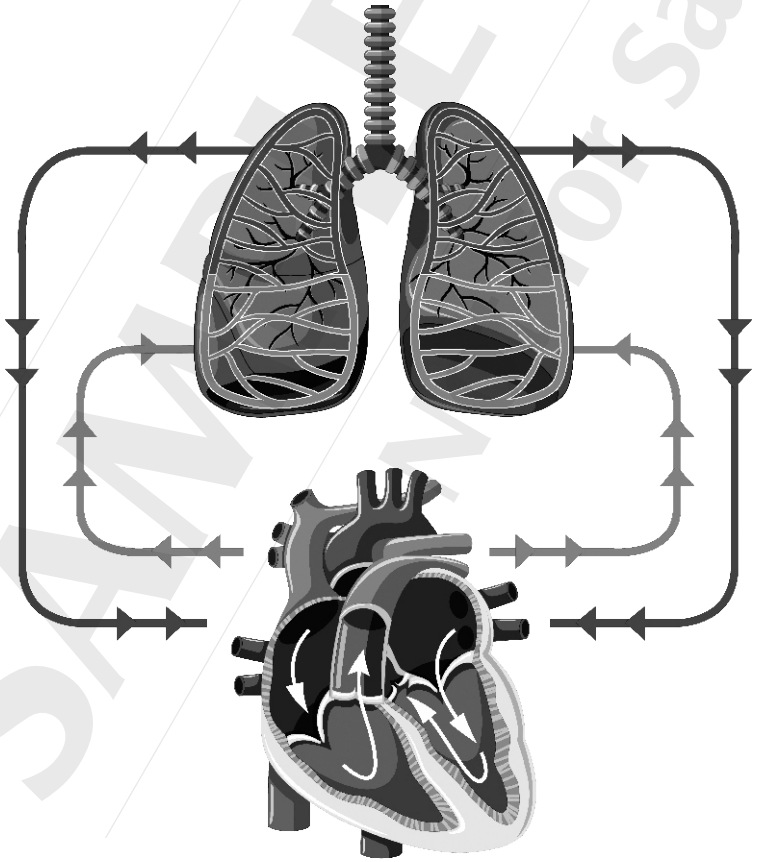
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Class 12th

Unique Notes

BIOLOGY

Prepared for the Session 2026-27
According to the New Curriculum of PECTAA 2025-26



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UNIQUE NOTES, BIOLOGY 12th

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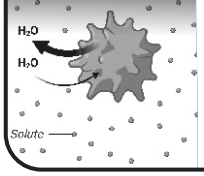
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Chapter 13



THERMOREGULATION AND OSMOREGULATION

Homeostasis
Osmoregulation
Problems & Methods of Osmoregulation
Thermoregulation
Feedback mechanisms
Ectotherms, Endotherms
Poikilotherms
Homeotherms

DESCRIPTIVE QUESTIONS

HOMEOSTASIS

Q1. What is Homeostasis? Describe three elements which operate homeostatic mechanisms. 12413001

Ans. Homeostasis

Homeostasis is vital process by which living organisms maintain a stable internal environment within a narrow range despite changes in their external surroundings. Homeostasis consists of a wide range of mechanisms that work in a coordinated fashion to regulate the body's internal environment.

Basic Mechanism of Homeostasis

Homeostasis is maintained through the collaboration of three essential elements i.e., receptors, control center, and effectors.

1. Receptors

Receptors or sensors are specialized structures (organs, tissues, cells or subcellular components) that detect changes in the internal or external environment. They also transmit the information of changes to the control center.

Examples:

- Receptor cells present in the skin can detect changes in temperature.
- Receptor cells in the blood vessels can detect changes in blood pressure.

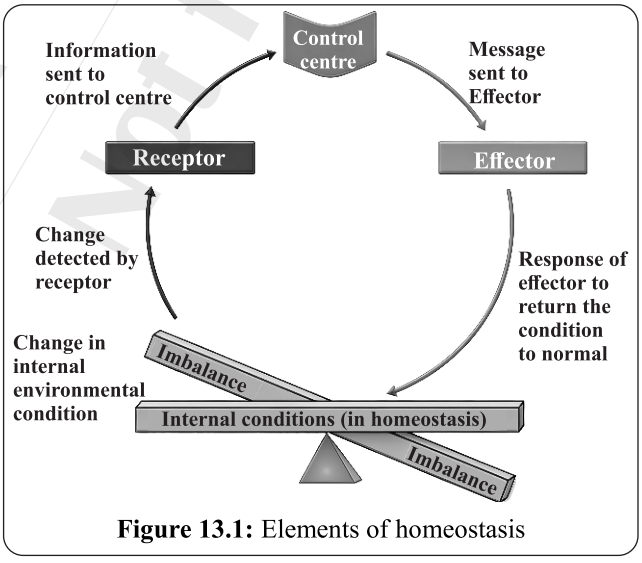


Figure 13.1: Elements of homeostasis

2. Control Centre

The component of homeostasis which have the ability to receive information from the receptors, process this information, and send appropriate message to the effectors. This coordination between these elements keeps the internal environment within narrow range which is optimal for the body's normal function. The brain, spinal cord and endocrine glands act as control centers in homeostasis.

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3. Effectors

Effectors are parts of the body which respond and perform actions when they receive message from the control centers.

Example: Muscles and glands act as effectors.

- Muscles respond by contracting while glands release their secretion. In this way, the responses of effectors restore the internal environment to its set points. When the body temperature drops below the set point, effectors in the skin cause vasoconstriction and muscles cause shivering. This response increase heat production and raises the body temperature to the set point.

Q2. Define feedback mechanism. Also relate the homeostatic mechanisms with the negative feedback system. **12413002**

Ans. Feedback Mechanisms

Feedback mechanisms are the regulatory processes in which the output or product of a system is used to control the behavior of the system itself.

Negative feedback mechanism

The type of feedback mechanism in which response is against (opposite direction) the initial stimulus is called negative feedback mechanism. The output or product of a system reduces the activity of the system and it is the most common form of regulation / feedback mechanisms.

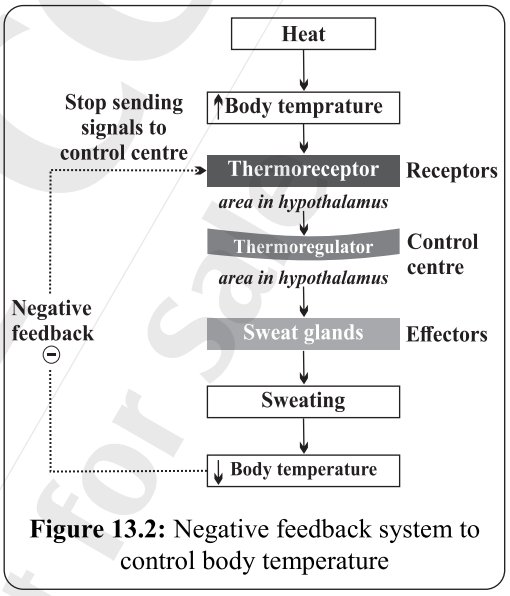


Figure 13.2: Negative feedback system to control body temperature

Examples:

Common examples of negative feedback include the regulation of body temperature, blood glucose levels, serum calcium levels, blood pressure and hormonal secretions.

Regulation of body temperature as an example of negative feedback mechanism:

When the core temperature exceeds the set point of **37°C,** the **thermoreceptors** in the hypothalamus of brain detect this change and send signals to the **control centre** (thermostat in hypothalamus). Then the control centre sends message to **effectors** (e.g., sweat glands) which respond by producing sweat, lowering the body temperature. The output of this process (lowering of temperature to the set point) influences the thermoreceptors negatively. As a result, the thermoreceptors stop sending message to the control centre to prevent hypothermia.

