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Thermoregulation

Physiology II lecture (aVLFY0422p)

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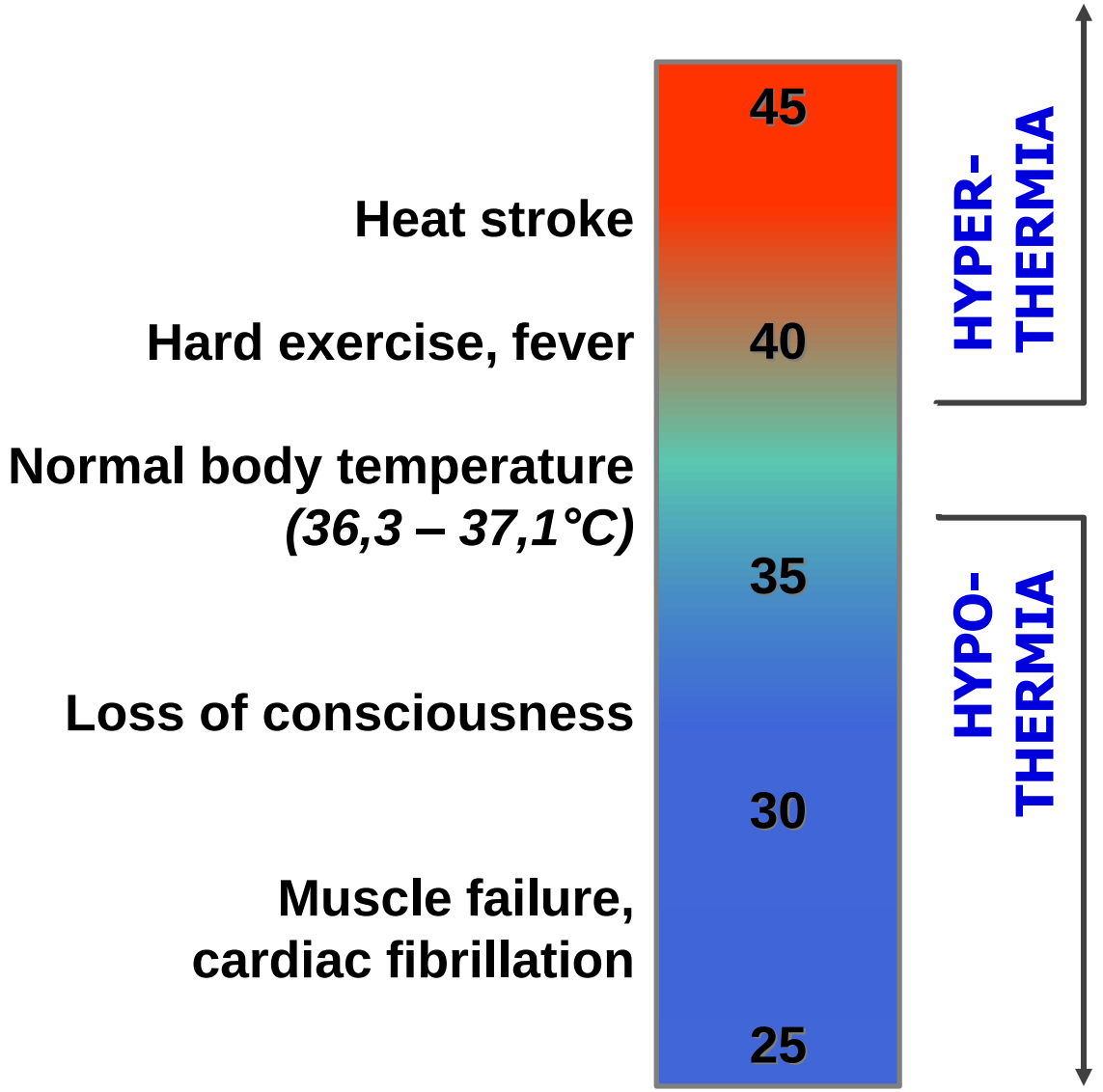
Body temperature – homeostatic parameter



