**Chapter 7.13: Environment Physiology**

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**Refresher Points**

* **Climatology** - Derived from Greek **"klima"** (place, zone) and "-logia", climatology or climate science studies climate. Scientifically defined as the average weather conditions over a period of time.
* **Climograph -** A graphical representation showing monthly average temperature and precipitation for a specific location. Used for a quick overview of a location's climate.
* **Paleoclimatology -** The study of historical climate changes through examining records like ice cores and tree rings (**dendroclimatology**).
* **Physiological Adaptation:** is the capacity and process of adjustment of the animal to itself and its external environment.
* **Acclimatization:** A long term adaptive physiological adjustment which result in an increased tolerance to continuous or repeated exposure to complex climatic stressors.
* **Acclimation:** Adaptive changes in response to a single climatic variable.
* **Weather:** Short term day to day fluctuations of the meteorological variables
* **Climate:** The long term (over 30 years) average condition of the meteorological variables in a given region
* **Microclimate:** Climatic conditions directly surrounding the animal.
* **Bioclimatology:** The interrelationship between climate, soil, plants and animals.
* **Critical Temperature:** The lowest ambient temperature at which animal or bird can maintain its body temperature at basal metabolic rate.
* **Hibernation:** Cessation of coordinated locomotor activity and a reduction in body temperature, total metabolism, heart beat and respiration during winter.
* **Estivation:** Refers to a torpid sleeping state during the summer.
* **General Adaptation Syndrome:** The nonspecific regulatory mechanism when animal is subjected to stress, in which regardless of the type of injury imposed by the environment, the body react in a similar manner. Such a nonspecific response is known as General Adaptation Syndrome.
* **Habituation -** Gradual reduction in response to repeated stimulation.
* **Homeostasis** -Physiological reactions involving pituitary, thyroid, and adrenal glands to maintain stability. The study of these processes is known as ecophysiology or physiological ecology.
* **Body Temperature Regulation:** The capability of an organism to maintain its body temperature within specific limits despite significant differences in external temperatures.
* **Thermoregulators:** Organisms that maintain a constant body temperature, adjusting to environmental temperatures.
* **Thermoconformers:** Organisms whose body temperature varies with the ambient temperature.
* **Thermoregulation in Organisms:** Both endotherms (homeotherms) and ectotherms (poikilotherms) can regulate their body temperature, but only endotherms (birds and mammals) can maintain a stable body temperature through the nervous, endocrine, respiratory, and circulatory systems.
* **Estivation -** Summer inactivity in some animals to conserve energy and water.
* **Macroclimate -** Climate characteristics of a large geographic area or open atmosphere.
* **Mesoclimate** - Climate conditions of a relatively small and specific area on the Earth's surface.
* **Microclimate** - Climatic conditions in the immediate surroundings of an organism.
* **Monsoon Climate -** Characterized by a dry winter and a wet summer, typically found in tropical regions.
* **Types of Thermoregulation**
* **Endothermy (Warm-Blooded): -** The ability to maintain a stable internal body temperature through internal metabolic processes. Examples: Birds and mammals.
* **Ectothermy (Cold-Blooded): -** The reliance on external environmental heat sources to regulate body temperature. Examples: Reptiles, amphibians, fish, and invertebrates.
* **Homeothermy: -** Maintaining a consistent body temperature regardless of environmental conditions. Typically found in endotherms.
* **Poikilothermy -** Body temperature varies with environmental conditions. Typically found in ectotherms.
* **Heterothermy: -** The ability to switch between homeothermy and poikilothermy. Examples: Certain species of bats and hummingbirds, which can enter torpor.
* **Four Ecological rules of Morphological Adaptation:**
1. **Golger’s Rule:** Breeds found in hot and humid region have more melanin pigmentation than the breeds found in cooler and drier region.
2. **Bergmann’s Rule:** The smaller sized breeds of a given species are found in the warmer part of the ecological range, the larger size breeds in cooler localities.
3. **Allen’s Rule:** The protruding body organs e.g. extremities, tail and ears are relatively shorter in cooler areas than in warmer parts.
4. **Wilson’s Rule:** Insulation cover based on the length of hair and thickness of adipose tissue is related to climate.
* Size and number of sweat glands per skin area are greater in Brahman cattle than in European breeds.
* Adipose tissue in hump of camel upon metabolism can yield amount of water greater than original mass of fat.
* Milk yield declines in Holstein cattle at 21ºC, in Brown Swiss and Jersey at 24-27ºC and in Brahman cattle at 32ºC.
* Poikilotherms are animals whose body temperature varies with the temperature of the environment
* **Poikilotherms** are known as temperature conformers (Cold blooded) and homeotherms are temperature regulators (Warm blooded)
* Heat loss mechanism:

