change in the thermal relation between an organism and its environment which, if uncompensated by a temperature-regulatory response, would disturb the thermal equilibrium.

THERMAL SWEATING. *See* SWEATING, THERMAL.

THERMAL TACHYPNEA: A rapid respiratory frequency accompanied by an increase in respiratory minute volume and a decrease in tidal volume, in response to a thermoregulatory drive to dissipate heat. (Gk. *takhus*—swift, fast; *pnoia*—breath.) Synonym: THERMAL POLYPNEA.

NOTE: Although POLYPNEA is more commonly used, TACHYPNEA is etymologically more correct.

THERMOGENESIS, NONSHIVERING (NST): An increase in the rate of heat production during cold exposure due to processes which do not involve contractions of voluntary muscles, i.e., increased heat production by processes other than tone, microvibrations, or clonic contractions of skeletal muscles. [W] or [$W \cdot m^{-2}$]

THERMOGENESIS, NONSHIVERING (OBLIGATORY) (NST(O)): That component of NONSHIVERING THERMOGENESIS (i.e., heat production unrelated to the contractions of voluntary muscles) which is independent of short-term changes in ambient temperature.

NOTE: NST(O) corresponds to BASAL METABOLIC RATE or STANDARD METABOLIC RATE. Although NST(O) is unaffected by short-term exposure to cold, it may be changed by processes of acclimatization to sustained cold or heat stress.

THERMOGENESIS, NONSHIVERING (THERMOREGULATORY) (NST(T)): The increase in NONSHIVERING THERMOGENESIS (i.e., heat production unrelated to the contractions of voluntary muscles) which occurs in some mammals and in some conditions when the animal is acutely exposed to cold.

NOTE: The term NONSHIVERING THERMOGENESIS usually refers to NST(T).

THERMOGENESIS, SHIVERING: An increase in the rate of heat production during cold exposure due to increased contractile activity of skeletal muscles not involving voluntary movements and external work. [W] or [$W \cdot m^{-2}$]

NOTE: Shivering thermogenesis progresses, as its intensity increases, from THERMOREGULATORY MUSCLE TONE, to microvibrations, to clonic contractions of both flexor and extensor muscles. All shivering thermogenesis is blocked by curare.

THERMOLABILITY, CONTROLLED. *See* TEMPERATURE LABILITY, CONTROLLED.

THERMOLABILITY, PASSIVE. *See* TEMPERATURE LABILITY, PASSIVE.

THERMONEUTRAL ZONE (TNZ): The range of ambient temperature within which metabolic rate is at a minimum, and within which temperature regulation is achieved by nonevaporative physical processes alone. [°C]

NOTE: Nonevaporative physical processes of temperature regulation consist of those autonomic and behavioral responses which vary the thermal conductance between the organism and the environment, i.e., by variations in peripheral vasomotor tone and piloerection, and by changes in body conformation, but excluding changes in thermal conductance due to additional external insulation (e.g., bedding, clothing).

THERMOPREFERENDUM: The thermal conditions which an individual organism or a species selects for its ambient environment in natural or experimental circumstances.

THERMORECEPTOR. *See* TEMPERATURE SENSOR.

THERMOREGULATION. *See* TEMPERATURE REGULATION.

THERMOREGULATORY CONDITIONED REFLEX: The physiological (autonomic and behavioral) responses of an organism to changes in its thermal environment, which can also be elicited by a conditioned stimulus.

THERMOREGULATORY MUSCLE TONE: The increase in the electrical activity of the skeletal musculature of a resting tachymetabolic temperature regulator during moderate cooling. [$\mu V \cdot {}^{-1}$]

NOTE: During more intensive cooling, thermoregulatory muscle tone is replaced by microvibrations and shivering.

THERMOTROPISM: The turning or movement of a plant or animal in response to a temperature stimulus. (Gk. *therme*—heat; *trope*—turn.)

THIGMOTHERMY: The dependence of the core temperature of an ectothermic animal on the conductive exchange of heat with its immediate environment, e.g., water, air, soil. (Gk. *thigma*—touch; *therme*—heat.)