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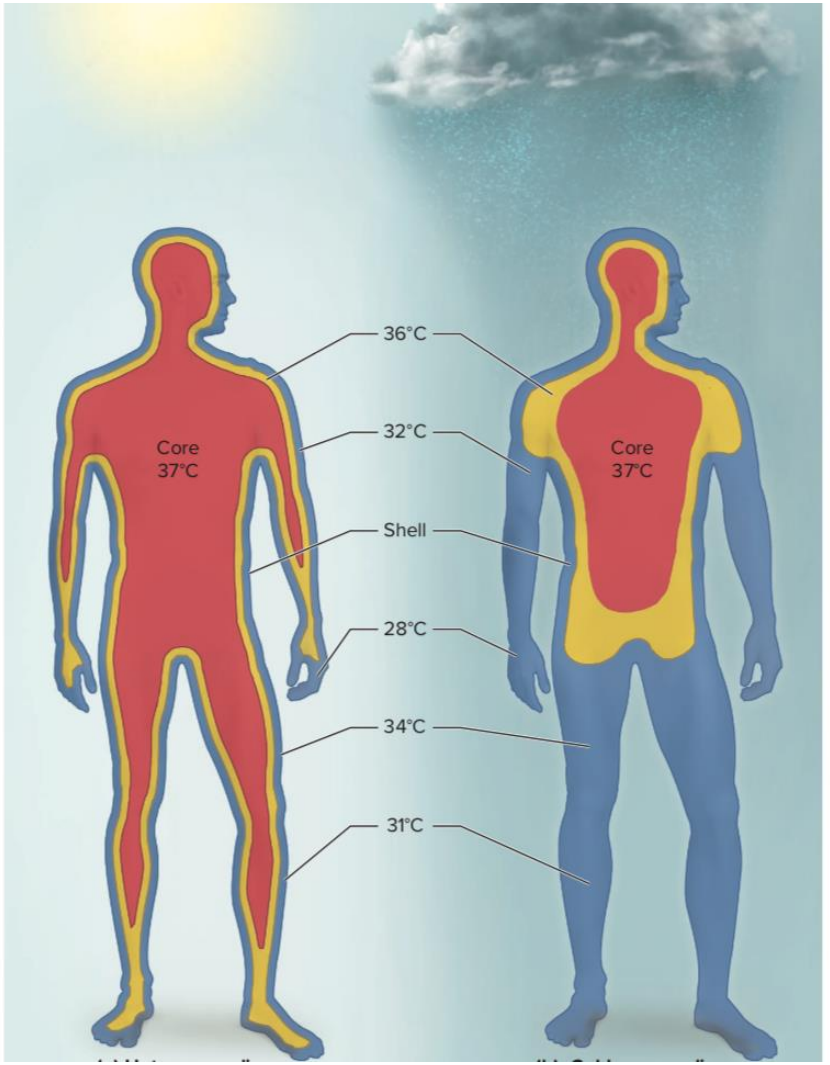
Body core vs. shell

- homeotherms vs. poikilotherms
- Body core temperature – regulated within certain (narrow) range
- Skin temperature (shell) – more variable (ambient t., core body t.)