i) Sensible heat loss by radiation, convection and conduction

ii) Insensible heat loss by Evaporation of water

* Horse, Camel and Man are true sweating species.
* Birds, Dog, Cat and Pigs are Nonsweating species.
* **Van’t Hoff effect:** Represent two to three fold increases in heat production brought about by a 10ºC increase in tissue temperature.
* The principal difference between fever and hyperthermia is that the thermoregulatory mechanism are little activated in fever but fully activated in hyperthermia**.**
* **General Adaptation Syndrome (GAS)**
* GAS describes the body's short-term and long-term reactions to stress, identified by Hans Selye.
* It involves a specific sequence of physiological responses to stressors such as extreme physical activity, temperature changes, infections, trauma, and lack of food or water.
* **Stress Response in Animals**
* Stress causes a rise in plasma glucocorticoid levels.
* The initial stress phase triggers a **"fight or flight"** response, preparing the body for physical activity.
* During this involuntary phase, the hormone epinephrine (adrenaline) is released, along with other biochemical messengers, which can decrease immune system effectiveness.
* **Photoperiodic Action**
* Mediated through the hypothalamus, increasing light exposure reduces melatonin secretion duration.
* This altered melatonin pattern influences the secretion of various hormones, affecting growth, reproduction, and lactation.
* **Biological Rhythm -** Refers to the cyclic repetition of biological activities in animals over a specific period.
* **Biological Clock -** The hypothetical internal mechanism that sets and regulates cyclic changes in various physiological processes.
* **Supra-Chiasmatic Nucleus -** The supra-chiasmatic nucleus (SCN) of the hypothalamus sets the biological clock, connected to the retina via retinohypothalamic fibers. Environmental factors influence the biological clock by acting on the organism.
* **Circadian Rhythm -** The term "circadian" is derived from Latin, meaning "around a day". It refers to the regular recurrence of physiological processes or activities that occur in a 24-hour cycle.
* **Circadian rhythms** are biological rhythms occurring every 24 hours, also known as **Free Running Period (FRP)** when in constant conditions. These rhythms are self-generated (endogenous) and primarily influenced by light intensity and temperature.
* **Pineal Gland and Circadian Rhythm**
* The pineal gland regulates circadian rhythm and is known as the **natural or indirect clock.**
* Photoperiod influences animals through the pineal gland.
* Melatonin is released during specific intervals, depending on the photoperiod (day length).
* Light inhibits melatonin production, resulting in higher blood concentrations of melatonin during the dark (night).
* **Dysbarism -** Also known as bends, Caisson's disease, or divers paralysis.
* Occurs when animals are taken from lower altitude to higher altitude.
* Mainly caused by nitrogen (N2).As animals ascend to high altitude, nitrogen escapes from the dissolved state in the blood, forming bubbles.
* **Bends -** A condition characterized by joint pain, typically in the legs, arms, and neck region.
* **Non-Shivering Thermogenesis (NST)**
* Definition: NST is the production of heat without muscular activity, achieved through the uncoupling of ATP production or by engaging in futile cycles.
* Brown Adipose Tissue (BAT):
* Purpose: BAT is specialized for thermogenesis.
* Location: Found in cervical and thoracic regions, near the central nervous system and heart.
* Characteristics: Contains fat-metabolizing enzymes, innervated by sympathetic nerves, rich in mitochondria and cytochromes, and highly vascularized.
* Occurrence: Present only in mammals, particularly neonates, hibernators, and cold-adapted species.
* Mechanism: Heat is generated by uncoupling oxidative phosphorylation in mitochondria. This process dissipates the proton gradient as heat instead of using it to synthesize ATP, involving an uncoupling protein.
* **NST in Birds:**
* Lack of BAT: Birds do not have BAT.
* Evidence of NST:
* Metabolic Rate Increase: Birds' metabolic rate increases before shivering starts as the ambient temperature (Ta) decreases.
* Shivering and MR Relationship: At very low Ta, shivering remains constant, but the metabolic rate continues to increase as Ta drops.
* **Heat Production Relative to Body Size**
* **Larger Bodies:** Produce more heat due to a greater volume.