TISSUE THERMAL CONDUCTANCE. *See* THERMAL CONDUCTANCE, TISSUE.

TOLERATED AMBIENT TEMPERATURE RANGE: The range of ambient temperature within which the body core temperature can be kept, by means of autonomic thermoregulatory processes, within certain limits typical for the species or the individual under consideration. [°C]

TORPOR: A state of inactivity and reduced responsiveness to stimuli associated with a reduction in metabolism and body temperature (e.g., during HIBERNATION or ESTIVATION).

TOTAL BODY AREA. *See* AREA, TOTAL BODY.

TOTAL ENVIRONMENT: All environmental factors which exert an influence on an organism and to which an organism must be adequately adapted in order to survive (i.e., competitors for food sources and predators as well as the many components of the physical environment and the climate).

TOTAL HEAT PRODUCTION: The rate of transformation of chemical energy into heat in an organism (METABOLIC HEAT PRODUCTION) plus any heat liberated within the body resulting from work done on the organism by an external force (NEGATIVE WORK). [$W \cdot m^{-2}$] or [W]

NOTE: During POSITIVE WORK and when no work is being done on or by the organism, TOTAL HEAT PRODUCTION equals METABOLIC HEAT PRODUCTION.

TOTAL RADIANT ABSORPTANCE. *See* RADIANT ABSORPTANCE, TOTAL.

TRANSMITTANCE, RADIATION (τ): The ratio of the radiant energy transmitted through a body to the total radiation incident on it.

UPPER CRITICAL TEMPERATURE. *See* CRITICAL TEMPERATURE, UPPER.

UPPER TEMPERATURE SURVIVAL LIMIT. *See* TEMPERATURE SURVIVAL LIMIT, UPPER.

USEFUL WORK ACCOMPLISHED. *See* WORK, POSITIVE.

VAPOR PRESSURE (WATER). *See* PRESSURE, WATER VAPOR.

VOLUME, THERMAL EXPANSION COEFFICIENT OF. *See* THERMAL EXPANSION COEFFICIENT OF VOLUME.

VOLUMETRIC SPECIFIC HEAT. *See* SPECIFIC HEAT, VOLUMETRIC.

WALLOWING: The thermoregulatory increase in evaporative heat loss by spreading an aqueous fluid (e.g., water, mud, urine) on the body surface.

WARM-BLOODED: The thermal state of an animal which maintains its core temperature considerably higher than that of the environment when subjected to a low ambient temperature. Synonym: TACHYMETABOLIC (preferred). Antonym: COLD-BLOODED.

NOTE: This maintained temperature gradient between the organism and its environment is dependent on the relatively high rate of metabolic heat produc-

tion (TACHYMETABOLISM) of WARM-BLOODED animals compared with the low rate of heat production (BRADYMETABOLISM) of COLD-BLOODED animals. Thus the terms TACHYMETABOLIC and BRADYMETABOLIC are preferred to the terms WARM-BLOODED and COLD-BLOODED because the first pair of terms relates to a more basic physiological distinction and because the second pair of terms has been used with various meanings not all of which are consistent with the definitions given here. WARM-BLOODED is not a synonym of HOMEOTHERMIC, because the definition of WARM-BLOODED does not specify the degree of temperature stability consistent with HOMEOTHERMY: the core temperatures of some warm-blooded animals vary considerably either nychthemerally or seasonally.

WET BULB TEMPERATURE. *See* TEMPERATURE, WET BULB.

WETTED AREA. *See* AREA, WETTED.

WETTEDNESS, SKIN (w): The fraction of the TOTAL BODY AREA (A_b) that is covered by sweat (the WETTED AREA, A_w), i.e., A_w/A_b.

NOTE: For man the total skin area would usually be taken to be the DUBOIS AREA (A_D).

WINDOW EMISSIVITY. *See* EMISSIVITY, WINDOW.

