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A role of the sympathetic nervous system in thermoregulation

Physiology II seminar (aVLFY0422s)

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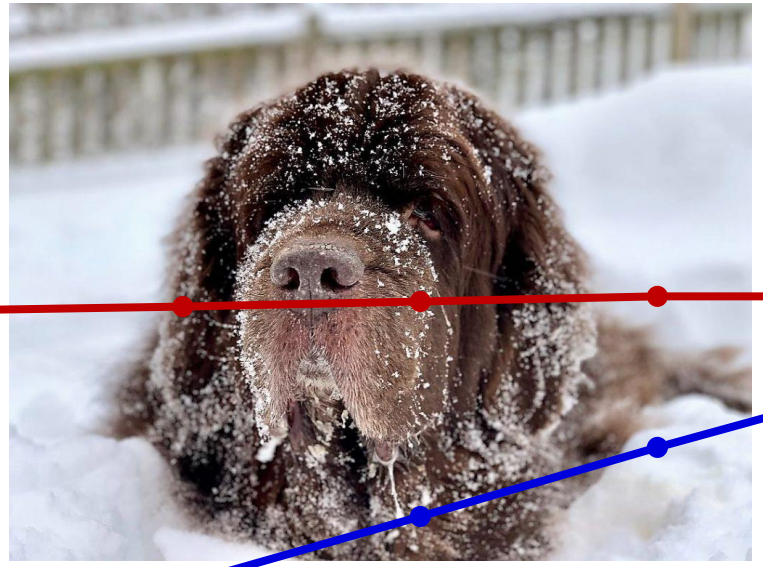
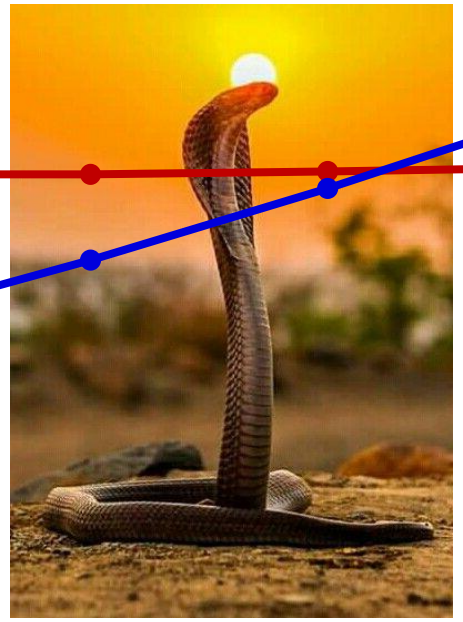
Homeotherms vs. poikilotherms





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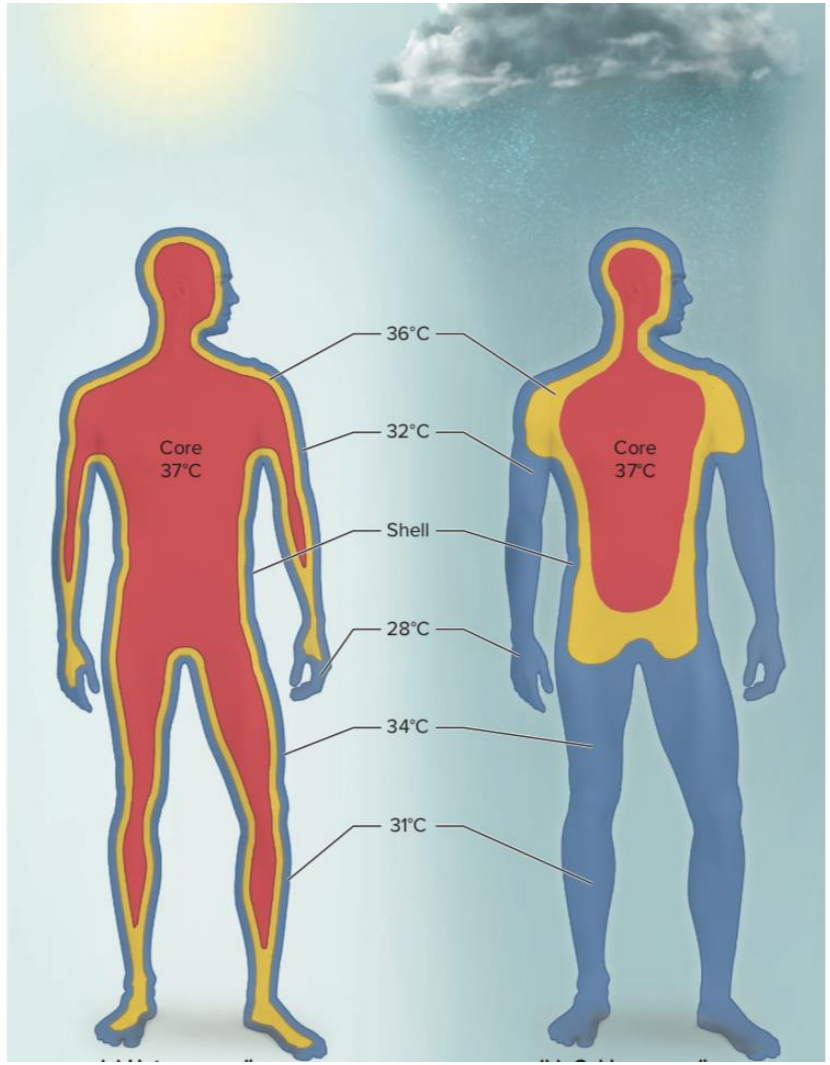
Body core vs. shell

- Body core temperature = homeothermic
  - regulated within narrow range
- Skin temperature (shell) = poikilothermic
  - more variable (ambient t., core body t.)