* **Heat Loss:** Smaller bodies lose heat more rapidly because their surface area is larger in proportion to their volume.
* **Heat Production Requirement:** Smaller animals must generate relatively more heat to maintain a constant body temperature compared to larger animals.
* **Sweating:**
* **Eccrine Glands:** Produce an aqueous secretion, innervated by cholinergic fibers of sympathetic nerves. Responsible for thermal sweating in humans.
* **Apocrine Glands:** Produce a protein-containing secretion from hair follicles, sensitive to epinephrine in the blood. Important for evaporative cooling in many domestic animals.
* Thermoregulatory Sweating: Triggered by skin warmth receptors and increased hypothalamic temperature.
* **Species Variations:**
	+ **Equines:** Sweating controlled by sympathetic nerves with epinephrine as the transmitter.
	+ **Dogs:** Insignificant sweating for heat regulation; rely on polypnea and panting.
	+ **Cows and Sheep**: Cows have significant evaporative cooling through the skin, while respiratory evaporation is more critical in sheep. Zebu cattle have a higher sweat gland density compared to European breeds.
1. **Fill in the blanks:**
2. Meteorological conditions immediately surrounding the individuals is called \_\_\_\_\_\_\_.
3. Study of relationship between animals, plants and environment is known as \_\_\_\_\_\_\_.
4. \_\_\_\_\_\_\_\_\_is a true sweating species.
5. ­­­­­­­­­­­­­­\_\_\_\_\_\_\_is an index of core body temperature in animals.
6. Centre for thermoregulation is located in \_\_\_\_\_\_\_.
7. Study of animal behavior is known as \_\_\_\_\_\_\_.
8. \_\_\_\_\_\_\_ is a warm blooded animal which maintains a constant body temperature despite changes in environmental temperature.
9. \_\_\_\_\_\_\_ is the range of environmental temperature within which the metabolic rate is minimum and constant.
10. Sensible ways of heat loss are \_\_\_\_\_\_\_, \_\_\_\_\_\_\_, \_\_\_\_\_\_\_.
11. Methods of heat gain during cold exposure are \_\_\_\_\_\_\_ and \_\_\_\_\_\_\_thermogenesis.
12. According to \_\_\_\_\_\_\_, Mammalian and avian breeds which inhabit warm and humid regions have more melanin pigmentation than those of the same species in cooler and drier regions.
13. \_\_\_\_\_\_\_, The smaller-sized breeds of a given species are found in the warmer parts of the ecological range, the larger-sized breeds in the cooler localities.
14. In Brahman Cattle (Indian breeds) - The large pendulous flaps, such as the neck and naval folds, prepuce and ears – act as ‘radiators’ dissipating heat to the atmosphere and this probably accounts for the superior \_\_\_\_\_\_\_ of these animals.
15. \_\_\_\_\_\_\_, The protruding body organs, eg: extremities, tails and ears are relatively shorter in the cooler parts of the ecological range of the species than in the warmer areas.
16. Birds increases heat loss by a mechanism named \_\_\_\_\_\_\_ which consists of rapid oscillation of their floor of the mouth and the upper part of the throat.
17. \_\_\_\_\_\_\_ is a behavioral and physiological adjustment to cold employed by some homeotherms.
18. \_\_\_\_\_\_\_ is a climatic condition of a larger area.
19. \_\_\_\_\_\_\_ refers to adaptive changes in response to a single climatic variable.
20. Normal body temperature in Poultry is \_\_\_\_\_\_\_.
21. \_\_\_\_\_\_\_Insensible water loss becomes sensible, once environmental temperature shoots above 35 ºC.
22. Science of study of behavior is generally termed as \_\_\_\_\_\_\_.
23. Larger the area of associative cortex, better will be memory.
24. A comprehensive descriptive analysis of different behavior exhibited by a particular species is known as \_\_\_\_\_\_\_.
25. Temperature below which shivering and nonshivering mechanism operate is called \_\_\_\_\_\_\_.
26. Transfer of heat from one place to another without the use of any medium is \_\_\_\_\_\_\_.
27. The ears of pigs and rodents in a hot environment are \_\_\_\_\_\_\_ than those of animals native to colder areas.
28. Animals that normally inhabit desert areas, such as the Camel, tend to have exceptionally \_\_\_\_\_\_\_ legs.
29. Animals inhabiting warm and humid regions show greater \_\_\_\_\_\_\_ than those found in cooler drier areas.
30. Acclimatization to cold seems to be accompanied by an increase in \_\_\_\_\_\_\_ thickness.
31. In Brahman cattle (Indian breed), the size and number of glands per skin area are \_\_\_\_\_\_\_ than in European breeds.
32. In fever, the “set point” is raised due to the presence of \_\_\_\_\_\_\_.