Adopted from: K.S. Saladin, *Anatomy & Physiology—The Unity of Form and Function,* 8th ed. (McGraw-Hill, 2018)

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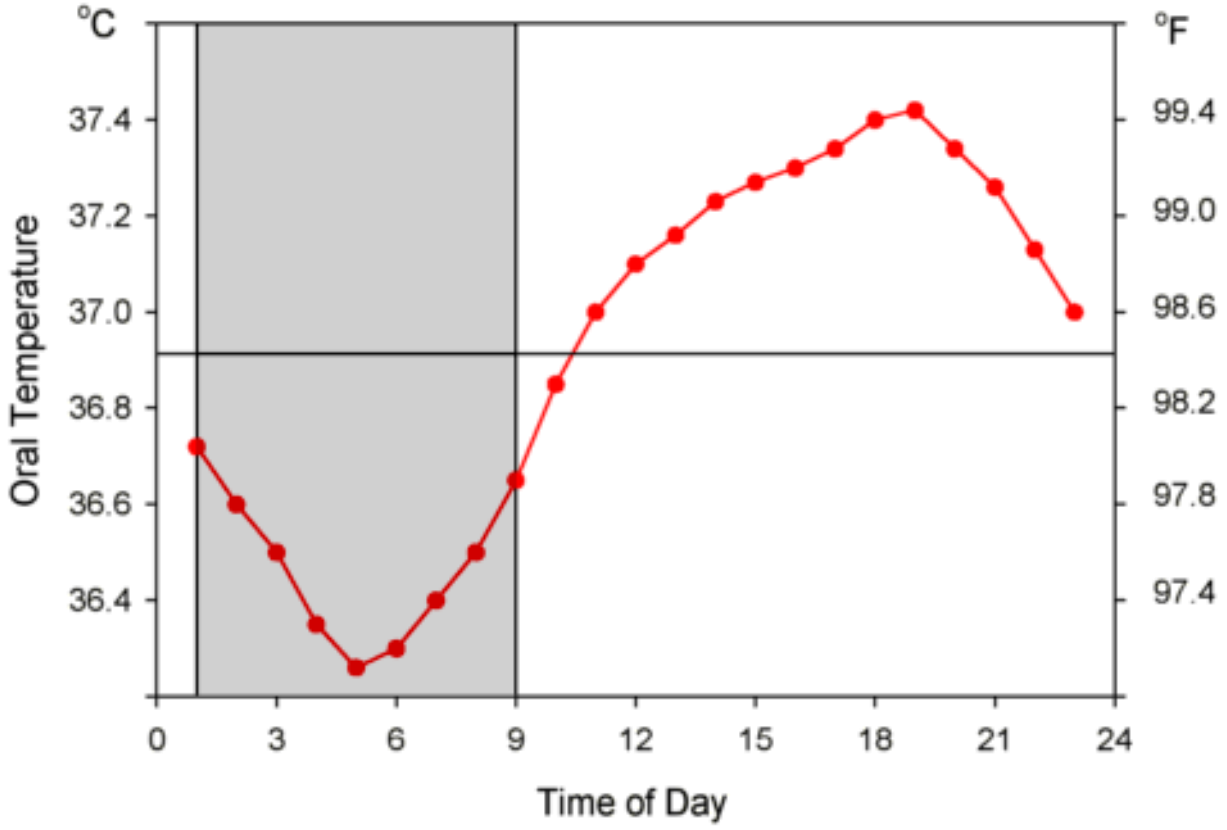
Variations of body core temperature

- Circadian rhythm
- Circamensal rhythm (women between puberty and menopause)
- Seasonal variations (circannul rhythm)
- Ageing