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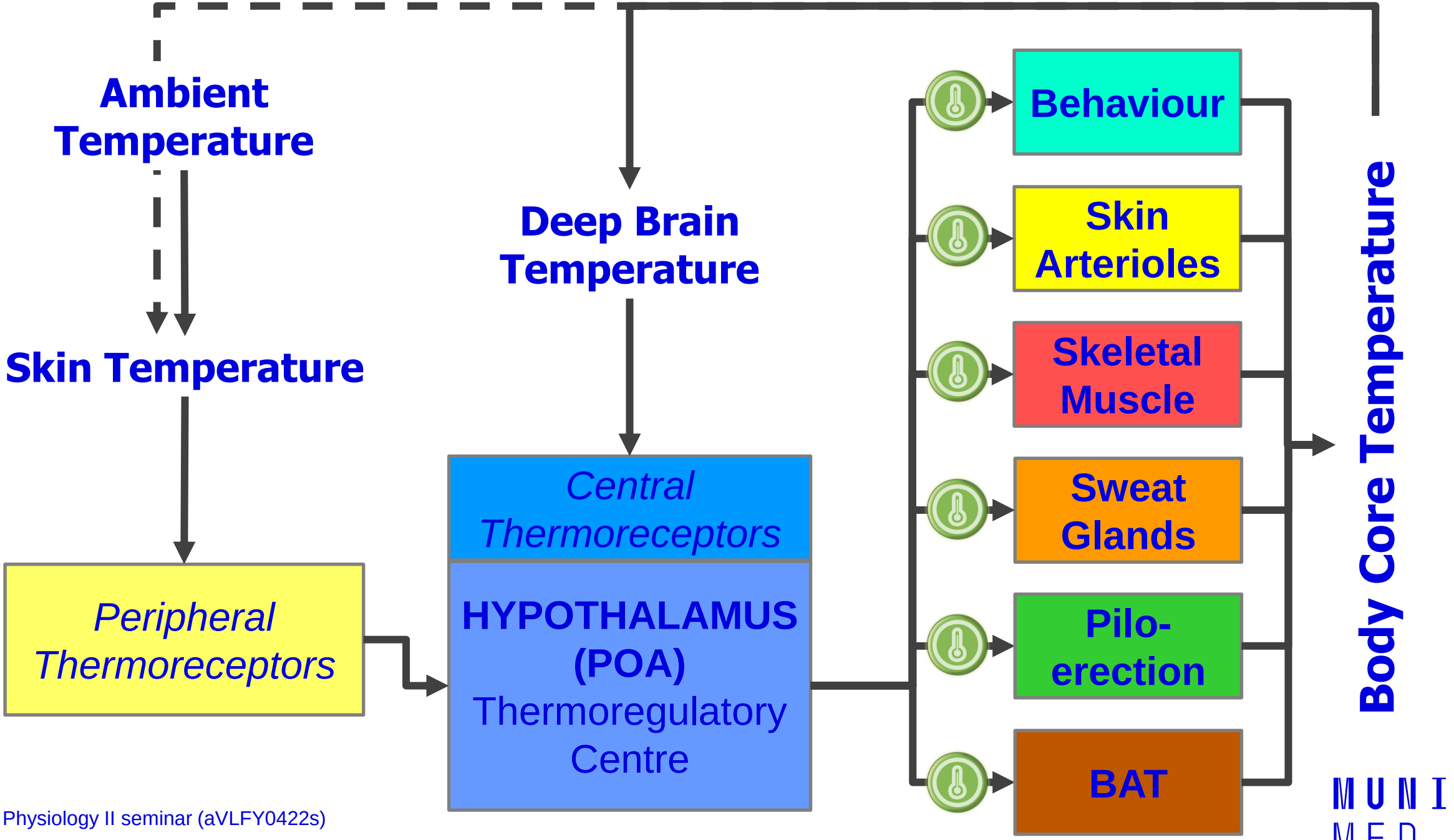
Ambient Temperature
Skin Temperature
Deep Brain Temperature
Peripheral Thermoreceptors
Central Thermoreceptors
HYPOTHALAMUS (POA)
Thermoregulatory Centre
Behaviour
Skin Arterioles
Skeletal Muscle
Sweat Glands
Pilo-erection
BAT
Body Core Temperature

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Sympathetic pathways to thermo effectors

- Skin circulation (vasomotor activity)
- Sweat glands (sweating)
- Brown adipose tissue (non-shivering thermogenesis)

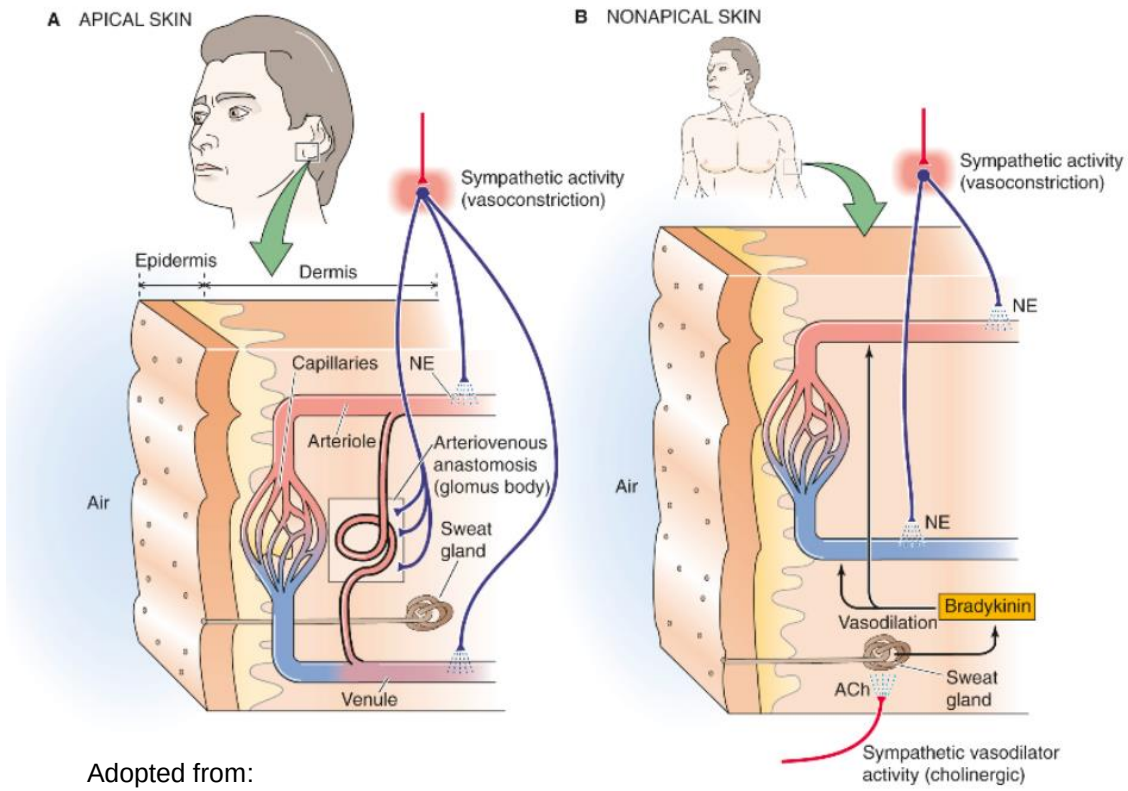
Skin circulation – apical vs. non-apical skin