**B) Multiple Choice Questions**

1. Short term day to day fluctuations in meteorological parameters are termed as
	1. Climate
	2. Macroclimate
	3. Microclimate
	4. Weather
2. Animals which can maintain their body temperature are called
	1. Homeotherms
	2. Isotherms
	3. Poikilotherms
	4. Monotherms
3. Evaporative cooling is most efficient at
	1. 30% RH
	2. 50% RH
	3. 75% RH
	4. 90% RH
4. The ratio of the amount of water vapors actually in air to the amount of water vapors that air can hold at a given temperature and pressure is called
	1. Specific humidity
	2. Relative humidity
	3. Absolute humidity
	4. Mixed ratio
5. The class of adrenal gland hormones that produce anti-inflammatory effects and promote normal metabolism to ensure adequate quantity of ATP during stress is
	1. Glucocorticoids
	2. Mineralocorticoids
	3. Catecholamines
	4. Gonadocorticoids
6. Choose the most appropriate statement
	1. Upper critical temperature is more detrimental than lower critical temperature
	2. Lower critical temperature is more detrimental than upper critical temperature
	3. Upper and lower critical temperatures have no effect on the body
	4. Upper and lower critical temperatures have the same effect on the body
7. A long-term adaptive physiological adjustment which results in increased tolerance to continuous or repeated exposure to complex climatic stressors
	1. Acclimation
	2. Acclimatization
	3. Habituation
	4. None of the above
8. Adaptive changes in response to a single climatic variable
	1. Acclimation
	2. Acclimatization
	3. Physiological adaptation
	4. None of the above
9. Sweating is an effective cooling mechanism because:
	1. Sweat secretion produces heat, which is carried to the skin surface in sweat
	2. Conversion of sweat into water vapor requires heat, which is supplied to the skin by blood flow
	3. Sweat dripping from the body carries away a large amount of heat
	4. The ions in sweat carry large amounts of heat from the body
10. In the cold, animals both conserve and produce heat. Which of the following is a method of heat conservation?
11. Shivering
12. Brown fat metabolism
13. Increased thyroxine secretion
14. Countercurrent heat exchange in the limbs
15. All of the above
16. Which of the following methods of heat loss can occur in an animal (body temperature =39ºC) standing in a room (temperature =42ºC) with relative humidity of zero? The walls of the room have a temperature of 31ºC.
17. Convection and evaporation
18. Convection and radiation
19. Evaporation and radiation
20. Radiation alone
21. Which of the following describes thermoregulation?
22. Temperature receptors in both the brain and the skin can initiate thermoregulatory responses
23. The brain temperature receptors have a greater influence on thermoregulation than do skin receptors
24. The core temperature at which shivering begins is higher if the skin is cold than if it is warm
25. Skin cooling can initiate shivering even if core temperature is normal
26. All the above
27. Which of the following correctly describes fever?
28. It results when the set point for body temperature decreases
29. It is accompanied by sweating to lose heat as body temperature rises
30. It is accompanied by shivering to gain heat as body temperature decreases when pyrogens are metabolized
31. It can be initiated by pyrogens from bacteria or leukocytes
32. All the above
33. Cattle of high altitude have
34. Higher hemoglobin affinity for oxygen
35. Increase in RBC count and hemoglobin
36. Decrease in PCV
37. None of the above
38. In Sheep of temperate regions, the wool production is
39. Maximum during winters
40. Maximum during summers
41. Unaffected by season
42. None of the above
43. Shivering may increase oxygen consumption by
44. 100%
45. 200%
46. 300%
47. 400%
48. Camel tolerate extreme heat of deserts because it
49. Drinks more water
50. Can pant
51. Can rise its body temperature
52. Can sweat profusely
53. The PO2 of dry atmospheric air approximates
54. 40 torr
55. 100 torr
56. 160 torr
57. 760 torr
58. The thermostat-like heat-regulating center of mammals is in the
59. Pons
60. Medulla Oblongata
61. Hypothalamus
62. Cerebrum
63. In man, thermal sweating is produced by
64. Eccrine glands
65. Apocrine glands
66. Paracrine glands
67. Autocrine glands
68. In domestic animals, thermal sweating is produced by
69. Eccrine glands
70. Apocrine glands
71. Paracrine glands