Q3. Define feedback mechanism. Also relate the homeostatic mechanisms with the positive feedback system. **12413003**

Ans. Feedback Mechanisms

Feedback mechanisms are the regulatory processes in which the output or product of a system is used to control the behavior of the system itself.

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Positive feedback mechanism

The type of feedback mechanism in which response is in the same direction to the initial stimulus is called positive feedback mechanism. The output or product increases the activity of the system. In this way, the positive feedback enhances the original stimulus. In homeostasis, positive feedback is less common than negative feedback.

Examples

It often happens in the processes that require rapid and significant changes e.g., blood clotting, labour, child birth and lactation.

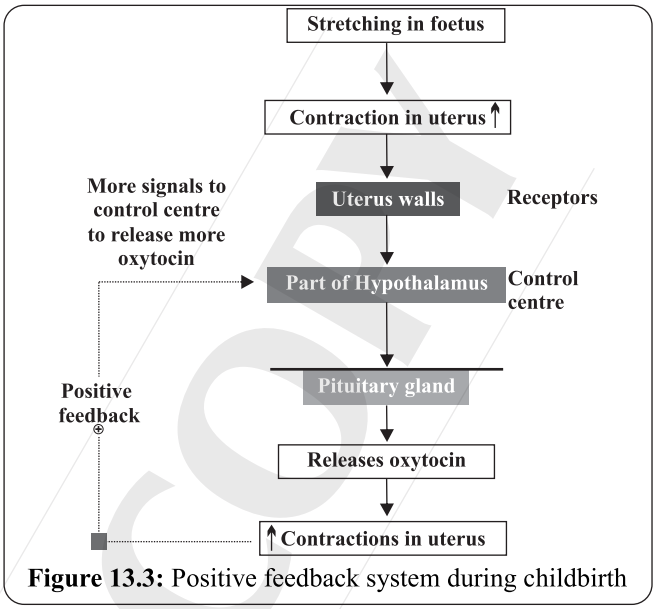


Figure 13.3: Positive feedback system during childbirth

Parturition (Childbirth) as an example of positive feedback mechanism: During childbirth, contractions in the smooth muscles of myometrium in the **uterus** send nerve impulses to the **control center** (part of hypothalamus) which send signals to **posterior pituitary gland** to release **oxytocin hormone.** Oxytocin then stimulates further the smooth muscles of uterus to contract more powerfully, which in turn sends more nerve impulses to hypothalamus, leading to the release of more oxytocin to aid in childbirth. This positive feedback loop continues until the baby is born.

Effect of un-regulated positive feedback on human;

Sometime, the un-regulated positive feedback systems can result in health problems. For example, in severe inflammation or infection, the immune cells release proteins called cytokines. These proteins further stimulate the immune response. If this positive-feedback is not properly regulated, it can lead to excessive inflammation and tissue damage.

OSMOREGULATION

Q4. Define osmoregulation. Also describe the classification of animals on the basis of osmoregulation. 12413004

Ans. Osmoregulation

The maintenance of the balance of water levels and solute concentration in the body fluids (blood, urine, saliva, CSF) is called osmoregulation. It ensures that the body fluids do not become too dilute or too concentrated to interfere with metabolism and physiological processes, including the maintenance of blood pressure, enabling the proper functioning of organs (especially vital organs).

Classification of animals on the basis of osmoregulation

On the basis of the ability of osmoregulation, the animals are divided into two groups i.e., **osmoconformers** and **osmoregulators.**

1. Osmoconformers

The animals which allow the osmotic concentrations of their body fluids to match their environment are called osmoconformers. They cannot maintain the concentration of water and solutes in their bodies, changing the concentrations with change in the surrounding medium to remain isotonic to their environment.

Habitat: These animals are usually found in marine water (environment with relatively stable solute concentrations).

Examples of osmoconformers include all marine invertebrates, some freshwater invertebrates and some marine vertebrates like hag fishes, sharks and rays.

2. Osmoregulators

The animals which have the ability to actively regulate the concentrations of water and solute in their body fluids are called osmoregulators. They use to maintain constant internal concentrations despite changes in external environment, by active transport of salts, accumulation of salts, and water conservation mechanisms.

Examples include most vertebrates in aquatic (fishes) and terrestrial (amphibians, reptiles, birds and mammals) environments are osmoregulators.

PROBLEMS AND METHODS OF OSMOREGULATION

Q5. Explain the different methods of osmoregulation found in freshwater and marine water. **12413005**

Ans. Osmoregulation is one of the most crucial process for the regulation of body metabolism and proper functioning of vital organs of all forms of life. The animals of different habitats adapt various methods for osmoregulatory adjustments, examples are as follow:

1. Osmoregulation in Freshwater

Generally, the freshwater animals are hypertonic to their environment. It means that they have higher solute concentration in body fluids than the surrounding water. Water tends to continuously enter their bodies through osmosis, particularly across permeable surfaces like gills. Essential salts and ions (like Na^+ and Cl^-) diffuse out of the body into the surrounding water.

Mechanism / adaptations regarding osmoregulation in fresh water

i. **Removal of excess water;** in osmoregulation, the animals of fresh water environment have to prevent water from entering their bodies and to eliminate the excess water that does enter. For this purpose, their kidneys are adapted to produce large volumes of diluted urine, which also leads to loss of some amount of salts from their body.

ii. **Compensation of the loss of salts**, they actively transport salts back into their bodies through gills and skin. Unlike marine water animals, freshwater animals rarely drink water.

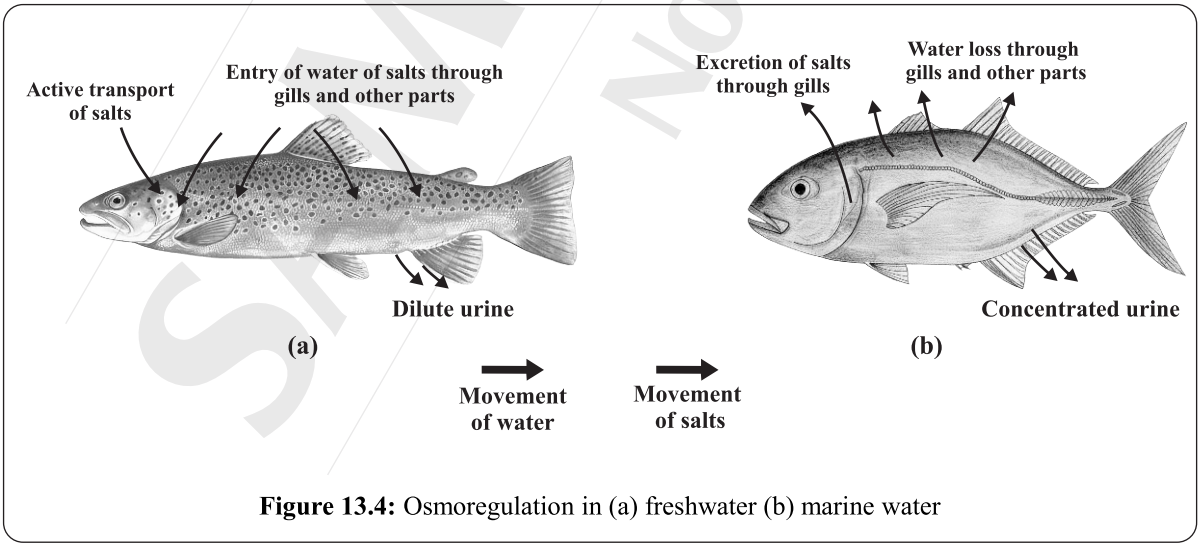


Figure 13.4: Osmoregulation in (a) freshwater (b) marine water

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Examples: Most fishes, Amoeba, Paramecium.