Apical skin

- a-v anastomoses
- Vasoconstriction: SNS (NA: α1R)
- Vasodilatation: passive

Non-apical skin

- Vasoconstriction: SNS (NA: α1R)
- Vasodilatation: SNS (Ach-?)



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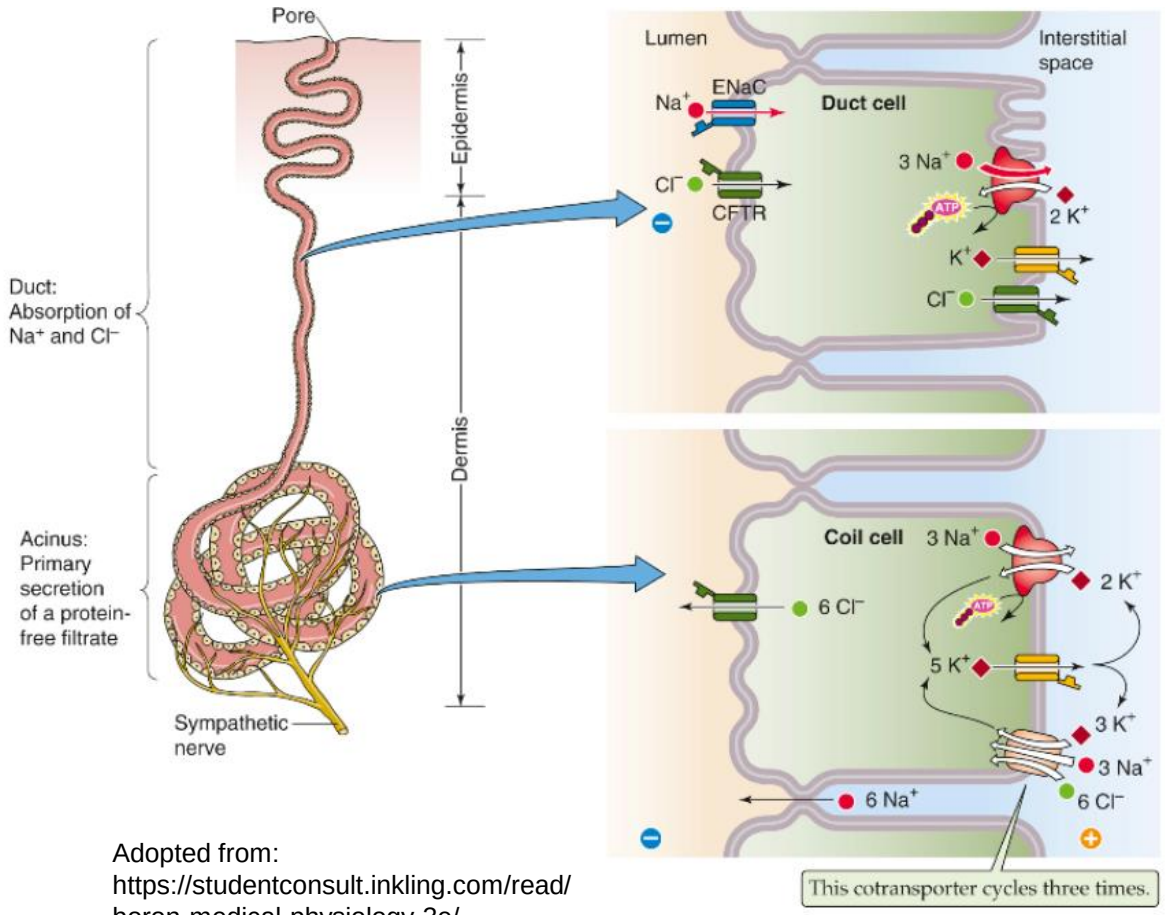
Regulation of sweat secretion

- Eccrine sweat glands
- Sweating reflex
- Efferent p. = sudomotor nn.
- sympathetic cholinergic fibers (Ach)