WORK EFFICIENCY (η): Work done on an external system per unit of energy expended by an organism in the performance of that work (i.e., total energy expended by an organism during the performance of work less that of basal metabolism). [%]

WORK, NEGATIVE ($-W$): The rate of work done on an organism by an external force. The quantity $-W$ in the BODY HEAT BALANCE EQUATION. [$W \cdot m^{-2}$] or [W] Antonym: WORK, POSITIVE.

WORK, POSITIVE ($+W$): The rate of work done by an organism on an external system. The quantity $+W$ in the BODY HEAT BALANCE EQUATION. [$W \cdot m^{-2}$] or [W] Synonym: WORK PRODUCTION, USEFUL WORK ACCOMPLISHED. Antonym: WORK, NEGATIVE.

WORK PRODUCTION. *See* WORK, POSITIVE.

ZONE OF THERMAL COMFORT. *See* THERMAL COMFORT, ZONE OF.

ZONE OF THERMAL INDIFFERENCE. *See* THERMAL INDIFFERENCE, ZONE OF.

ZONE OF THERMONEUTRALITY. *See* THERMONEUTRAL ZONE.

APPENDIX 1. *Système Internationale (SI) Units Used in the Glossary*

	Quantity	Symbol for Quantity	SI Unit	Abbreviations
Basic	electric current	I	ampere	A
	temperature	T	degree Kelvin	K
	mass	m	kilogram	kg
	length	l	meter	m
	time	t	second	s
Supplementary	plane angle	θ	radian	rad
	solid angle	Ω	steradian	sr
Derived	temperature	T	degree Celsius (0°C = 273.15 K)	°C
	energy	E	joule ($kg \cdot m^2 \cdot s^{-2}$)	J
	force	F	newton ($J \cdot m^{-1}$)	N
	electric potential difference	V	volt ($J \cdot A^{-1} \cdot s^{-1}$)	V
	power	W	watt ($J \cdot s^{-1}$)	W
	pressure	P	pascal ($kg \cdot m^{-1} \cdot s^{-2}$) ($= N \cdot m^{-2}$)	Pa
			or bar ($= 10^5$ Pa)	bar
			or torr (= 133.3 Pa)	Torr

APPENDIX 2. *Symbols Used in the Glossary*

Symbol or Abbreviations	Term	SI Units (Abbreviations) (ND = No Dimensions)
A_b	AREA, TOTAL BODY	m^2
A_D	AREA, DUBOIS	m^2
A_p	AREA, PROJECTED	m^2
A_r	AREA, EFFECTIVE RADIATING	m^2
A_s	AREA, SOLAR RADIATION	m^2
A_w	AREA, WETTED	m^2
BMR	METABOLIC RATE, BASAL	W, $W \cdot m^{-2}$, $W \cdot kg^{-1}$, $W \cdot kg^{-3/4}$
C	THERMAL CONDUCTANCE	$W \cdot m^{-2} \cdot °C^{-1}$
C	CONVECTIVE HEAT TRANSFER	$W \cdot m^{-2}$
D	DIFFUSIVITY, MASS	$m^2 \cdot s^{-1}$
E	IRRADIANCE	$W \cdot m^{-2}$
E	EVAPORATIVE HEAT TRANSFER	$W \cdot m^{-2}$
F	RADIATION SHAPE FACTOR	ND
H	body height	m
H	METABOLIC HEAT PRODUCTION	$W \cdot m^{-2}$
H_r	RADIANT FLUX, EFFECTIVE	$W \cdot m^{-2}$