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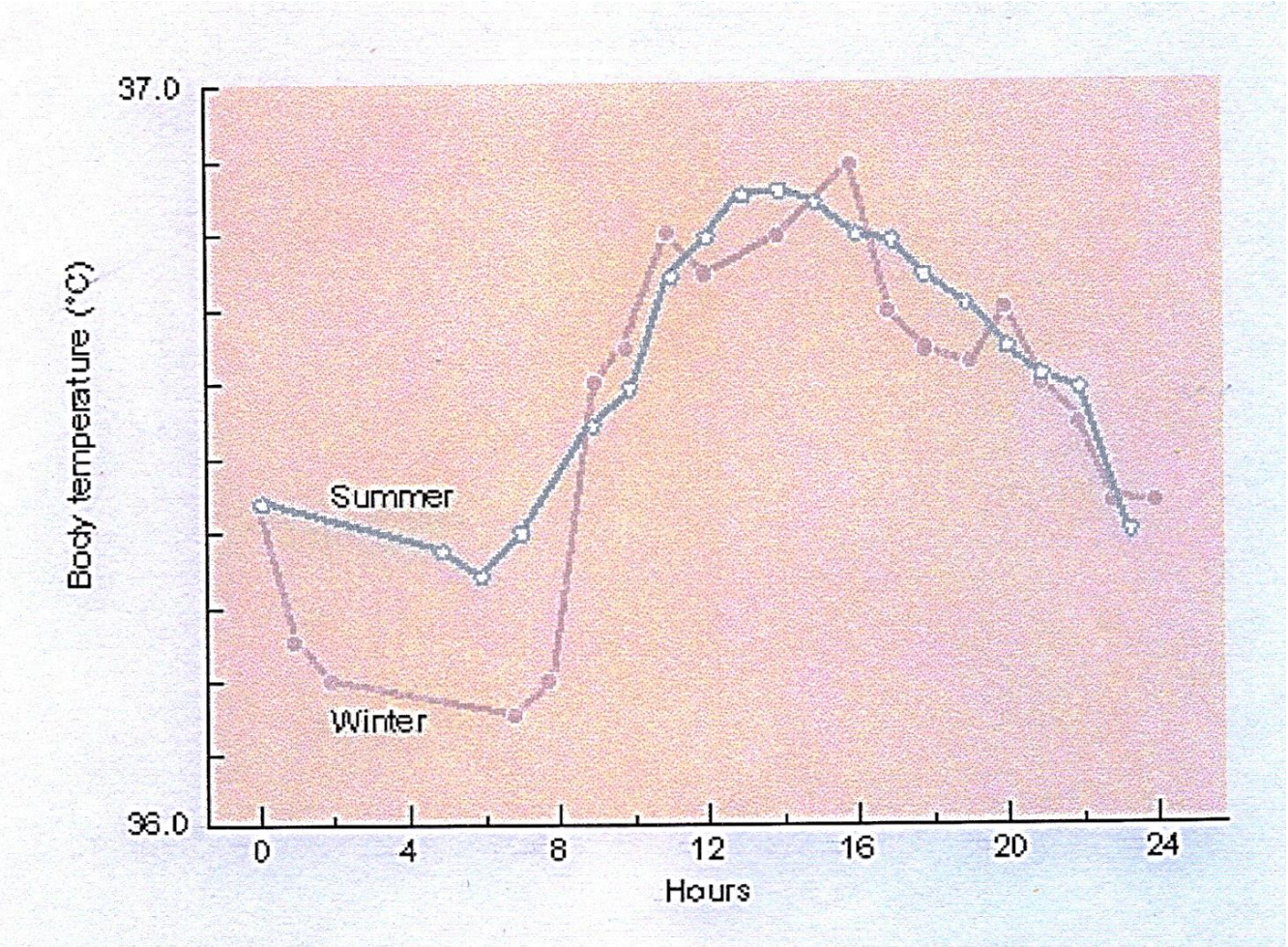
Variations of body core temperature