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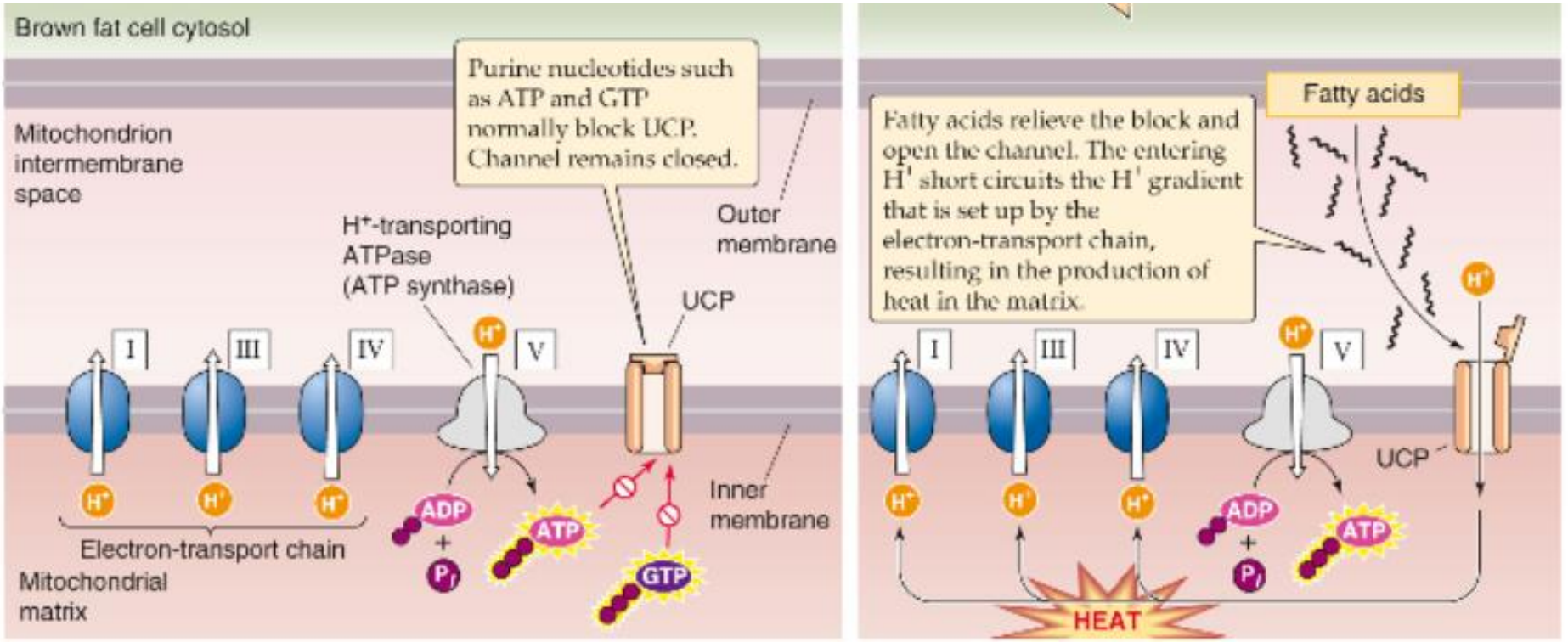
Activation of brown adipose tissue

- Sympathetic system: NA (β3 receptors)
- UCP1



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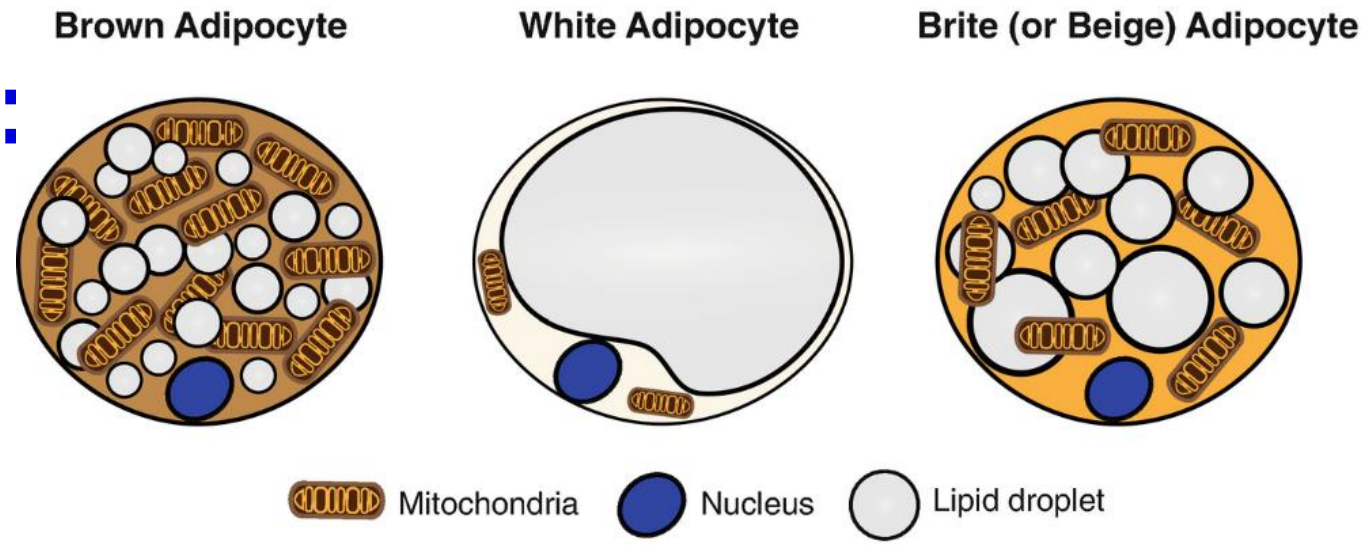
Adipose tissue: brown, white and beige



	Brown	*White*	*Brite/beige*
UCP1 Expression	Positive	Negative	Positive
Mitochondrial Density	High	Low	Medium
LD Morphology	Multi-locular	Uni-locular	Multi-locular
Primary Function	Thermogenesis Endocrine	Energy storage Endocrine	Thermogenesis? Endocrine?