72. Autocrine glands
73. One of the animals without sweat glands
74. Cow
75. Dog
76. Rabbit
77. Sheep
78. Region of biosphere in which normal metabolic processes of organisms take place
79. Parabiosphere
80. Environment
81. Eubiosphere
82. Atmosphere
83. Animals that allow their internal environment to be controlled by external factors are known as
84. Regulators
85. Conformers
86. Heterotherms
87. Endotherms
88. At 40ºC ambient temperature, which of the following ways of heat loss is most important in Sheep?
89. Evaporation
90. Conduction
91. Convection
92. Radiation
93. Endogenous pyrogen leading to the development of fever
	1. Interleukin-I
	2. Prostaglandin-E1
	3. Interferon
	4. Acetylsalicylic acid
94. The rate of entry into torpor in birds is
	1. Directly related to body size
	2. Inversely related to body size
	3. Has no relation to body size
	4. None of the above
95. Receptors which are responsible for sensing cold are
96. Ruffinis endings
97. Pacinian corpuscle
98. Meissners corpuscle
99. End bulb of Krause
100. The highest environmental temperature at which the animals can no longer maintain its life protective processes is referred to as
	1. Upper lethal temperature
	2. Upper critical temperature
	3. Lower critical temperature
	4. Comfort zone
101. Which one of the following animals has the greatest heat loss from sweating?
	1. Sheep
	2. Cat
	3. Dogs
	4. Horses
102. The average rectal temperature in a healthy cow should be about
	1. 98.6ºF
	2. 101.5 ºF
	3. 104 ºF
	4. 106.5 ºF
103. The primary motor center for shivering is located
	1. Posterior pituitary
	2. Anterior pituitary
	3. Anterior Hypothalamus
	4. Posterior Hypothalamus
104. The primary motor center for heat loss is located
	1. Posterior pituitary
	2. Anterior pituitary
	3. Anterior Hypothalamus
	4. Posterior Hypothalamus
105. Sweat glands include
	1. Apocrine
	2. Eccrine
	3. Scent gland
	4. All the above
106. Animal loses body temperature more easily when exposed to
	1. Cold
	2. Heat
	3. Thermal Neutral Zone
	4. None of the above
107. Smearing body with saliva is a response to heat in
	1. Dog
	2. Cat
	3. Cattle
	4. Buffalo
108. In the temperate zone, the growth rate of animals is reduced due to poor quality of fodder available during
	1. Winter
	2. Summer
	3. Fall
	4. All of the above
109. The most important environmental factor required for normal reproduction in poultry is
	1. Relative humidity
	2. Light
	3. Geomagnetism
	4. Temperature
110. The hormone associated with stress is:
	1. Adrenaline
	2. Cortisol
	3. Insulin
	4. Thyroxine
111. The term used for animals that sleep during the summer is:
	1. Hibernation
	2. Torpor
	3. Estivation
	4. Diapause
112. Animals that sleep during the winter are said to be in:
	1. Estivation
	2. Hibernation
	3. Brumation
	4. Aestivation
113. Animals that are temperature conformers are known as:
	1. Homeotherms
	2. Ectotherms
	3. Endotherms
	4. Poikilotherms
114. Animals that regulate their body temperature internally are called:
	1. Poikilotherms
	2. Homeotherms
	3. Ectotherms
	4. Mesotherms
115. Avoiding painful stimuli by the animal is due to
	1. Short term memory
	2. Medium term memory
	3. Long term memory
	4. Immediate memory
116. Stress causes the adrenal medulla to release
	1. Norepinephrine and ANP
	2. Epinephrine and Norepinephrine
	3. Epinephrine and vasopressin
	4. Epinephrine, norepinephrine and vasopressin
117. Absolute photo-refractoriness is seen in
	1. Chicken
	2. Turkey
	3. Pigeon
	4. Ducks
118. General Adaptation syndrome is activated by the
	1. Hypothalamus
	2. Pituitary gland
	3. Adrenal gland
	4. Thyroid gland
119. Brown fat when compared to white fat
	1. A major site of lipid storage
	2. Has fewer mitochondria
	3. An important source of heat production
	4. Forms large subcutaneous deposits for heat production
120. Agonistic behavior indicates
	1. Aggression
	2. Feeding
	3. Sexual behavior
	4. Grouping
121. Trend in avian and mammalian species with the evolution of larger average body sizes (such as Penguins) in cold climate species compared to warm climate relatives.
	1. Bergman’s rule
	2. Allen’s rule
	3. Golger’s rule
	4. Fick’s Principle
122. Awakening gland in hibernation
	1. Hypophysis cerebri
	2. Brown adipose tissue
	3. Heart
	4. Pituitary
123. Which of the following is used to measure indoor wind velocity?
	1. Cup anemometer
	2. Kata thermometer
	3. Wind vane
	4. Barometer

