







## SAMPATH LANKADHEERA



Animal Form and Function Homeostasis

ADVANCED LEVEL

# **Biology**

Unit - 05 **Animal Form and Function** 

o Homeostasis

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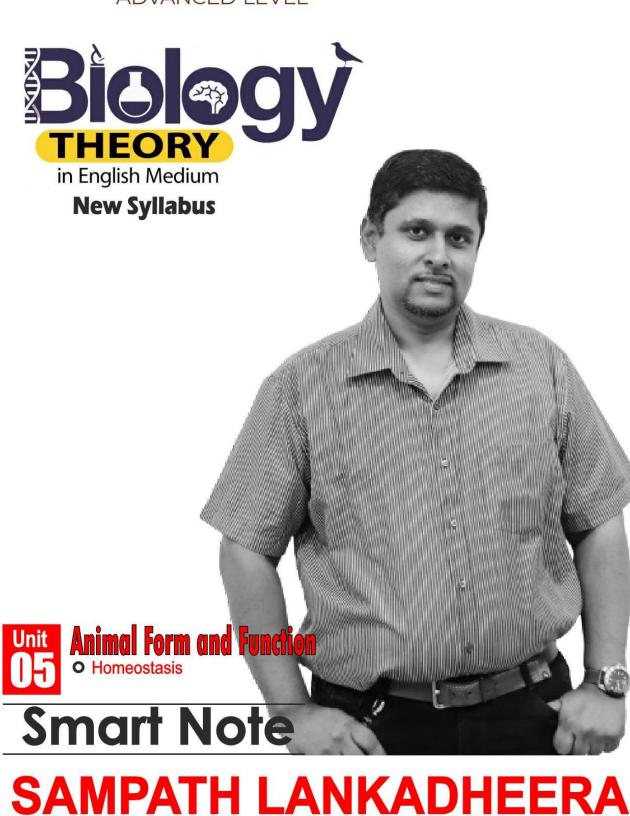


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#### Homeostasis

- Homeostasis is a steady state condition where body's internal environment remains relatively constant within narrow physiological limits despite significant changes in the external environment.
- Surroundings outside of the body are referred to as the external environment. Internal environment is the immediate surroundings of the body cells which provides the cells with the medium in which they have to live. Examples for the internal environment of the body are interstitial fluid and the blood.
- Many animals and humans exhibit homeostasis for a range of physical and chemical properties. For example, humans maintain a fairly constant body temperature, blood pH, blood glucose and blood osmolality within narrow physiological limits.
- Homeostasis is important for maintaining the internal environment in a steady and balance state and to establish optimum conditions for the human body.

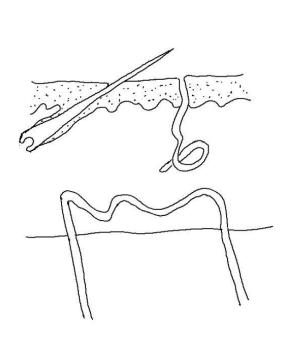
- Homeostatic control systems in the human body mainly depend on negative feedback mechanisms to maintain a constant level thereby preventing serious changes in the internal environment.
- Homeostasis is achieved by maintaining a variable (e.g. body temperature, blood glucose) at or near a particular value (set point).
- A fluctuation in the variable above or below the set point serves as the stimulus detected by a sensor (detector). When a signal is received from the sensor, a control center generates output that triggers a response, a physiological activity that helps to return the variable towards the set point level. The set point level is achieved by the negative feedback control of the stimulus by the response.