APPENDIX 2—*Continued*

Symbol or Abbreviations	Term	SI Units (Abbreviations) (ND = No Dimensions)
I	RADIANT INTENSITY	$W \cdot sr^{-1}$
I_λ	RADIANT INTENSITY, SPECTRAL	$W \cdot sr^{-1} \cdot nm^{-1}$
I_{cl}	THERMAL INSULATION, CLOTHING	$m^2 \cdot °C \cdot W^{-1}$
K	CONDUCTIVE HEAT TRANSFER	$W \cdot m^{-2}$
$\mathbf{L_e}$	RADIANCE	$W \cdot sr^{-1} \cdot m^{-2}$
$L_{e,th}$	RADIANCE, THERMAL	$W \cdot sr^{-1} \cdot m^{-2}$
LOMR	METABOLIC RATE, LEAST OBSERVED	W, $W \cdot m^{-2}$, $W \cdot kg^{-1}$, $W \cdot kg^{-3/4}$
M_e	RADIANT EXITANCE	$W \cdot m^{-2}$
$M_{e,s}$	RADIANT EXITANCE, SELF	$W \cdot m^{-2}$
$M_{e,th}$	RADIANT EXITANCE, THERMAL	$W \cdot m^{-2}$
M	METABOLIC FREE ENERGY PRODUCTION	$W \cdot m^{-2}$
MMR	METABOLIC RATE, MAXIMUM	W, $W \cdot m^{-2}$, $W \cdot kg^{-1}$, $W \cdot kg^{-3/4}$
MOMR	METABOLIC RATE, MINIMUM OBSERVED	W, $W \cdot m^{-2}$, $W \cdot kg^{-1}$, $W \cdot kg^{-3/4}$
MR	METABOLIC RATE	W, $W \cdot m^{-2}$, $W \cdot kg^{-1}$, $W \cdot kg^{-3/4}$
NST	THERMOGENESIS, NONSHIVERING	W, $W \cdot m^{-2}$
NST(O)	THERMOGENESIS, NONSHIVERING (OBLIGATORY)	W, $W \cdot m^{-2}$
NST(T)	THERMOGENESIS, NONSHIVERING (THERMOREGULATORY)	W, $W \cdot m^{-2}$
P	PRESSURE	Pa, bar, Torr
$P_{s,T}$	PRESSURE, VAPOR (SATURATED) AT TEMPERATURE T	Pa, bar, Torr
P_w	PRESSURE, WATER VAPOR	Pa, $N \cdot m^{-2}$, bar, Torr
PMR	METABOLIC RATE, PEAK	W, $W \cdot m^{-2}$, $W \cdot kg^{-1}$, $W \cdot kg^{-3/4}$
Q	RADIANT ENERGY	J
Q_λ	RADIANT ENERGY, SPECTRAL	$J \cdot nm^{-1}$
R_w	gas constant (water vapor)	$3.47 m^3 \cdot Torr \cdot kg^{-1} \cdot K^{-1}$
R	THERMAL RESISTANCE	$°C \cdot m^2 \cdot W^{-1}$
R	RADIANT HEAT EXCHANGE	$W \cdot m^{-2}$
RMR	METABOLIC RATE, RESTING	W, $W \cdot m^{-2}$, $W \cdot kg^{-1}$, $W \cdot kg^{-3/4}$
S	STORAGE OF BODY HEAT	$W \cdot m^{-2}$
SMR	METABOLIC RATE, STANDARD	W, $W \cdot m^{-2}$, $W \cdot kg^{-1}$, $W \cdot kg^{-3/4}$
T_a	TEMPERATURE, AMBIENT	°C
$\overline{T}_b$	TEMPERATURE, MEAN BODY	°C
T_{db}	TEMPERATURE, DRY BULB	°C
T_{dp}	TEMPERATURE, DEW-POINT	°C
T_{eff}	TEMPERATURE, EFFECTIVE	°C
T_g	TEMPERATURE, GLOBE	°C
T_o	TEMPERATURE, OPERATIVE	°C
$\overline{T}_r$	TEMPERATURE, MEAN RADIANT	°C
$\overline{T}_{sk}$	TEMPERATURE, MEAN SKIN	°C
T_{wb}	TEMPERATURE, WET BULB	°C
TNZ	THERMONEUTRAL ZONE	°C
$\dot{V}O_{2\,max}$	OXYGEN CONSUMPTION, MAXIMUM	$ml \cdot s^{-1}$, $l \cdot min^{-1}$
W	body weight	kg
W	WORK	W, $W \cdot m^{-2}$
c	SPECIFIC HEAT	$J \cdot kg^{-1} \cdot °C^{-1}$
h	HEAT TRANSFER COEFFICIENT, COMBINED NONEVAPORATIVE	$W \cdot m^{-2} \cdot °C^{-1}$
h_c	HEAT TRANSFER COEFFICIENT, CONVECTIVE	$W \cdot m^{-2} \cdot °C^{-1}$
h_D	MASS TRANSFER COEFFICIENT (DIFFUSION)	$m \cdot s^{-1}$
h_e	HEAT TRANSFER COEFFICIENT, EVAPORATIVE	$W \cdot m^{-2} \cdot kPa^{-1}$, $W \cdot m^{-2} \cdot Torr^{-1}$
h_k	HEAT TRANSFER COEFFICIENT, CONDUCTIVE	$W \cdot m^{-2} \cdot °C^{-1}$
h_r	HEAT TRANSFER COEFFICIENT, RADIATIVE (LINEAR)	$W \cdot m^{-2} \cdot °C^{-1}$
k	THERMAL CONDUCTIVITY	$W \cdot m^{-1} \cdot °C^{-1}$
$\dot{m}$	MASS TRANSFER RATE	$kg \cdot s^{-1}$