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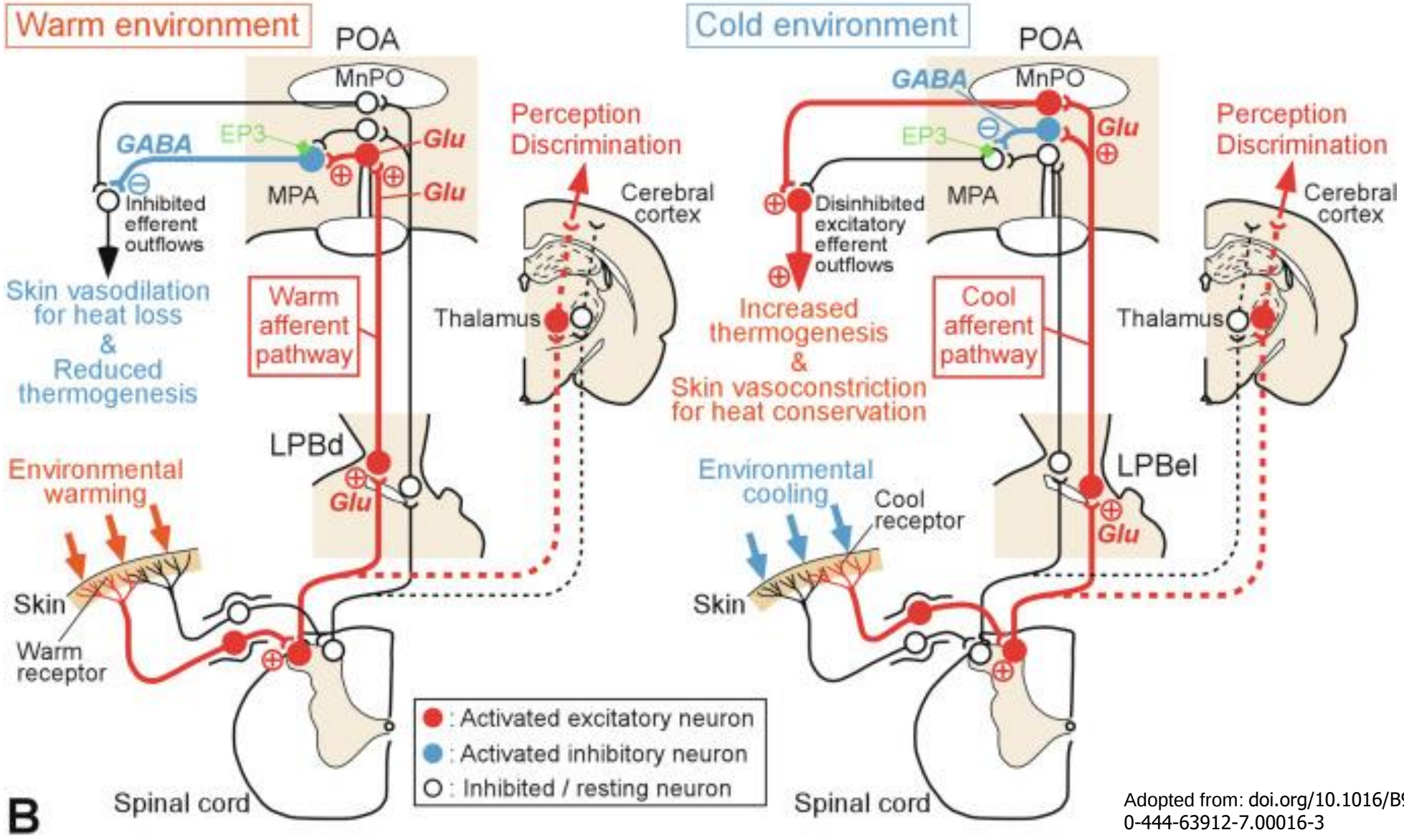

Adopted from: doi.org/10.1016/B978-0-444-63912-7.00016-3

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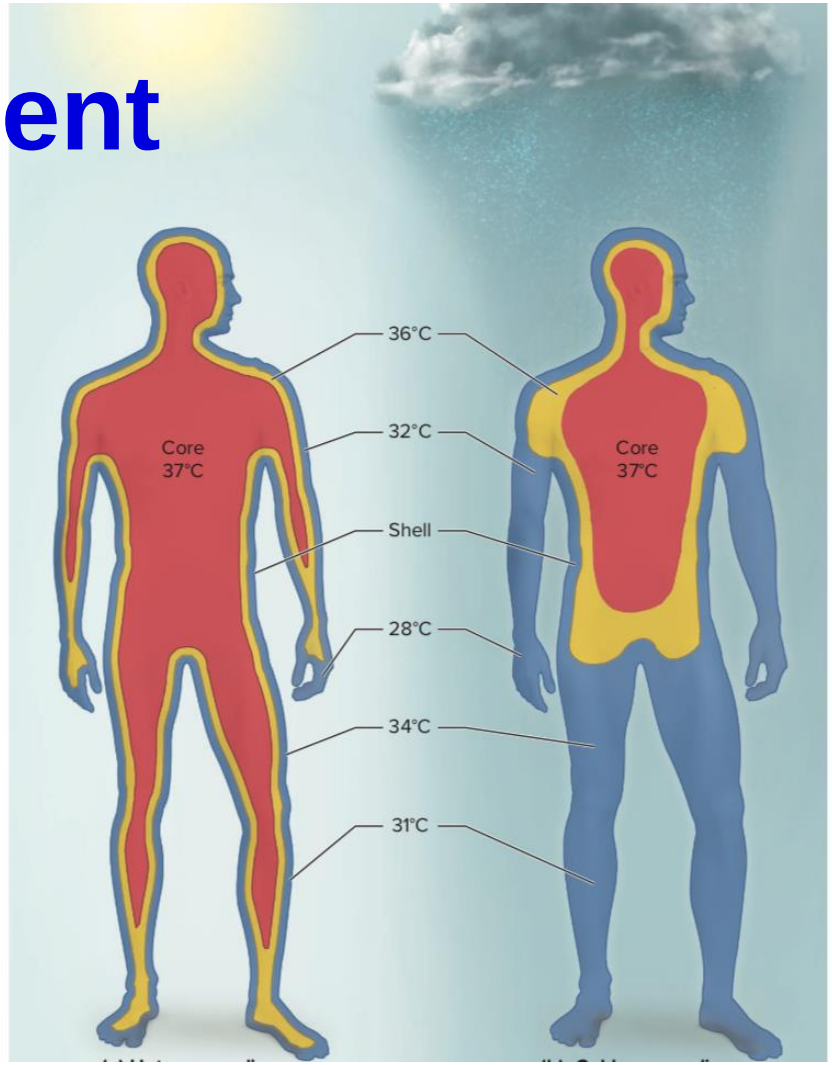
Body temperature measurement Where and how?