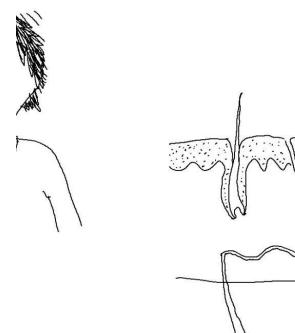




Homeostatic regulation of body temperature in humans 2010/2015				
•••••				
•	If the body temperature is outside the normal range, a group of nerve cells in the hypothalamus of the brain ("body's temperature control center") functions as a thermostat and responds to the temperature increase or decrease by activating heat loss mechanisms or promoting heat gain mechanisms respectively until the body temperature reaches the preset level.			
•	High peripheral temperature (Eg. When the person is in hot surroundings) is detected by warm receptors in the skin.			
•	High deep body temperature (Eg. due to high body heat generation after exercise) is detected by hypothalamic temperature sensitive nerve endings when warm blood pass through the hypothalamus.  These nerve impulses are sent to the "body's temperature control center" (thermostat) in the hypothalamus.			
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Incr	ease in Body Temperature			
•	In response to the increase in body temperature above the preset level, the 'thermostat" in the hypothalamus sends impulses to activate heat loss mechanisms and to inhibit heat gain mechanisms that lower the body temperature until the set point.			
•	The following heat loss mechanisms promote the decrease in body temperature.			
•	When body temperature is within the normal range again, the warm temperature sensitive receptors are no longer stimulated and their signals to the 'hypothalamic thermostat" stops due to the negative feedback mechanism.			
Deci	rease in body temperature			
•	Then, additional heat loss mechanisms stop and blood flow to the peripheries returns to normal.			
•	Low peripheral temperature (when in cold surroundings) is detected by cold receptors in the skin.			
•	Low deep body temperature (due to more heat loss and low heat generation in the body) is detected by temperature sensitive nerve endings in the hypothalamus.			
•	These nerve impulses are sent to the body's temperature control center (thermostat) in the hypothalamus.			
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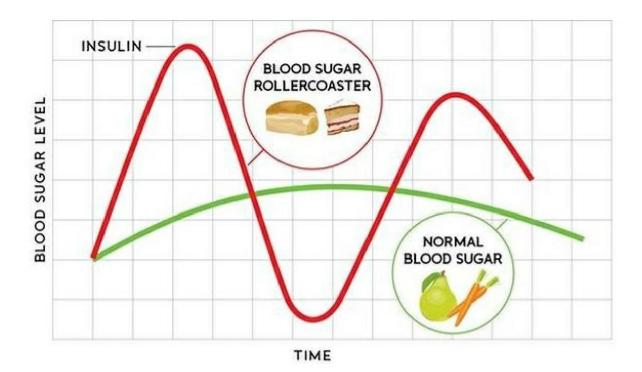