**C. Match the following.**

1. Match the following.

|  |  |
| --- | --- |
| i. Stress | 1.Poikilotherms |
| ii. Summer Sleep  | 2.Homeotherms |
| iii. Temperature Regulators  | 3. Hibernation |
| iv. Winter Sleep | 4. Cortisol |
| v. Temperature Conformers  | 5. Estivation |

2.Match the Biological Conditions with their Descriptions

|  |  |
| --- | --- |
| i. Circadian Rhythm | 1. Right heart failure in cattle at high altitudes.  |
| ii. Dysbarism | 2. Condition characterized by joint pain, typically in the legs, arms, and neck region. |
| iii. Brisket Disease | 3. Regulation of biological activities in a 24-hour cycle |
| iv. Mountain Sickness | 4. Symptoms include distress, fatigue, and disturbances in circulatory, respiratory, and reproductive systems at high altitudes. |

3.Match the Meteorological Instruments with their Uses

|  |  |
| --- | --- |
| i. Cup anemometer | 1. Measures atmospheric pressure. |
| ii. Barometer | 2. Indicates wind direction. |
| iii. Wind vane | 3. Measures wind speed |
| iv. Kata thermometer | 4. Measures air temperature with high precision |

4. Matching Definitions with Terms

|  |  |
| --- | --- |
| i. Climatology | 1. The study of historical climate changes through examining records like ice cores and tree rings. |
| ii. Climograph | 2. A graphical representation showing monthly average temperature and precipitation for a specific location. |
| iii. Paleoclimatology | 3. Scientifically defined as the average weather conditions over a period of time. Derived from Greek "klima" (place, zone) and "-logia". |
| iv. Weather | 4. Short-term day-to-day fluctuations of meteorological variables. |
| v. Climate | 5. The long-term (over 30 years) average condition of meteorological variables in a given region. |
| vi. Microclimate | 6. Climatic conditions directly surrounding the animal. |

5. Matching Physiological Responses with Terms

|  |  |
| --- | --- |
| i.Physiological Adaptation | 1. A long-term adaptive physiological adjustment which results in an increased tolerance to continuous or repeated exposure to complex climatic stressors. |
| ii. Acclimatization | 2. The lowest ambient temperature at which an animal or bird can maintain its body temperature at basal metabolic rate. |
| iii. Acclimation | 3. Adaptive changes in response to a single climatic variable. |
| iv. Critical Temperature | 4. The capacity and process of adjustment of the animal to itself and its external environment. |

6. Matching Climate Classifications with Descriptions

|  |  |
| --- | --- |
| i. Macroclimate | 1. Climate characteristics of a large geographic area or open atmosphere. |
| ii.Mesoclimate | 2. Climatic conditions in the immediate surroundings of an organism. |
| iii. Microclimate | 3. Climate conditions of a relatively small and specific area on the Earth's surface. |
| iv. Monsoon Climate | 4. Characterized by a dry winter and a wet summer, typically found in tropical regions. |

7. Matching Ecological Rules with Adaptations

|  |  |
| --- | --- |
| i. Golger's Rule | 1. More melanin pigmentation in hot and humid regions. |
| ii. Bergmann's Rule | 2. Shorter extremities, tail, and ears in cooler regions. |
| iii. Allen's Rule | 3. Smaller body size in warmer regions, larger size in cooler regions. |
| iv. Wilson's Rule | 4. Thicker fur or adipose tissue in colder regions. |

