THERMOREGULATION
by

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OUTLINE

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Definition: Thermoregulation is the maintenance of a constant body temperature by animals most commonly birds and mammals.

Classification of Animals on Temperature regulatory bases

1.Ectotherms

2.Endotherms

Differences between the 2

Endotherms use internal corrective mechanisms to maintain their temperatures

- Ectotherms use mostly behavioural mechanisms e.g. lying under the sun or moving into shades

Basic Principles on Temperature Transmission

- Conduction: Heat loss by contact between two surfaces in direct contact with one another
- Radiation: This is the transfer of energy between two separate objects at different temperatures using electromagnetic waves

- Ultra violet and visible radiation from the sun
- Infra red or warm heat radiation from inside the body
- Convection: Loss of heat by contact between e surface and a moving medium e.g. air, water
- Evaporation: Heat loss through evaporation of water or sweat from the body.

Why We Need to Regulate Temperature

- There is usually a limit beyond which an organism's biochemical processes and tissues are deeply affected or damaged

- Enzymes depend on temperature changes
- Protein synthesis and degradation can also be altered if temperature changes persist.
- Temperatures also cause other pathological effects such as heat stroke.

Temperature control in Humans

-Temperature in humans is controlled by the thermoregulatory centre of the hypothalamus of the brain.

- Receive information from the peripheral thermosensors which are located in the skin, abdominal organs and muscles and also from internal or blood temperature.

Rise in hypothalamic temperature

-Vasodilation in the skin

-Reduce muscular tone

-Looses motivation for physical activities and reduced clothing

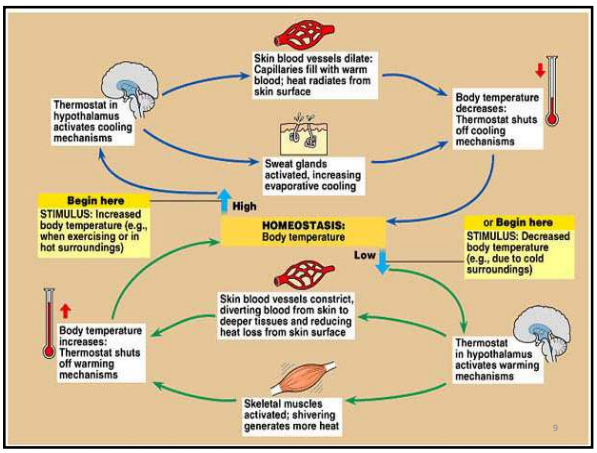
-Sweating

-Reduced activities of the adrenal cortex and thyroid gland.

A fall in hypothalamic temperature by cooling the shell and core

- Cutaneous vasoconstriction

- Increase muscle tone and shivering
- Sympathetic activation with secretion of catecholamines
- Oxidation of fatty acids and glucose
- Increase secretion of the thyroid and adrenal gland
- Muscle tone is increased and shivering triggered



DYNAMIC GAIN AND SET POINT CONTROL

- Dynamic gain systems respond continuously to feedback signals

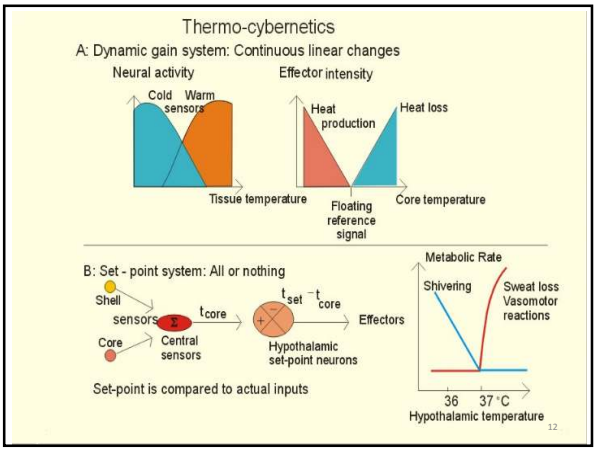
Set point systems

-Do not respond to a temperature rise before set point is reached.

-Caudal hypothalamus works as a thermostat

-When temperature rises above the required set point such as 37^0c effectors turn on and compensatory heat loss is almost linear.

-When temperature falls below the set point, compensatory mechanisms are relatively inactive



Temperature regulatory mechanisms

Human thermo-control system

- Dynamic and set point characteristics

-Implies widespread cutaneous and deep sensors

-Their effect converge towards the hypothalamic integrator which acts as a thermostat

-Inhibitory neurones perform crossing inhibition diagram.