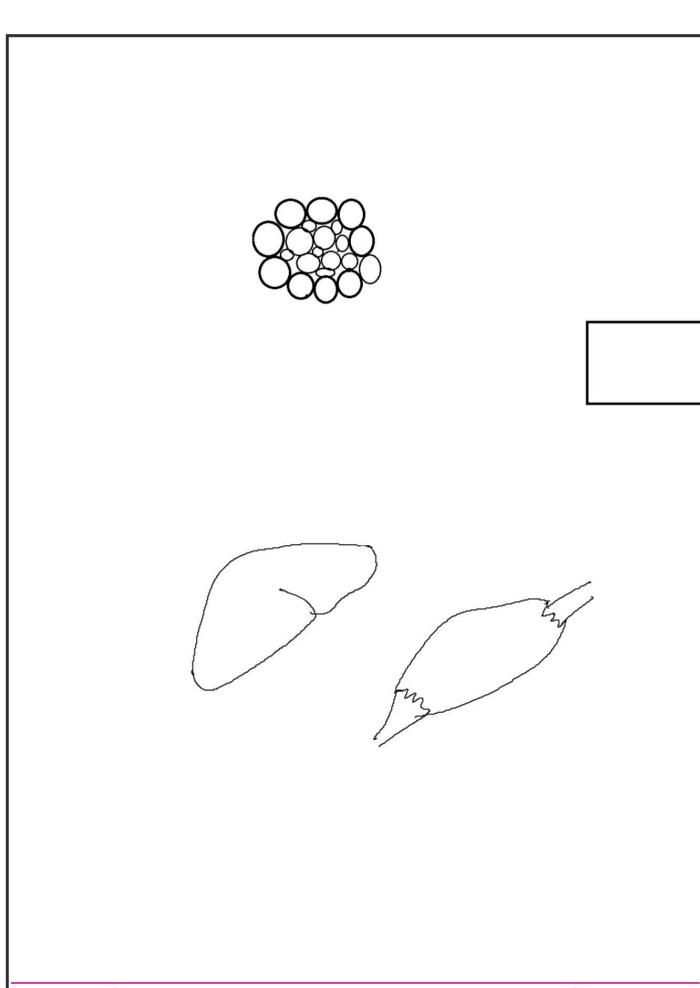




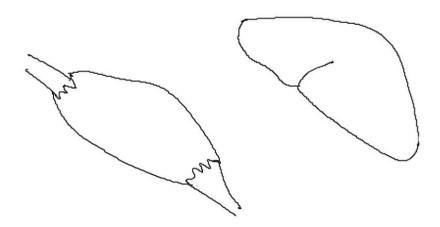
•	1.	e following heat conservation and heat gain mechanisms promote the increase in body temperature.  Constriction of blood vessels in the skin which divert the blood from the skin to deeper tissues thereby reducing heat loss through the skin surface  Shivering: rapid repetitive contractions of skeletal muscles to generate heat					
	2. 3.	Contracting hair erector muscles to generate heat to some extent					
	3. 4.	Stimulating secretions of more thyroid hormones (e.g. thyroxin) and adrenalin into the blood which in-					
		crease the metabolic rate and cellular metabolism (especially oxidation of fat in the liver) to produce more heat					
••••	•••••						
••••	•••••						
Но	meo	static regulation of blood glucose level					
•		numans, normal blood glucose level is $70 - 110 \text{ mg}/100 \text{ ml}$ (while fasting) which is sufficient for immediate eds of the body cells.					
•		e blood glucose levels can fluctuate throughout the day within physiological limits in non-diabetic persons.					
	In t	In the human body, blood sugar levels are homeostatically controlled by opposing actions of two hormones secreted by the pancreas: insulin and glucagon.					
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•		en glucose level in the blood reaches normal range, blood glucose level can in turn directly control the					
•		nen glucose level in the blood reaches normal range, blood glucose level can in turn directly control the cretion of insulin levels from the pancreas through negative feedback.					
•							

- This mechanism prevents further lowering of the glucose level in the blood beyond the normal limits.
- Low blood glucose levels below the normal limit, stimulate the secretion of glucagon from alpha cells of the islets of Langerhans into the circulating blood.
- Glucagon acts on specific target tissues to promote increase of the blood glucose level.
- Glucagon promotes the breakdown of glycogen in the liver and skeletal muscles and release of glucose into blood.
- When glucose level in the blood reaches normal range, blood glucose level can in turn directly control the secretion of glucagon levels from the pancreas through negative feedback which prevents further increasing of the glucose level in the blood beyond the normal limits.









Osmoregulation				
<ul> <li>In human body, osmotic balance is achieved by two ways:</li> <li>Controlling the amount of water</li> </ul>				
2. Controlling the amount of salt gained and lost by the body				
<ul> <li>Blood water homeostasis is controlled by the hypothalamus.</li> </ul>				
<ul> <li>Hypothalamus contains osmoreceptors which can detect the osmolarity of the blood passing through the brain.</li> </ul>				
• In response to the osmolarity (or osmotic pressure) of the blood, the hypothalamus controls the sensation of thirst, and secretion of the hormone ADH from the posterior pituitary.				
• When blood osmolarity is increased beyond the physiological limits, it is sensed by the osmoreceptors in the				
<ul> <li>hypothalamus which stimulates the posterior pituitary to release ADH to the blood circulation.</li> <li>ADH acts on the kidney tubules and stimulates the reabsorption of water through distal convoluted tubules of</li> </ul>				
the nephrons and collecting ducts producing concentrated urine.				
<ul> <li>When blood osmolarity is decreased, ADH is not secreted, so water reabsorption through distal convoluted tubules of the nephrons and collecting ducts stop thereby producing diluted urine.</li> </ul>				

### Role of the liver in homeostasis.

- Liver is an active organ and plays an important role in maintaining homeostasis of the human body. The functions of the liver include the following.
- Carbohydrate metabolism: The liver plays an important role in maintaining blood glucose levels within normal ranges. When blood glucose is increased (e.g. after a meal), glucose is stored as glycogen under the stimulation of insulin. If blood glucose level is reduced (e.g. starvation), glycogen is converted back to glucose under the influence of glucagon hormone.
- Fat metabolism: When the body needs excess energy, fats that are stored in the liver cells are metabolized to produce ATP
- Protein metabolism: In the liver cells, nitrogen part of some amino acids that are not needed for new
  protein synthesis are removed (deamination) and excreted in urine or transferred to carbohydrates to
  synthesize new nonessential amino acids (transamination). Liver also synthesizes plasma proteins (e.g.
  albumin, globulins) from amino acids.
- Breakdown of erythrocytes and defense against microbial infections: In humans, liver is a site for red blood cell breakdown. Macrophages located in the liver are involved in microbial defense.
- Detoxification of drugs and toxicants: The liver plays an important role in detoxification.
- **Production of heat:** Liver is the major heat producing organ of the body as it has a high metabolic rate