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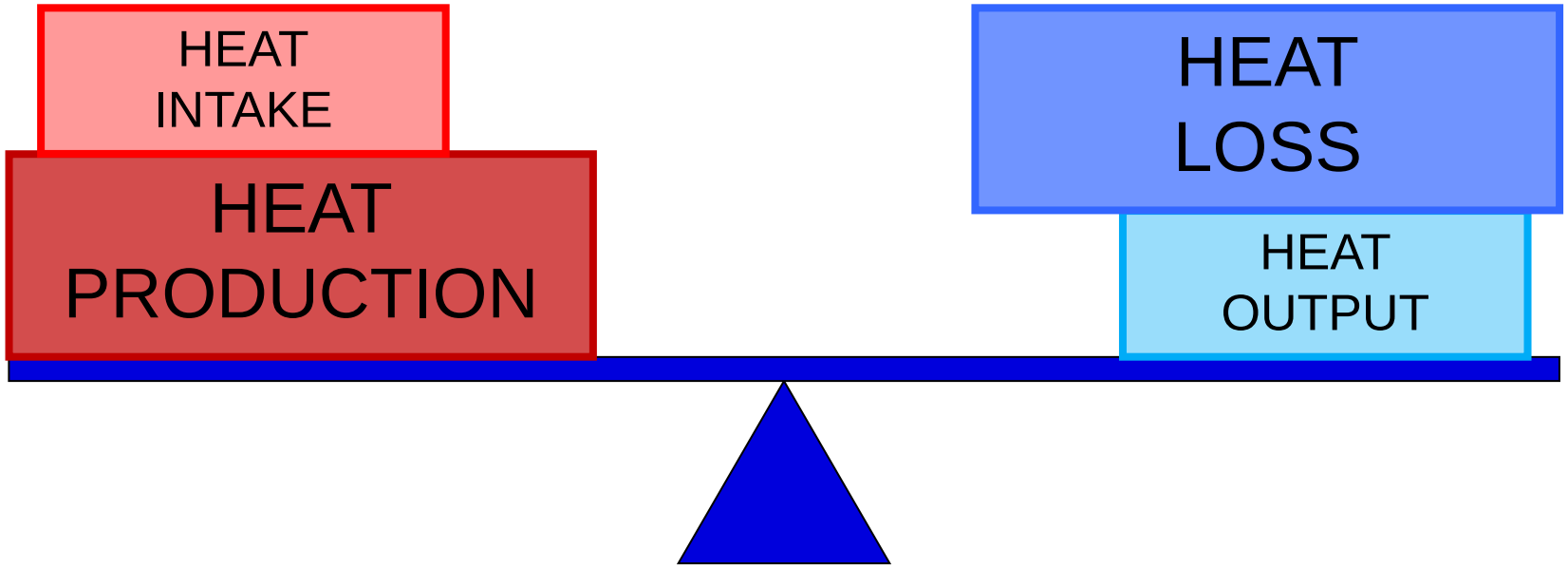
A fine balance of body core temperature



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Heat vs. temperature

- **Heat [J]** – energy transfered to or from the system; measure of the internal energy state

- **Temperature [K, °C, °F]** – a measure of heat content; mean kinetic energy of the particles (molecules, ions)

Transfer of heat within the body

- primarily by **CONVECTION**
- medium = blood

- minor amount by **CONDUCTION**
- direct contact of organs/tissues

Heat production

- Metabolism: metabolic rate ≈ heat production
- Physical activity (active muscle contraction) – rest vs. exercise

- Postprandial thermogenesis (food intake)

- Shivering thermogenesis
- Non-shivering thermogenesis (brown adipose tissue)

Heat intake and loss

- passive processes

- RADIATION
- CONVECTION
- CONDUCTION

- skin-environment temperature gradient

Heat output (active loss)

- EVAPORATION
- sensible perspiration = sweat production (1 L of evaporated s. = 2 428 kJ)
- Insensible perspiration = diffusion of water through skin and mucosae

- from the skin to the environment
- (RADIATION)
- (CONDUCTION)
- (CONVECTION)