APPENDIX 2—*Continued*

Symbol or Abbreviations	Term	SI Units (Abbreviations) (ND = No Dimensions)
rh	HUMIDITY, RELATIVE	%
w	WETTEDNESS, SKIN	ND
Φ	RADIANT FLUX	W
Φ_λ	RADIANT FLUX, SPECTRAL	$W \cdot nm^{-1}$
Ω	solid angle	sr
α	RADIANT ABSORPTANCE, TOTAL	ND
α	DIFFUSIVITY, THERMAL	$m^2 \cdot s^{-1}$
β	THERMAL EXPANSION COEFFICIENT OF VOLUME	K^{-1}
γ	HUMIDITY, ABSOLUTE	$kg \cdot m^{-3}$
ϵ	EMISSIVITY	ND
$\epsilon_{(\theta,\Phi)}$	EMISSIVITY, DIRECTIONAL	ND
ϵ_λ	EMISSIVITY, SPECTRAL	ND
ϵ_h	EMISSIVITY, HEMISPHERICAL	ND
ϵ_w	EMISSIVITY, WINDOW	ND
η	WORK EFFICIENCY	%
θ	angular coordinate, vertical	rad
λ	LATENT HEAT OF VAPORIZATION	$J \cdot kg^{-1}$ (2.425×10^6 at 30°C)
λ	wavelength	m, nm
ρ	DENSITY	$kg \cdot m^{-3}$
ρ	REFLECTANCE, RADIATION	ND
σ	STEFAN-BOLTZMANN CONSTANT	$W \cdot m^{-2} \cdot K^{-4}$ (5.67×10^{-8})
τ	TRANSMITTANCE, RADIATION	ND
ϕ	angular coordinate, horizontal	rad
ϕ	HUMIDITY, RELATIVE	ND

APPENDIX 3. *Glossary Consultants*

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Cooper, K. E. (Canada)
Cowles, R. B. (USA)
Cranston, W. I. (England)
Dill, D. B. (USA)
Donhoffer, S. (Hungary)
Dybkaer, R. (Denmark)
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Findlay, J. D. (Scotland)
Fox, R. H. (England)
Frens, J. (The Netherlands)
Gagge, A. P. (USA)
Grayson, J. (Canada)
Hammel, H. T. (USA)
Hardy, J. D. (USA)
Hart, J. S. (Canada)
Heath, J. E. (USA)
Hellon, R. (England)
Hensel, H. (Germany)
Hildwein, G. (France)
Ingram, D. L. (England)
Jansky, L. (Czechoslovakia)
Kayser, C. (France)
Kerslake, D. McK. (England)
Kirschner, L. B. (USA)
Macfarlane, W. V. (Australia)
McLean, J. A. (Scotland)
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Mitchell, D. (South Africa)
Mitchell, J. W. (USA)
Molnar, G. W. (USA)
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Mount, L. E. (England)
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Thauer, R. (Germany)
Underwood, C. R. (England)
Webb, P. (USA)
Whittow, G. C. (USA)
Wyndham, C. H. (South Africa)