2. Osmoregulation in Marine Water

Most marine animals are hypotonic to their environment. This means that external environment has a much higher solute (salt) concentration than their internal tissues. Water constantly leaves their bodies via osmosis through the gills and skin. They have excess of salts in the body because salts continuously diffuse from the environment into their bodies and due to drinking of sea water.

Mechanism / adaptations regarding osmoregulation in marine water

The fishes living in marine water have to conserve water and remove excess salts. This is achieved by the following strategies;

i. **Production of highly concentrated urine**: As water tends to leave their bodies constantly these fishes **drink sea water** all the time to compensate for the water loss and their **kidneys** conserve water by producing very small amounts of highly concentrated urine.
ii. **Removal of excess salts:** To remove the excess salts, specialized **chloride cells** in the gills use energy (ATP) to actively pump salts out of the blood and back into the environment. The excess salt is removed through their **kidneys** and some marine fishes also have special salt excreting glands in rectum called **rectal glands**, which remove salts from blood into the digestive tract to eliminate along with faeces.

Examples: Bony fishes and Hag fishes.

Q6. Elaborate the osmoregulation in terrestrial habitats. Also describe their osmoregulatory adaptations. **12413006**

Ans. Osmoregulation in Terrestrial Habitats

The major problem of terrestrial animals is the evaporative loss of water to the atmosphere from respiratory surfaces, through the skin, and via the excretion of wastes. They have to ensure that water intake (from drinking and food) and metabolic water production is equal to the water lost to the environment. So, these animals are provided with anatomical, physiological, and behavioral adaptations to maintain osmotic balance which are as follow;

i) Anatomical adaptations: They have relatively impermeable outer layers to prevent evaporative water loss:

- Insects possess a **waxy exoskeleton** made of chitin.
- Reptiles have **waterproof scales** made of keratin.
- Mammals and birds have **dead keratinized skin** cells and also have sebaceous glands (**oil secreting glands** which secrete a hydrophobic thin layer of oil**)**.

ii) Physiological adaptations

- Kidneys play a vital role to **retain water** inside the body by the reabsorption of water from filtrate.
- Liver converts the primary waste product of protein metabolism i.e., ammonia into urea or uric acid **(by urea cycle)** which requires less amount of water for excretion.

iii) Behavioral adaptations

- Many desert animals **stay underground** during the heat of the day to avoid evaporation. They emerge only at night when the air is cooler and more humid.
- Terrestrial animals feed upon seeds of desert plants in which large amount of carbohydrates are stored.

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- **For example:** Some animals, like the Kangaroo rat, survive entirely on **water of metabolism** (produced as a by-product of cellular respiration).

Q7. Explain the nature of nitrogenous wastes in relation to habitats. 12413007

Ans. **Nature of Excretory Products in relation to Habitats**

In many animals, osmoregulation is coupled with the removal of metabolic wastes from the body. The nitrogenous wastes (e.g., ammonia, urea, uric acid) are the main metabolic wastes. These wastes are excreted as water solutes. The animals of different types of habitats excrete different forms of nitrogenous wastes.

Types of Nitrogenous wastes

1. Ammonia – NH_3

- It is produced when amino group (-NH_2) is removed from amino acids or nucleic acids and is combined with H^+ to form ammonia (NH_3) in the liver. Ammonia is highly toxic and so it is excreted rapidly.
- One gram of ammonia requires **500 mL of water** to dissolve it to nontoxic level. Such plenty of water can only be afforded by freshwater animals.
- Animals which excrete ammonia as their major nitrogenous waste product are called **ammonotelic.**
- **Examples:** Most fishes, protozoans, sponges, and coelenterates. The marine animals excrete ammonia directly into the water.

2. Urea – $CO(NH_2)_2$

- As the terrestrial animals face the challenge of conserving water, they cannot afford to excrete ammonia with a plenty of water. They convert ammonia to urea in their liver and then excrete urea through kidney. Urea is less toxic than ammonia.
- One gram of urea requires **50 mL of water** to dilute it to the nontoxic level.
- The animals which excrete urea as their major nitrogenous waste product are called **ureotelic.**
- **Examples:** Mammals, most amphibians, sharks etc.

3. Uric Acid – $C_5H_4N_4O_3$

- Some animals, face an extreme water conservation challenge due to the arid nature of their environment. They cannot afford to even excrete urea. They convert ammonia to uric acid by using lot of energy. Uric acid is less toxic than urea, less soluble in water and make precipitates.
- One gram of uric acid requires just **1 mL of water** for its excretion.
- The animals which excrete uric acid as their major nitrogenous waste product are called **uricotelic**.
- **Examples:** Insects, desert animals, birds and most reptiles etc.

THERMOREGULATION

Q8. What is thermoregulation? Also classify animals on the basis of the source of body's heat. 12413008

Ans. **Thermoregulation**

Thermoregulation is the homeostatic process by which an organism maintains its internal body temperature within a tolerable range, regardless of the temperature of the external environment.

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Importance

- **Enzymes** have an optimal temperature at which they function most efficiently. If temperature falls below the optimal level, enzyme-substrate collisions decrease, and metabolic rates drop. If temperature rises well above the optimal level, enzymes begin to denature and lose their function permanently.
- The **lipid bilayer** of cell membranes is temperature sensitive. At high temperature, cell membranes can lose their selective permeability and low temperatures can make membranes rigid and brittle.

Types of Animals on the basis of Heat Source

Animals are classified into two major groups.

1. Ectotherms

Ectotherms are animals that gain most of their body heat from **external sources**. Their internal temperature generally fluctuates with the temperature of their surroundings.

Adaptations in ectotherms

Ectotherms use **behavioral thermoregulation**. As their metabolism rate is very low they cannot produce enough heat to raise and maintain their body temperature, so they rely on the heat from the environment.

- If they are **too cold**, they bask in the sun (radiation) or sit on a warm rock (conduction).
- If they are **too hot**, they seek shade or burrow into the cool earth.
- In **very cold climates,** they become dormant during the coldest months.

Examples: Most invertebrates are ectotherms. Among the vertebrates, fishes, amphibians, and reptiles are ectotherms.

2. Endotherms

Endotherms generate the majority of their body heat through internal metabolism. They maintain a relatively constant body temperature, often higher than the environment.

Adaptations of Endotherms

They use **physiological and anatomical** adaptations usually for thermoregulation. Their metabolism rate is fair enough so they produce enough heat to raise and maintain their body temperature and do not require to rely on external environment usually.

- During **cold temperature**, the higher centres send impulses to skeletal muscles leading to shivering (muscle contractions) or burn brown adipose tissue for heat. Most endotherms have insulation to retain heat such as hair, feathers, or fat.
- During **high temperature**, hypothalamus causes vasodilation (by increasing the diameter of superficial blood vessels) and sweating (by sweat glands).

Examples: Birds and mammals are endotherms.

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Q9. Classify the animals on the basis of the ability to thermoregulate. 12413009

Ans. Types of animals on the basis of ability to thermoregulate

There are two major divisions of animals on the basis of the ability of thermoregulation.

1. Poikilotherms

Poikilotherms are the animals that are **unable to maintain their body temperature** within narrow limits. Their body temperature varies considerably, usually matching the temperature of their environment. Poikilotherms do not need to consume massive amounts of food to "fuel" a constant temperature. It allows them to survive in nutrient-poor environments where a homeotherm would starve.