- Arm pit
- Oral cavity (sublingual)
- Rectum
- External auditory tube
- Skin over temporal artery



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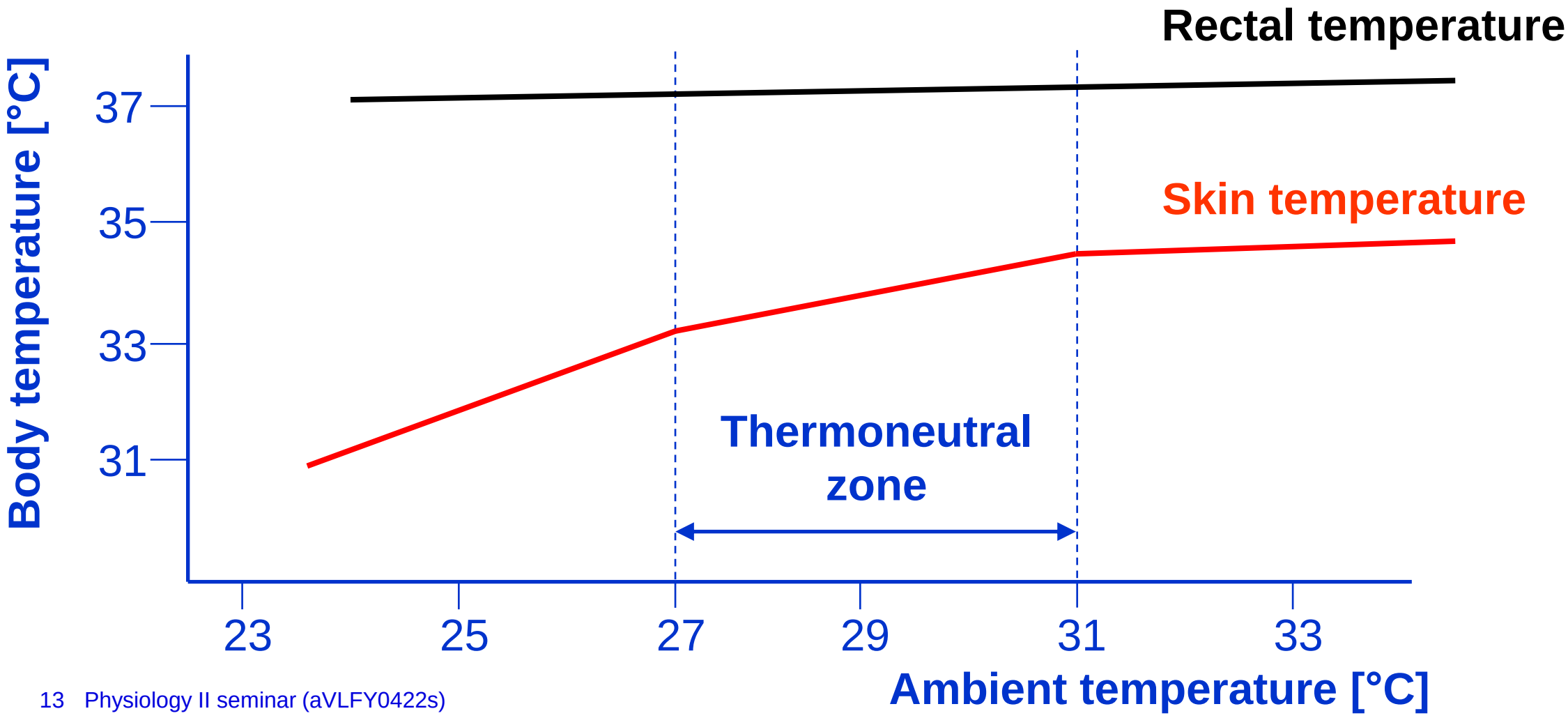
Rectal vs. skin temperature



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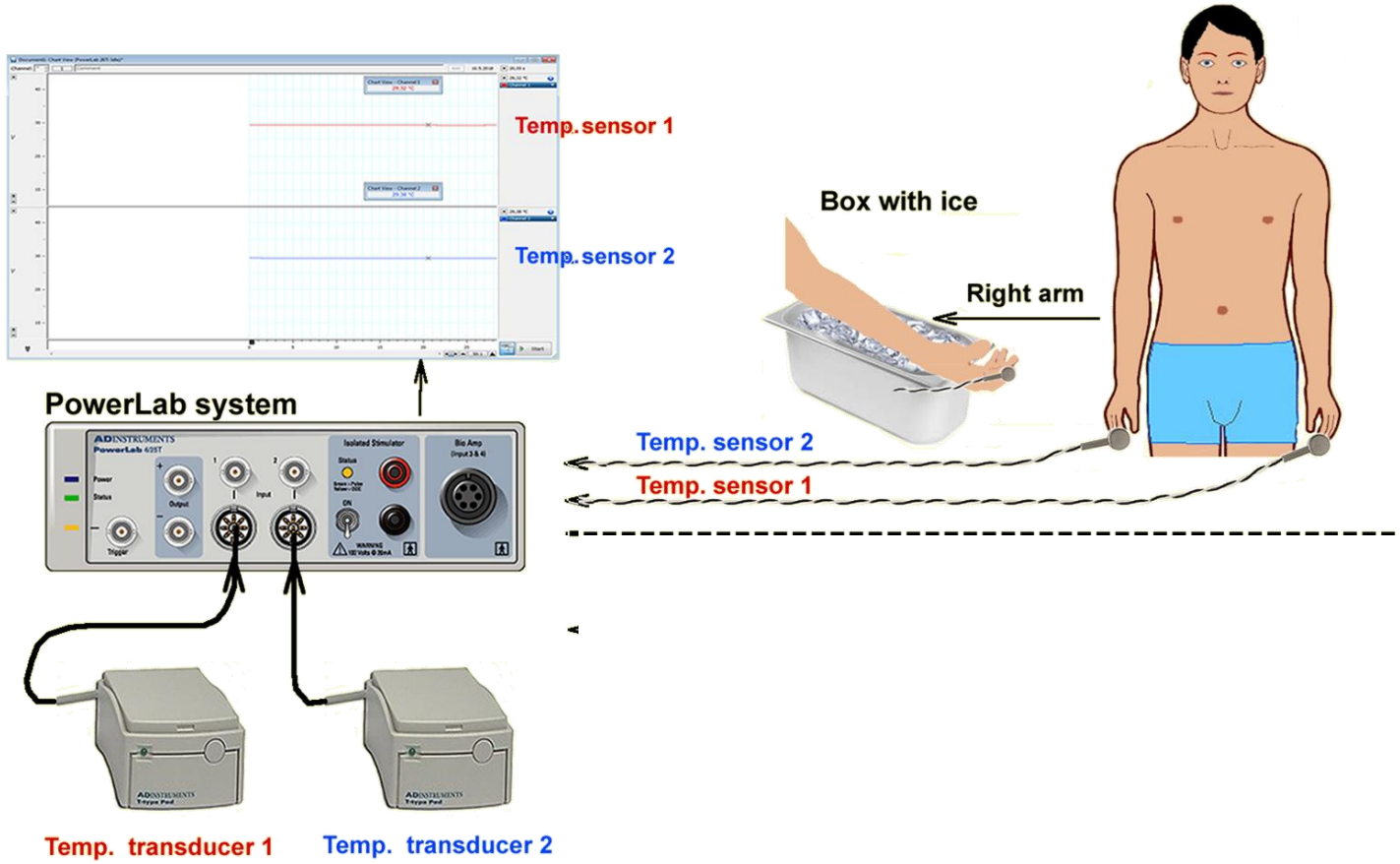
EXPERIMENT 1:
Local cold exposure affects skin temperature