#### MCQ

- 1. Which one of the following statements is correct regarding the regulation of body temperature in man?
  - (1) Lowering of the environmental temperature stimulates the thermoregulatory centre in the cerebellum.
  - (2) Rise in body temperature inhibits the secretion of hormones that increase the metabolic rate.
  - (3) Rise in environmental temperature contracts the hair erector muscles in the skin.
  - (4) Decrease in body temperature produces more sweat.
  - (5) Lowering of environmental temperature dilates the superficial blood vessels in the skin
- 2. Which statement regarding human skin is incorrect?
  - (1) It contains all four basic types of tissues (2) It synthesizes vitamin A.
  - (3) It acts as an excretory organ. (4) It prevents entry of microorganisms into the body.
  - (5) It helps in thermoregulation. (AL/2002)
- 3. Which of the following is not homeostasically regulated in the internal environment of man
  - (1) Glucose (2) Temperature (3) Urea (4) Carbon dioxide (5)Wate (AL/2005)
- 4. Which of the following statement/statements is/are true regarding human kidney?
  - (A) It is involved in the production of red blood cells. (B) It regulates the pH of blood.
  - (C) Its tubules secrete glucose. (D) It is the major osmo-regulatory organ of the body.
  - (E) It synthesizes urea. (AL/2005)
- 5. Which one of the following is an incorrect statement regarding human liver?
  - (1) It is the largest gland in the body. (2) It is the main storage centre of the body.
  - (3) It aids in the digestion of lipids. (4) It is involved in temperature regulation.
  - (5) The secretion of bile from it is stimulated by cholecystokinin. (AL/2006)
- 6. Which of the following statement/s is/are correct regarding homoeothermy in man?
  - (A) It is regulated by negative feedback mechanisms. (B) Hypothalamus is essential for homoeothermy.
  - (C) Elevation of temperature is sensed by Krause's bulbs. (D) Erection of hair plays a major role in reducing heat loss
  - (E) Homoeothermy is achieved mainly by involuntary mechanisms.

(AL/2008)

(AL/2000 Bio)

- 7. Which of the following statements is / are correct regarding regulation of blood glucose level in man?
  - (A) Fasting blood glucose level is 70-110 mg/100 ml blood.
  - (B) Blood glucose level is regulated by negative feedback mechanisms.
  - (C) Rise in Blood glucose level inhibits insulin secretion.
  - (D) Glucagon stimulates conversion of glycogen to glucose.
  - (E) Distal convoluted tubule of nephron plays an important role in glucose homoeostasis. (AL/2009)
- 8. Which of the following statements regarding human skin is / are incorrect?
  - (A) All four types of basic tissues can be seen in the dermis. (B) It excretes salts and urea.
  - (C) Nerve endings do not penetrate in to the epidermis.
  - (D) Epidermis is a stratified squamous epithelium containing glands.
  - (E) It synthesizes vitamin D. (AL/2011 new)
- 9. In man, which one of the following does not occur in response to rise in environmental temperature?
  - (1) Stimulation of Ru翻 ni corpuscles

(5) Reduction in metabolic rate

- (2) Sweating
- (3) Contraction of erector pilli muscles of the skin
- (4) Dilation of skin blood vessels
- 10. Which of the following statements regarding homoeostasis in man is incorrect?
  - (1) It is the maintenance of a constant internal environment.
  - (2) It is mediated via negative feedback mechanisms. (3) Blood urea level is homoeostatically regulated.
  - (4) Liver plays an important role in homoeostasis. (5) Homoeostatic mechanisms are mainly involuntary.

(2013/20)

(2012 Old/19)





	5.7.2: Investigates how a constant internal environment is maintained within a range in the body					
2012 AL						
Α	(i) What is homoeostasis?					
	(ii) What are the hormones involved in osmo-regulation in man?					
	(iii) What are the essential components of a negative feedback mechanism?					
	(iv) Name the hormones which increases the blood glucose level in man.					
2016 AL						
	i) What is homeostasis?					
	ii) State three factors that are homeostatically regulated in man					
	iii) State two advantages of homeostasis in man					
	iv) State one disadvantage of homeostasis in man					
	v) Human liver plays a variety of roles in homeostasis. State four such roles					
	vi) Give two examples of positive feedback mechanisms operating in man.					