Examples: All invertebrates are poikilotherms. Among vertebrates fishes, amphibian and reptiles are also poikilotherms.

2. Homeotherms

These animals maintain relatively constant internal body temperature regardless of environmental fluctuations. They use "thermostats" (hypothalamus in the brain) to trigger cooling or heating responses.

Examples: Include mammals and birds. For instance, **humans** maintain their internal temperature at roughly **37°C** whether they are in very cold or very hot environments.

Q10. Describe the regulatory strategies in man for thermoregulation. 12413010

Ans.

Thermoregulation in Humans

Humans are endothermic homeotherms. They regulate body temperature through negative feedback mechanism.

The thermoreceptors present in skin detect increase or decrease in body temperature. They send signals to the control centre i.e., hypothalamus which also contains thermoreceptors. Hypothalamus sends signals to muscles and glands which produce corrective responses.

Strategies of Thermoregulation

1. Responses to overheating (Hyperthermia)

- When body temperature rises above **37°C** (Hyperthermia), **vasodilation** occurs. It is the expansion of blood capillaries which lie just beneath the epidermis of the skin leading to more flow of blood in these capillaries to remove excess heat from blood.
- Responses also include **sweating**. Evaporation of sweat carries heat from the body and produces **cooling effect**.
- The **thyroid glands** may decrease the secretion of thyroxine, which lowers the basal metabolic rate. So, the internal heat production is reduced.

2. Responses to Cooling (Hypothermia)

i. When body temperature falls below **37°C** (hypothermia), the responses may include **vasoconstriction** (narrowing of blood vessels). It reduces blood flow to the skin and so there is less loss of heat from blood.

ii. **Shivering** (spasmodic contraction of skeletal muscles) produces heat which helps to raise the body temperature.

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iii. Tiny muscles at the base of hair follicles contract **(goosebumps)**, trapping air in the erected hairs and act as insulator for the heat.

iv. Increased basal metabolic rate (**BMR**) also produces heat to raise the body temperature.

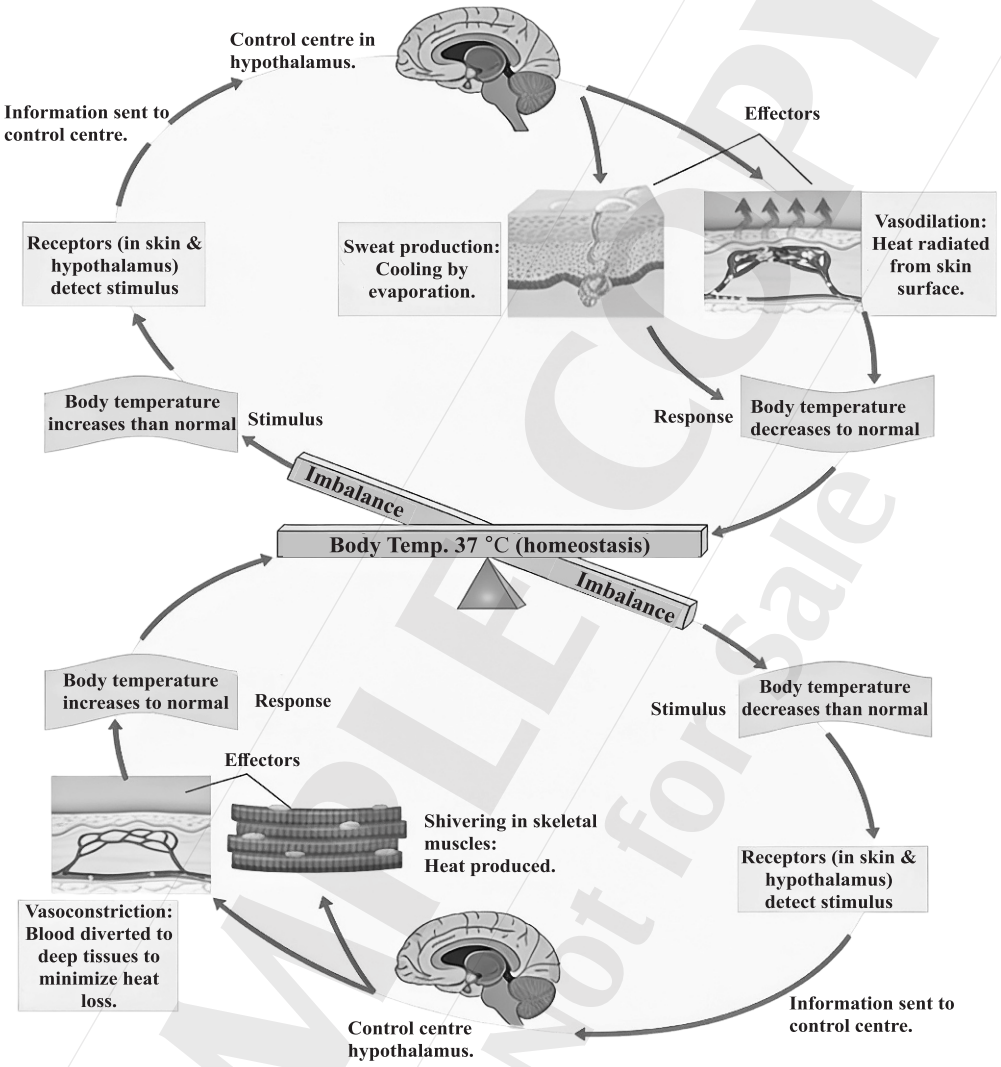


Figure 13.5: Thermoregulation in humans

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MULTIPLE CHOICE QUESTIONS (EXERCISE)

1. Which term covers the rest of the three? 12413011
(a) Osmoregulation
(b) Excretion
(c) Thermoregulation
(d) Homeostasis

2. Marine fishes compensate for water loss by: 12413012
(a) Producing dilute urine
(b) Drinking seawater
(c) Absorbing salt
(d) Reducing thirst

3. How do freshwater fish primarily gain water? 12413013
(a) Drinking (b) Active transport
(c) Osmosis (d) Diffusion

4. **What is the primary heat source of endotherms?** 12413014
   (a) Sunlight
   (b) Internal metabolism
   (c) Warm rocks
   (d) Convection
5. **What is the control center for human thermoregulation?** 12413015
   (a) Pituitary gland
   (b) Hypothalamus
   (c) Adrenal gland
   (d) Medulla oblongata
6. **Which waste product requires the most water for excretion?** 12413016
   (a) Ammonia (b) Urea
   (c) Uric acid (d) Creatinine
7. **Which nitrogenous wastes is the least toxic and water -insoluble?** 12413017
   (a) Urea (b) Ammonia
   (c) Uric Acid (d) Nitrate
8. **In which part of the body, the conversion of ammonia to urea takes place?** 12413018
   (a) Liver (b) Muscles
   (c) Brain (d) Small intestine

MULTIPLE CHOICE QUESTIONS (SLO BASED)