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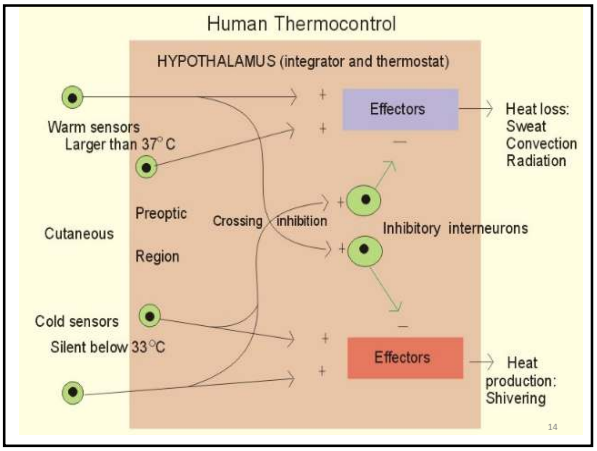

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- Shivering is released from cutaneous cold sensors
- Cold shell activates deep cold sensors in the preoptic hypothalamus
- Preoptic thermostat simultaneously reduces heat loss by crossing inhibition
- Sweat is released by preoptic warm sensors as soon as their temperature is 37^0c or above set point temperature.
- In conclusion, preoptic warm sensors show set point characteristics below the set point and cold sensors show set point characteristics above the set point.

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Thermoregulatory Effectors and Their Response to High and Low temperature Table.

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Effector	Response to low temperature	Response to high temperature
Smooth muscles in arterioles in the skin	**Muscles contract causing vasoconstriction. Less heat is carried from the core to the surface of the body, maintaining core temperature. Extremities can turn blue and feel cold and can even be damaged (frostbite).**	**Muscles relax causing vasodilation. More heat is carried from the core to the surface, where it is lost by convection and radiation(conduction is generally low, except when in water). Skin turns red.**
Sweat glands	No sweat produced.	Glands secrete sweat onto surface of skin, where it evaporates. Since water has a high latent heat of evaporation, it takes heat from the body. High humidity, and tight clothing made of man-made fibres reduce the ability of the sweat to evaporate and so make us uncomfortable in hot weather. Transpiration from trees has a dramatic cooling effect on the surrounding air temperature.

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Erector pili muscles in skin (attached to skin hairs)	**Muscles contract, raising skin hairs and trapping an insulating layer of still, warm air next to the skin. Not very effective in humans, just causing "goose bumps".**	**Muscles relax, lowering the skin hairs and allowing air to circulate over the skin, encouraging convection and evaporation.**
Skeletal muscles	Shivering: Muscles contract and relax repeatedly, generating heat by friction and from metabolic reactions (respiration is only 40% efficient: 60% of increased respiration thus generates heat).	No shivering.

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Adrenal and thyroid glands	Glands secrete adrenaline and thyroxine respectively, which increases the metabolic rate in different tissues, especially the liver, so generating heat.	Glands stop secreting adrenaline and thyroxine.
Behaviour	Curling up, huddling, finding shelter, putting on more clothes.	Stretching out, finding shade, swimming, removing clothes.

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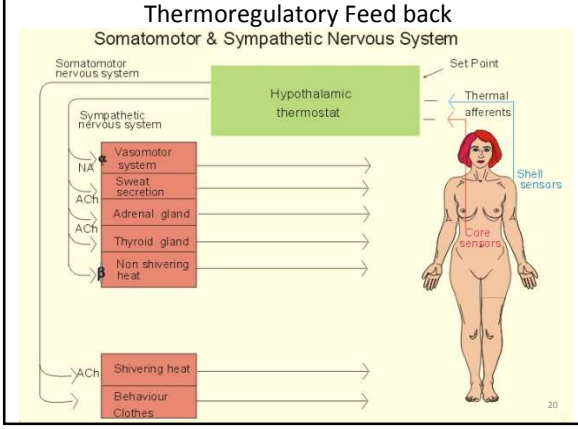
Thermoregulatory Feed back



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- Cholinergic sympathetic fibres control sweat secretion.
- Vasodilator bradykinin is liberated in the skin, Thus profuse secretion is always accompanied by vasodilation.
- Sympathetic activation releases thyroid hormone
- Adrenal medulla releases catecholamines
- Non shivering heat production is controlled by the sympathetic nervous system via adrenergic Beta receptors.

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- Noradrenaline (NA) released at the nerve terminals close to the adipocytes stimulate the liberation of free fatty acid and their subsequent oxidation
- Shivering is induced by way of the motor system.
- The central shivering pathway passes from the hypothalamus to the motor neurons in the spinal cord
- Thermoregulatory behaviour

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THANKS FOR LISTENING

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