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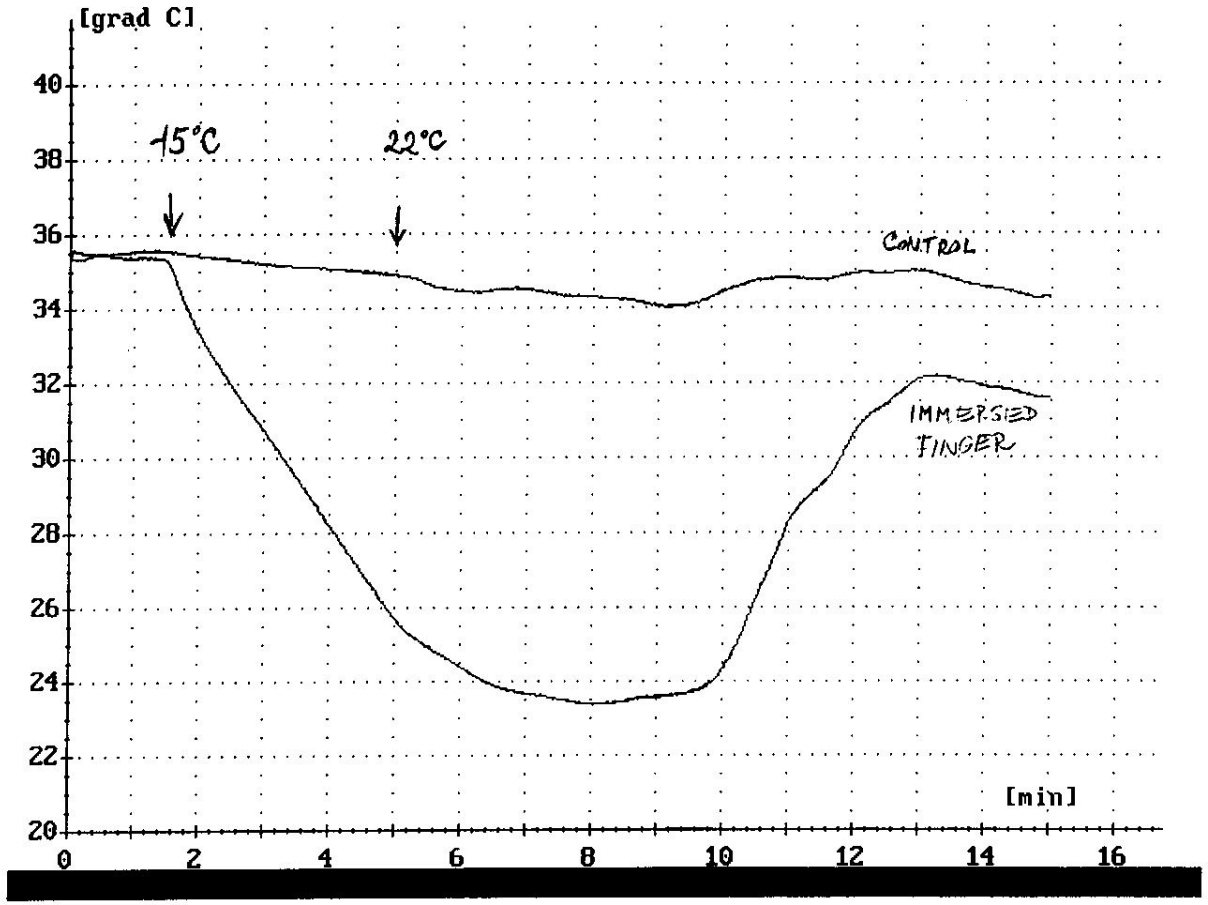
Result 1