Homeostasis

9. **The process by which living organisms maintain a stable internal environment, despite fluctuations in their external surroundings is called:** 12413019
   (a) Homeostasis (b) Osmoregulation
   (c) Hemopoiesis (d) Excretion
10. **Which of the following is not the element of homeostasis?** 12413020
    (a) Receptor (b) Control centre
    (c) Effector (d) Stimulus
11. **Organs, tissues, cells or subcellular components that have the ability to detect changes in internal or external environment are called;** 12413021
    (a) Sensors (b) Effectors
    (c) Integrators (d) Glands
12. **Which of the followings is not related to receptors?** 12413022
    (a) Spinal cord (b) Hypothalamus
    (c) Blood vessels (d) Skin
13. **Select the control center among the following;** 12413023
    (a) Endocrine gland
    (b) Brain
    (c) Spinal cord
    (d) Skin
14. **Which of the following pairs is an effector?** 12413024
    (a) Brain and spinal cord
    (b) Spinal cord and glands
    (c) Glands and muscles
    (d) Brian and heart
15. **Distinguish the element of homeostatic mechanism, which have ability to receive information, process this information and send appropriate message.** 12413025
    (a) Receptor (b) Sensor
    (c) Control centre (d) Effector
16. **Which of the following responds by releasing their secretion?** 12413026
    (a) Glands (b) Muscles
    (c) Receptors (d) Blood vessels

Feedback Mechanism

17. **The regulatory processes in which the output or product of a system is used to control the behavior of the system itself is called:** 12413027
    (a) Feedback mechanism
    (b) Feed forward mechanism
    (c) Endosmosis
    (d) Redox reaction

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18. **The mechanism in which the output of a system reduces the activity of the system is termed as.** 12413028
    (a) Feed forward mechanism
    (b) Negative feedback mechanism
    (c) Positive feedback mechanism
    (d) Unregulated feedback mechanism
19. **Which of the following is an example of negative feedback mechanism?** 12413029
    (a) Childbirth (b) Blood clotting
    (c) Lactation (d) Thermoregulation
20. **Set point of thermoregulation in humans is:** 12413030
    (a) 37°C (b) 38°C
    (c) 37.8°C (d) 37.1°C
21. **Mark the process which does not comes under the category of negative feedback mechanism?** 12413031
    (a) Thermoregulation
    (b) Hormone secretion
    (c) Blood glucose levels
    (d) Lactation
22. **Thermoreceptors that detect change in set point of 37°C are located in:** 12413032
    (a) Muscles (b) Skin
    (c) Kidneys (d) Joints
23. **The regulatory mechanisms in which the output of a process, increases the activity of the system is called:** 12413033
    (a) Feedback mechanisms
    (b) Negative feedback mechanisms
    (c) Positive feedback mechanisms
    (d) Feed forward mechanisms
24. **During childbirth oxytocin from pituitary gland is released in response to:** 12413034
    (a) Contractions in uterus
    (b) Labour pains
    (c) Contraction in fetus
    (d) All of above
25. **Which proteins are released by immune cells during severe infections?** 12413035
    (a) Antibodies (b) Cytokines
    (c) Cytokinins (d) Immunoglobulins
26. **Poorly regulated positive feedback mechanisms can lead to:** 12413036
    (a) Health issues (b) Tissue damage
    (c) Inflammation (d) All of above

Osmoregulation

27. **The process of maintenance of water and solutes in the body fluids is called:** 12413037
    (a) Osmosis (b) Osmoregulation
    (c) Chemiosmosis (d) Both a and c
28. **Which of the following is controlled by osmoregulatory mechanisms?** 12413038
    (a) Blood pressure (b) Temperature
    (c) Excretion (d) Digestion
29. **The animals which allow the osmotic concentrations of their body fluids to match their environment are called:** 12413039
    (a) Osmoconformers
    (b) Osmoregulators
    (c) Osmoreceptors
    (d) All of above
30. **Which of the following are Osmoconformers?** 12413040
    (a) All marine invertebrates
    (b) Hag fishes
    (c) Sharks and rays
    (d) All of above
31. **Mark the animals which does not come under category of osmoregulators.** 12413041
    (a) Most vertebrates in aquatic environment
    (b) Most vertebrates in terrestrial environment
    (c) Humans
    (d) Rays and hag fishes

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32. The animals that regulate concentrations of water and solute in body fluids are called: 12413042
(a) Osmoregulators
(b) Osmoconformers
(c) Osmoregulation
(d) Receptors

33. The animals which can maintain constant internal water and solute concentrations despite changing concentrations in environment are: 12413043
(a) Osmoregulators
(b) Osmoregulation
(c) Osmoconformers
(d) All marine invertebrates

Problem and Methods of Osmoregulation

34. Freshwater animals are _____ to their environment. 12413044
(a) Hypotonic (b) Hypertonic
(c) Isotonic (d) None of above

35. The animals which have higher solute concentration in body fluids than the surrounding water are: 12413045
(a) Marine water animals
(b) Terrestrial animals
(c) Freshwater animals
(d) Both b and c

36. Which statement is not true about osmoregulation in freshwater animals? 12413046
(a) Produce concentrated urine
(b) Prevent water from entering their bodies
(c) Eliminate excess water
(d) Compensate salt loss by active transport of salts back into their bodies.

37. Which statement is not true regarding osmoregulation strategies in marine water animals? 12413047
(a) Water constantly leaves their bodies via osmosis
(b) Excess salts in their body due to drinking of sea water
(c) Produce concentrated urine
(d) Prevent water from entering their bodies

38. Special salt excreting glands in rectum called rectal glands are the characteristic of some fishes for: 12413048
(a) Osmoregulation
(b) Thermoregulation
(c) Removal of faeces
(d) Homeostasis

39. Conversion of ammonia into urea or uric acid by liver is an adaptation for osmoregulation in mammals. 12413049
(a) Anatomical (b) Physiological
(c) Behavioral (d) Psychological

40. Which of the following nitrogenous waste is highly toxic? 12413050
(a) Ammonia
(b) Urea
(c) Uric acid
(d) Trimethylamine oxide

41. Mark the correct sequence of nitrogenous waste from highly toxic to lowest toxic. 12413051
(a) Urea, uric acid, ammonia
(b) Ammonia, uric acid, urea
(c) Uric acid, urea, ammonia
(d) Ammonia, urea, uric acid

42. The animals which excrete uric acid as their major nitrogenous waste are called: 12413052
(a) Ureotelic (b) Uricotelic
(c) Ammonotelic (d) Uricemia

43. $C_5H_4N_4O_3$ is the molecular formula of: 12413053
(a) Urea (b) Uric acid
(c) Ammonia (d) Creatinine

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44. The number of N-atoms in the molecular formula of uric acid are: 12413054
(a) 5 (b) 4
(c) 3 (d) 2

45. One gram of urea nitrogen requires how much amount of water to dilute in to nontoxic levels? 12413055
(a) 500 ml (b) 1 liter
(c) 50 ml (d) 5 ml

46. Which of the following animals is not ammonotelic? 12413056
(a) Insects (b) Sponges
(c) Coelenterates (d) Protozoans

47. Select the nitrogenous compound which is formed as a by-product of purine catabolism? 12413057
(a) $CO(NH_2)_2$ (b) $C_5H_4N_4O_3$
(c) $C_4H_5N_4O_3$ (d) $C_3H_5N_4O_4$

48. Gout is caused by formation of _____ crystals in joints and tissues. 12413058
(a) Urea (b) Ammonia
(c) Uric Acid (d) Calcium oxalate

Thermoregulation

49. The maintenance of core temperature within tolerable narrow range, regardless of the temperature fluctuations in external environment is called: 12413059
(a) Thermogenesis (b) Thermokinetics
(c) Thermophile (d) Thermoregulation

50. Mark the correct statement, "if temperature falls below the optimal level": 12413060
(a) Enzymes began to denature
(b) Cell membranes become rigid and brittle
(c) Enzymes lose their function permanently
(d) Enzyme-substrate collisions decrease and metabolic rates drop

51. Which of the following animals is ectotherm? 12413061
(a) Frog (b) Pigeon
(c) Human (d) Bats

52. The animals which generate majority of their body heat through internal metabolism are called: 12413062
(a) Ectotherm (b) Endotherm
(c) Poikilotherm (d) Heterotherm