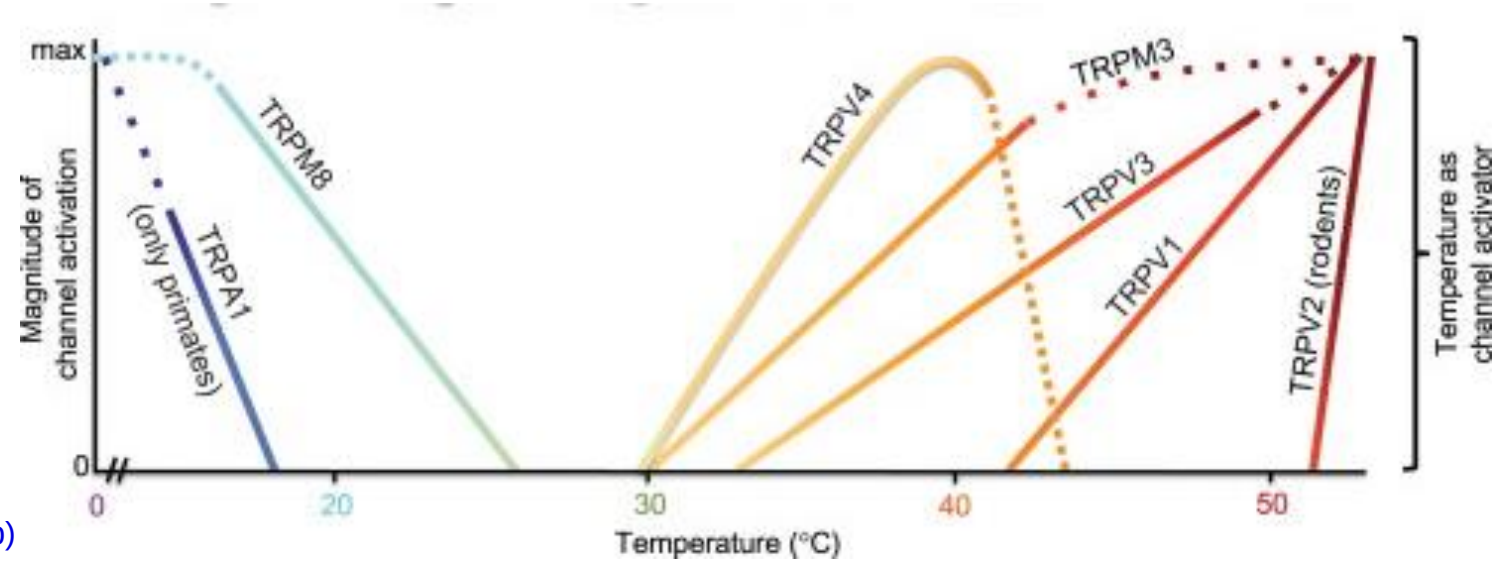
Thermoregulation

- All processes involved in keeping the body core temperature within the range
- Thermoregulatory behaviour
- Social thermoregulation

Afferentation

- Central thermoreceptors – deep brain temperature
- temperature-sensitive neurons in anterior preoptic hypothalamus

- Peripheral thermoreceptors – skin temperature
- TRP channels



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Thermoregulatory centre

- anterior preoptic HYPOTHALAMUS

- integration of afferent information
- modifying the efferent pathways (vegetative, somatic) to the thermal effectors

- „set-point“ vs. threshold temperature for the effector(s)

Thermal effectors

- Behaviour
- Cutaneous circulation
- Sweat glands
- Skeletal muscles (shivering)
- Horripilation
- Brown adipose tissue (nonshivering thermogenesis)

Cold-induced thermoregulatory mechanisms

- Decrease of heat loss
  - Behaviour: Decrease of body surface, taking warm clothes
  - Vasoconstriction in the skin. Horripilation
  - Inhibition of sweating
- Increase of heat production
  - Skeletal muscles: Intentional movements (behaviour). Shivering
  - Nonshivering thermogenesis (brown adipose tissue, NA, β3R, UCP1)
  - Hunger (increas of food intake)

Warm-induced thermoregulatory mechanisms

- Increase of heat loss/output
  - Skin vasodilatation
  - Increase of sweating (evaporation)
  - Increase of ventilation
- Decrease of heat production/intake
  - Behaviour: Moving out of the sun, taking light clothes. Inactiveness (decrease of intentional movements), apathy
  - Loss of appetite