8. Match the following animal characteristics with the adaptations they represent.

|  |  |
| --- | --- |
| i. Sensible heat loss | 1. The initial stress phase that prepares the body for physical activity through hormone release |
| ii. Insensible heat loss | 2. The body's short-term and long-term reactions to stress, involving a sequence of physiological responses. |
| iii. General Adaptation Syndrome (GAS) | 3. Evaporation of water |
| iv. Fight-or-flight response | 4. Radiation, convection, conduction |
| v. Sets the internal biological clock based on light exposure. | 5. Releases melatonin |

9. Matching Biological Timekeeping with Mechanisms

|  |  |
| --- | --- |
| i. Photoperiodic Action | 1. The internal mechanism that sets and regulates cyclic changes in physiology. |
| ii. Biological Clock | 2. The specific part of the hypothalamus that sets the biological clock and is influenced by light. |
| iii. Circadian Rhythm | 3. The influence of light exposure on melatonin secretion, affecting hormones and physiology. |
| iv. Suprachiasmatic Nucleus (SCN) | 4. The regular recurrence of biological processes occurring in a 24-hour cycle. |

10. Match the following terms with their descriptions.

|  |  |
| --- | --- |
| i. Hibernation | 1. A state of dormancy in insects during unfavorable conditions. |
| ii. Torpor | 2. A period of inactivity and lowered body temperature in warm-blooded animals during winter. |
| iii. Estivation | 3. A general term for a state of inactivity and lowered physiological activity. |
| iv. Diapause | 4. A period of dormancy in some cold-blooded animals during hot and dry periods. |

11. Match the following tactile receptors with their functions.

|  |  |
| --- | --- |
| i. Ruffini endings | 1. Sensitive to deep pressure and stretch. |
| ii. Pacinian corpuscle | 2. Sensitive to light touch and texture. |
| iii. Meissner corpuscle | 3. Sensitive to cold temperatures. |
| iv. End bulb of Krause | 4. Sensitive to vibrations of low frequency. |

**Answers**

**A. Fill in the blanks**

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Microclimate | 16 | Hibernation |
| 2 | Ecology | 17 | Macroclimate |
| 3 | Horse (Many species sweat, but the question asks for a true sweating species) | 18 | Acclimation |
| 4 | Rectal temperature | 19 | 107º F |
| 5 | Hypothalamus | 20 | True |
| 6 | Ethology | 21 | Ethology |
| 7 | Homeotherm | 22 | True |
| 8 | Thermal neutral range | 23 | Ethogram |
| 9 | Radiation, Conduction, Convection | 24 | Lower Critical Temperature |
| 10 | Shivering and nonshivering thermogenesis | 25 | Radiation |
| 11 | Golger’s Rule | 26 | Longer |
| 12 | Bergmann’s Rule | 27 | Long |
| 13 | Heat tolerance | 28 | Pigmentation |
| 14 | Allen’s Rule | 29 | Skin |
| 15 | Gular flutter | 30 | Greater |
|  |  | 31 | Pyrogen |

**B. MCQs**

1. d
2. a
3. a
4. b
5. a
6. a
7. b
8. a
9. b
10. d
11. c (Evaporative and radiation. Radiation is possible because the wall temperature is lower than the animal's body temperature)
12. e (All of the above)
13. d (All of the above)
14. b (Increase in RBC count and hemoglobin)
15. a (Maximum during winters)
16. d (400%)
17. c
18. c
19. c
20. a
21. b
22. c
23. c
24. b
25. a
26. a
27. b
28. d
29. a
30. d
31. b
32. d
33. c
34. d
35. a
36. b
37. a
38. b
39. b
40. c
41. b
42. d
43. b
44. c
45. b
46. b
47. a
48. c
49. a
50. a
51. b
52. a

**C. Match the following.**

|  |  |
| --- | --- |
| 1 | i-4, ii-5, iii-2, iv-3, v-1 |
| 2 | i-3, ii-2, iii-1, iv-4 |
| 3 | i-3, ii-1, iii-2, iv-4 |
| 4 | i-3, ii-2, iii-1, iv-4, v-5, vi-6 |
| 5 | i-4, ii-1, iii-3, iv-2 |
| 6 | i-1, ii-3, iii-2, iv-4 |
| 7 | i-1, ii-3, iii-2, iv-4 |
| 8 | i-4, ii-3, iii-2, iv-1, v-5 |
| 9 | i-3, ii-1, iii-4, iv-2 |
| 10 | i-2, ii-3, iii-4, iv-1 |
| 11 | i-2, ii-4, iii-1, iv-3 |