53. Which animals do not need to consume massive amount of food to fuel a constant temperature? 12413063
(a) Endotherms (b) Poikilotherms
(c) Homeotherms (d) Heterotherms

54. The animals which maintain relatively constant internal body temperature regardless of environmental fluctuations are called: 12413064
(a) Homeotherms (b) Poikilotherms
(c) Heterotherms (d) Ectotherms

55. As per thermoregulation, humans are: 12413065
(a) Ectothermic homeotherms
(b) Ectothermic poikilotherms
(c) Endothermic homeotherms
(d) Endothermic ectotherms

56. Mark the correct response, when body temperature rises above 38°C: 12413066
(a) Vasoconstriction occurs
(b) Vasodilation occurs
(c) Goosebumps occurs
(d) Increased basal metabolic rate

57. Vasoconstriction, spasmodic contraction of skeletal muscles, increased metabolic rate are the: 12413067
(a) Responses of overheating
(b) Responses when body temperature rises above 38°C
(c) Responses to hypothermia
(d) All of above

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ANSWER KEY

1	d	2	b	3	c	4	b	5	b
6	a	7	c	8	a	9	a	10	d
11	a	12	a	13	b	14	c	15	c
16	a	17	a	18	b	19	d	20	a
21	d	22	b	23	c	24	a	25	b
26	d	27	b	28	a	29	a	30	d
31	d	32	a	33	a	34	b	35	c
36	a	37	d	38	a	39	b	40	a
41	d	42	b	43	b	44	b	45	c
46	a	47	b	48	c	49	d	50	d
51	a	52	b	53	b	54	a	55	c
56	b	57	c						

SHORT QUESTION ANSWERS (EXERCISE)

1. Define Osmoregulators and Osmoconformers. 12413068

Ans:

Osmoconformers	Osmoregulators
• Osmoconformers are the animals which allow the osmotic concentrations of their body fluids to match their environment. They cannot maintain the concentration of water and solutes in their bodies. • **Examples** of osmoconformers include all marine invertebrates, some freshwater invertebrates and some marine vertebrates like hag fishes, sharks and rays.	• The animals that can regulate the concentrations of water and solute in body fluids are called osmoregulators. They can maintain constant internal concentrations despite the changing concentration in the environment. • **Examples** most vertebrates in aquatic and terrestrial environments are osmoregulators.

2. Define thermoregulation and explain its needs. 12413069

Ans: Thermoregulation is the homeostatic process by which an organism maintains its internal body temperature within a tolerable range, regardless of the temperature of the external environment.

Need for Thermoregulation

We know that enzymes have an optimal temperature at which they function most efficiently. If temperature falls below the optimal level, enzyme-substrate collisions decrease, and metabolic rates drop. If temperature rises well above the optimal level, enzymes begin to denature and lose their function permanently.

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3. What are the two types of animals on the basis of the ability to thermoregulate? 12413070

Ans: Animals are classified into two major groups.

Poikilotherms	Homeotherms
• Poikilotherms are the animals that are unable to maintain their body temperature within narrow limits. Their body temperature varies considerably, usually matching the temperature of environment. • All invertebrates are poikilotherms. Among vertebrates fishes, amphibian and reptiles are also poikilotherms.	• These animals maintain relatively constant internal body temperature regardless of environmental fluctuations. They use "thermostats" (hypothalamus in the brain) to trigger cooling or heating responses. • Examples include mammals and birds. For instance, **humans** maintain their internal temperature at roughly **37°C** whether they are in very cold or very hot environments.

4. Differentiate between: 12413071

Ans.

Ectotherms and endotherms

Ectotherms	Endotherms
• Ectotherms are animals that gain most of their body heat from external sources. Their internal temperature generally fluctuates with the temperature of their surroundings. • Most invertebrates are ectotherms. Among the vertebrates, fishes, amphibians, and reptiles are ectotherms.	• Endotherms generate the majority of their body heat through internal metabolism. They maintain a relatively constant body temperature, often higher than the environment. • Birds and mammals are endotherms.

Vasodilation and Vasoconstriction

Vasodilation	Vasoconstriction
• It is the expansion of blood capillaries which lie just beneath the epidermis of the skin (superficial blood vessels). • When body temperature rises above **37°C** (Hyperthermia), **vasodilation** occurs. • It is negative feedback in response to increased core temperature due to excessive heat in the external environment.	• Vasoconstriction is narrowing of superficial blood vessels. • When body temperature falls below **37°C** (hypothermia), the responses may include **vasoconstriction and shivering.** Vasoconstriction reduces blood flow to the skin and so there is less loss of heat from blood. • It is negative feedback in response to decreased core temperature due to cold conditions in the external environment.

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Homeotherms and poikilotherms

Poikilotherms	Homeotherms
• Poikilotherms are the animals that are unable to maintain their body temperature within narrow limits. Their body temperature varies considerably, usually matching the temperature of environment. • All invertebrates are poikilotherms. Among vertebrates fishes, amphibian and reptiles are also poikilotherms.	• These animals maintain relatively constant internal body temperature regardless of environmental fluctuations. They use "thermostats" (hypothalamus in the brain) to trigger cooling or heating responses. • Examples include mammals and birds. For instance, **humans** maintain their internal temperature at roughly **37°C** whether they are in very cold or very hot environments.

Ammonotelic and Ureotelic

Ammonotelic	Ureotelic
• Animals which excrete **ammonia** as their major nitrogenous wastes are called ammonotelic. • Freshwater animals e.g., most fishes, protozoans, sponges, coelenterates are ammonotelic.	• The animals which excrete **urea** as their major nitrogenous waste product are called ureotelic. • Mammals, most amphibians, shark and some bony fishes are ureotelic.

Uricotelic and Ureotelic

Uricotelic	Ureotelic
• The animals which excrete uric acid as their major nitrogenous waste product are called uricotelic. • Insects, desert animals, birds and most reptiles are uricotelic.	• The animals which excrete urea as their major nitrogenous waste product are called ureotelic. • Mammals, most amphibians, shark and some bony fishes are ureotelic.

SHORT QUESTION ANSWERS (SLO BASED)

Homeostasis

5. Define Homeostasis. Write the names of homeostatic processes. 12413072

Ans: Homeostasis is vital process by which living organisms maintain a stable internal environment within a narrow range despite changes in their external surroundings. Homeostasis consists of a wide range of mechanisms that work in a coordinated fashion to regulate the body's internal environment.

Important homeostatic processes

- Thermoregulation
- Osmoregulation
- Excretion

6. Write the names of three essential elements of homeostatic mechanisms. 12413073

Ans: Homeostasis is maintained and regulated through the collaboration of three essential elements which are as follow:

- Receptors
- Control centre
- Effectors

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7. Define Receptors. Write examples. 12413074

Ans: Receptors or sensors are specialized structures (organs, tissues, cells or subcellular components) that detect changes in the internal or external environment. They also transmit the information of changes to the control center.

For example, receptor cells present in the skin can detect changes in temperature. Similarly, receptor cells in the blood vessels can detect changes in blood pressure.

8. What are control centers? How they are involved in homeostasis? 12413075

Ans:

- The control centers receive information from the receptors, process this information, and send appropriate message to the effectors.
- These messages ensure that the internal environment remains within a narrow range of set points.
- The brain, spinal cord and endocrine glands act as control centers in homeostasis.

9. What are Effectors? Write examples. 12413076

Ans: Effectors are parts of the body which respond when they receive message from the control centers.

- Muscles and glands act as effectors.
- Muscles respond by contracting while glands release their secretion.

For example, when the body temperature drops below the set point, effectors in the skin and muscles cause shivering. This response increase heat production and raises the body temperature to the set point.

Feedback Mechanisms

10. What are feedback mechanisms? Write their types. 12413077

Ans: Feedback mechanisms are the regulatory processes in which the output or product of a system is used to control the behavior of the system itself. Feedback mechanisms are the foundations of homeostasis.

Types of feedback mechanism

There are two types of feedback mechanisms.

1.Negative Feedback

2.Positive Feedback

11. Define negative feedback mechanism. Also write its examples. 12413078

Ans: The type of feedback mechanism in which response is against (opposite direction) the initial stimulus.

- A negative feedback system is a mechanism in which the output or production of a system reduces the activity of the system.
- It is the most common form of regulation.

Common examples of negative feedback include the regulation of body temperature, blood glucose levels, and hormonal secretions.

12. How thermoregulation comes under negative feedback? 12413079

Ans:

- If body temperature exceeds the set point of 37°C, the thermoreceptors in the hypothalamus of brain detect this change.
- They send signals to the control centre (thermoregulator in hypothalamus).
- The control center sends message to effectors (e.g., sweat glands).
- The effectors respond by producing sweat which lowers the temperature.
- The output of this process (lowering of temperature to the set point) influences the thermoreceptors negatively. As a result, the thermoreceptors stop sending message to the control centre.

13. Define Positive feedback. Write examples. 12413080

Ans: The type of feedback mechanism in which response is in the same direction to the initial stimulus.

- A positive feedback system is a regulatory mechanism in which the output or product feed increases the activity of the system.

- In this way, the positive feedback enhances the original stimulus.

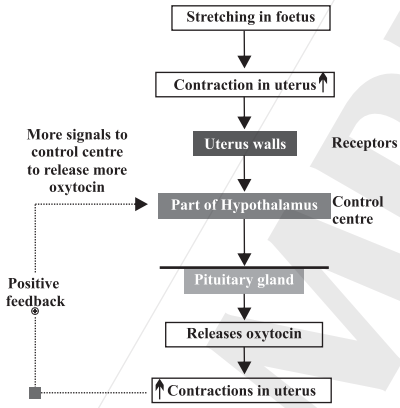
Examples:

In homeostasis, positive feedback is less common than negative feedback. It often happens in the processes that require rapid and significant changes e.g., blood clotting, labour, child birth and lactation.

14. Childbirth (parturition) is an example of positive feedback. Justify. 12413081

Ans: During childbirth, contractions of the uterus send nerve impulses to the control centre (part of hypothalamus). The control centre sends signals to pituitary gland to release oxytocin hormone. Oxytocin then stimulates further contractions of the uterus, which in turn sends more nerve impulses to hypothalamus, leading to the release of more oxytocin. This positive feedback loop continues until the baby is born.

15. Draw the flowchart showing childbirth as an example of positive feedback. 12413082



Osmoregulation

16. Define Osmosis. 12413083

Ans:

- Osmosis is the diffusion of water across a membrane, and it always occurs from a more dilute (hypotonic) solution to a less dilute (hypertonic) solution.
- The osmotic pressure of a solution is a measure of its tendency to take in water by osmosis.

17. Define Osmoregulation. Write its importance. 12413084

Ans:

- The maintenance of the balance of water and solutes in the body fluids is called osmoregulation. It ensures that the body fluids do not become too dilute or too concentrated.
- It is essential for many physiological processes, including maintaining proper blood pressure, enabling the proper function of organs, and regulating metabolism.

Problems and Methods of Osmoregulation

18. Briefly describe the mechanism of osmoregulation in fresh water. 12413085

Ans:

- Generally, the freshwater animals are hypertonic to their environment.
- Water continuously enters their bodies through osmosis, particularly across permeable surface like gills.
- Essential salts and ions (like Na^+ and CI^-) diffuse out of the body into the surrounding water. To compensate the loss of salts, they actively transport salts back into their bodies by gills and skin.
- In osmoregulation, they prevent water from entering their bodies and eliminate the excess water that does enter. For this purpose, they produce large volumes of diluted urine.

19. Describe how animals of marine water are adapted to live in hypertonic environment? 12413086

Ans:

- Most marine animals are hypotonic to their environment. Water constantly leaves their bodies via osmosis through the gills and skin and salts continuously diffuse from the environment into their bodies. In addition, they have excess of salts in the body due to drinking of sea water.

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- To **compensate for the water loss**, marine animals drink seawater continuously and also conserve water by producing very small amounts of highly concentrated urine.
- To **remove the excess salts**, specialized chloride cells in the gills use energy (ATP) to actively pump salts out of the blood and back into the environment. They also remove excess salts through their kidneys.

20. What are rectal glands? 12413087

Ans: Some marine fishes also have special salt excreting glands in rectum called rectal glands. These glands remove salts from blood into the digestive tract which are then eliminated along with faeces.

21. Discuss osmoregulation in terrestrial habitats. How they are adapted? 12413088

Ans: Terrestrial animals lose water to the atmosphere through evaporation from respiratory surfaces, through the skin, and via the excretion of waste. They have to ensure that water intake (from drinking and food) and metabolic water production is equal to the water lost to the environment. These animals have anatomical, physiological, and behavioral adaptations to maintain osmotic balance.

22. Write anatomical adaptations in terrestrial animals for osmoregulation. 12413089

Ans: Terrestrial animals have relatively **impermeable outer layers** to prevent evaporative water loss.

For example, insects possess a waxy exoskeleton made of chitin. Reptiles have waterproof scales made of keratin. Mammals and birds have dead keratinized skin cells and also have oil secreting glands in skin.

23. Discuss the behavioral adaptations in desert animals to maintain osmoregulation. 12413090

Ans:

- Many desert animals stay underground during the heat of the day to avoid evaporation. They emerge only at night when the air is cooler and more humid.
- Terrestrial animals feed upon seeds of desert plants in which large amount of carbohydrates are stored. Some animals, like the Kangaroo rat, survive entirely on water of metabolism (produced as a by-product of cellular respiration).

24. Define anhydrobiosis. Write an example. 12413091

Ans: The ability of terrestrial animals to tolerate various levels of dehydration is called anhydrobiosis.

Example: Certain invertebrates, like tardigrades (water bears), enter a different state when they lose almost all their body water. In this state metabolism slows down, allowing the organism to survive extreme drought, heat or freezing conditions. They return to active when water returns to normal levels in body fluid.



Tardigrade (Water bear)

25. Relate the amount of water required for removal of ammonia and urea. 12413092

Ans: As the terrestrial animals face the challenge of conserving water, they cannot afford to excrete ammonia with a plenty of water. They convert ammonia to urea in their liver and kidneys by utilizing energy. Urea is

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less toxic than ammonia. One gram of urea requires 50 mL water to dilute it to the nontoxic level. While One gram of ammonia requires 500 mL of water to dissolve it to nontoxic level. Such plenty of water can only be afforded by freshwater animals.

26. How animals of arid environment regulate excretion of their nitrogenous waste? 12413093

Ans: The animals, such as insects, desert animals, birds and most reptiles face an extreme water conservation challenge due to the arid nature of their environment. They cannot afford to even excrete urea. They convert ammonia to uric acid by using lot of energy. Uric acid is even less toxic than urea. It is less soluble in water and makes precipitates. One gram of uric acid requires just 1 mL of water for its excretion. The animals which excrete uric acid are called uricotelic e.g., insects and birds.

27. Do humans excrete uric acid as a nitrogenous waste? 12413094

Ans: Yes, human also excrete a small amount of uric acid in urine. Uric acid is a by-product of the breakdown of purines (found in many foods, particularly meat and some types of vegetables).

Uric acid is produced in the liver. In healthy individuals, most of the uric acid produced is excreted in the urine, but when there is an excess of uric acid in the blood, it can lead to the formation of uric acid crystals in joints and tissues, causing painful conditions such as gout.

Thermoregulation

28. Write behavioral strategies in Ectotherms for thermoregulation. 12413095

Ans: Ectotherms use behavioral strategies for thermoregulation. If they are too cold, they bask in the sun (radiation) or sit on a warm rock (conduction). If they are too hot, they seek shade or burrow into the cool earth. In very cold climates, they become dormant during the coldest months.

29. Humans are endothermic homeotherms. Comment. 12413096

Ans: Humans have ability to maintain their body temperature within a tolerable narrow range (36.1°C – 37.8°C) so they are homeotherms.

As humans generate heat through internal metabolism so they are endotherms, hence humans are endothermic homeotherms.

30. What are heterotherms? Give examples. 12413097

Ans: Heterotherms are those animals which are capable of varying degrees of endothermic heat production but generally do not regulate their body temperature within a narrow range.

Example: Bats, humming bird etc.

31. Describe the role of skin and blood vessels in hypothermia and hyperthermia. 12413098

Ans:

- **When body temperature rise above 37°C (Hyperthermia)**, vasodilation occurs. It is the expansion of blood capillaries which lie just beneath the epidermis of the skin. So, there is more flow of blood in these capillaries to remove more heat from blood. Responses also include sweating. Evaporation of sweat carries heat from the body and produces cooling effect.
- **When body temperature falls below 37°C (hypothermia)**, the responses may include vasoconstriction, shivering and increase in metabolic rate.
  - **i. Vasoconstriction** reduces blood flow to the skin and so there is less loss of heat from blood.
  - **ii. Shivering** (spasmodic contraction of skeletal muscles) produces heat which helps to raise the body temperature.
  - **iii.** Tiny muscles at the base of hair follicles contract **(goosebumps)**. Air is trapped in the erected hair and act as insulator for the heat.

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iv. Increased **basal metabolic rate** also produces heat to raise the body temperature.

32. How thermoreceptors are involved in behavioral responses for thermoregulation? 12413099

Ans: The thermoreceptors also stimulate the higher centers of brain. So, we 'feel' warmth or coldness. It allows us to take more actions like taking a bath or turning the fans or heaters on.

33. Why do poikilotherms require less food compared to homeotherms? 12413100

Ans: Poikilotherms do not need to consume massive amounts of food to "fuel" a constant temperature as they are cold blooded and do not maintain temperature in narrow range. It allows them to survive in nutrient-poor environments where a homeotherm would starve.

LONG QUESTIONS (EXERCISE)

Q1: Describe the elements which operate homeostatic mechanisms. 12413101

Ans: See answer of Q 1 in theory.

Q2: Relate the homeostatic mechanisms with the negative and positive feedback systems. 12413102

Ans: See answer of Q 2 and Q 3 in theory.

Q3: Explain the different methods of osmoregulation found in freshwater, marine water and terrestrial habitats. 12413103

Ans: See answer of Q 5 and Q 6 in theory.

Q4: Explain the nature of nitrogenous wastes in relation to habitat. 12413104

Ans: See answer of Q 7 in theory.

Q5: Classify animals on the basis of the source of body's heat. 12413105

Ans: See answer of Q 8 in theory.

Q6: Classify the animals on the basis of the ability to thermoregulate. 12413106

Ans: See answer of Q 9 in theory.

Q7: Describe the regulatory strategies in man for thermoregulation. 12413107

Ans: See answer of Q 10 in theory.

INQUISITIVE QUESTIONS

Q1: Why positive feedback mechanisms in humans are sometimes associated with severe health problems? 12413108

Ans: Sometime, the un-regulated positive feedback systems can result in health problems. For example, in severe inflammation or infection, the immune cells release proteins called cytokines. These proteins further stimulate the immune response. If this positive-feedback is not properly regulated, it can lead to excessive inflammation and tissue damage.

Q2: List some of the behavioral responses of the animals to maintain homeostasis. 12413110

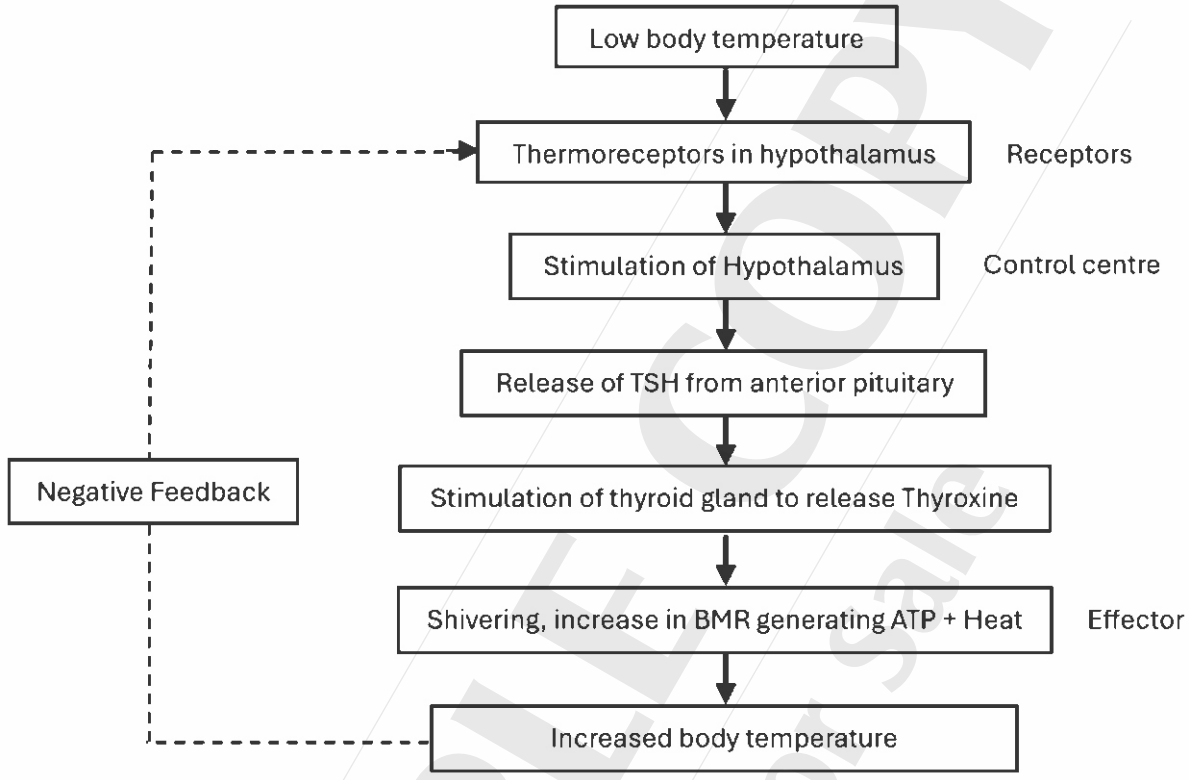
Ans: Many desert animals stay underground during the heat of the day to avoid evaporation. They emerge only at night when the air is cooler and more humid.

Terrestrial animals feed upon seeds of desert plants in which large amount of carbohydrates is stored. Some animals, like the Kangaroo rat, survive entirely on water of metabolism (produced as a by-product of cellular respiration).

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Q3: Draw a flow chart to show negative feedback of homeostatic mechanisms by taking an example of hormone. 12413111

Ans:



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