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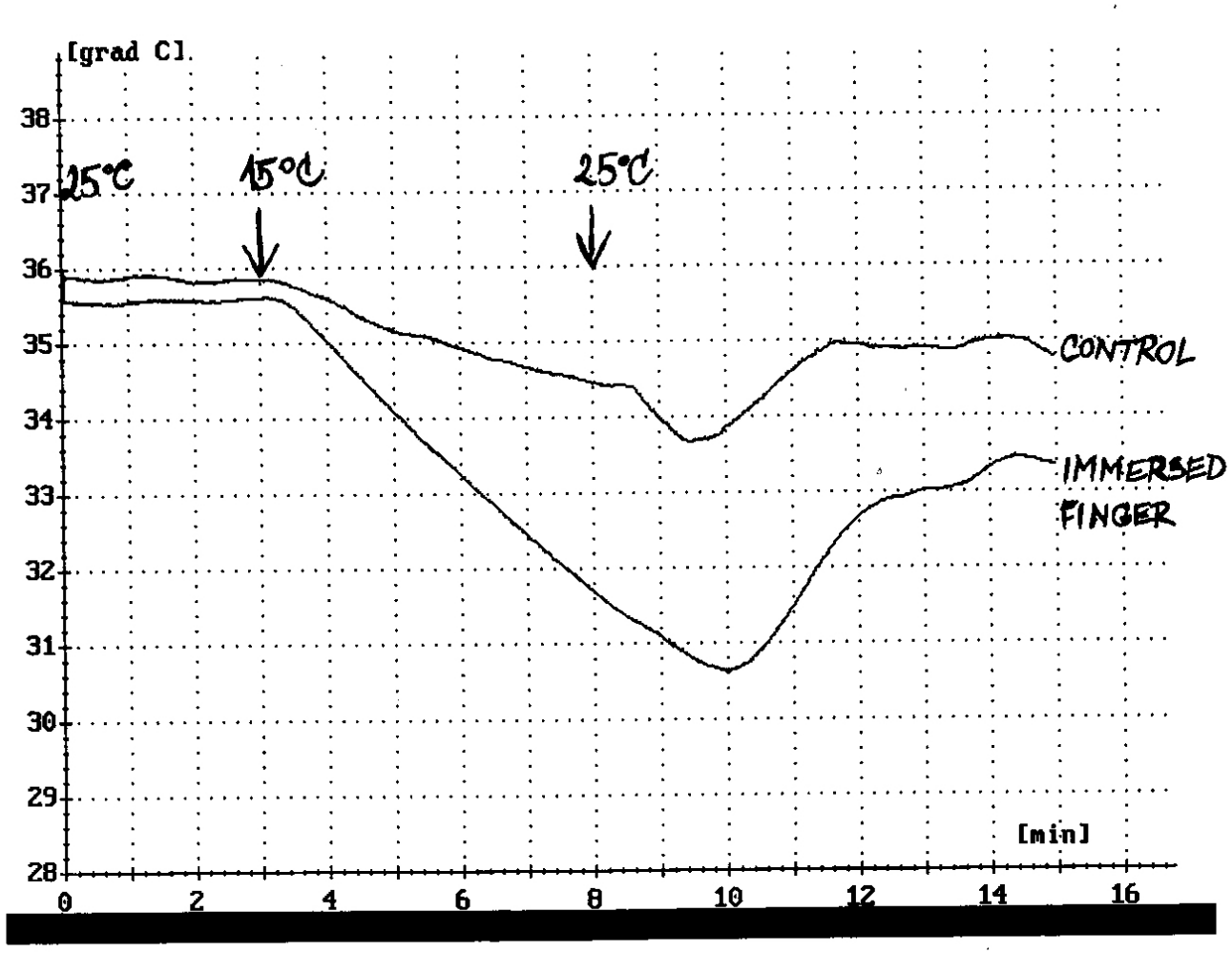
Result 2



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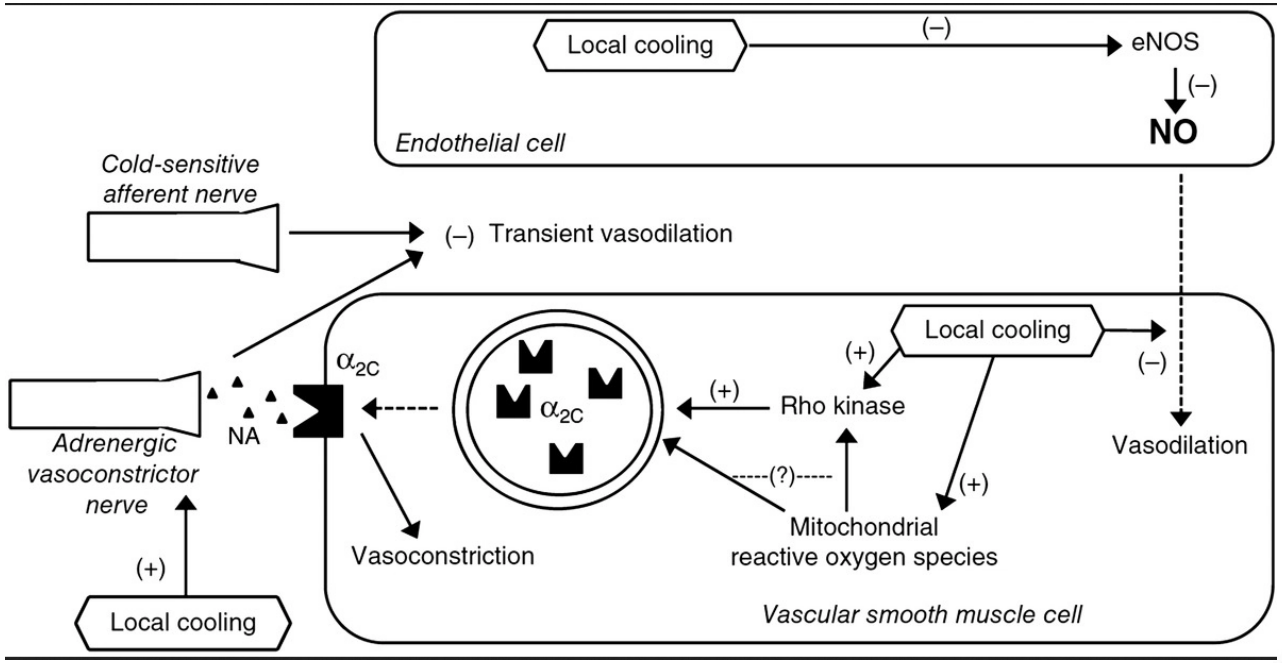
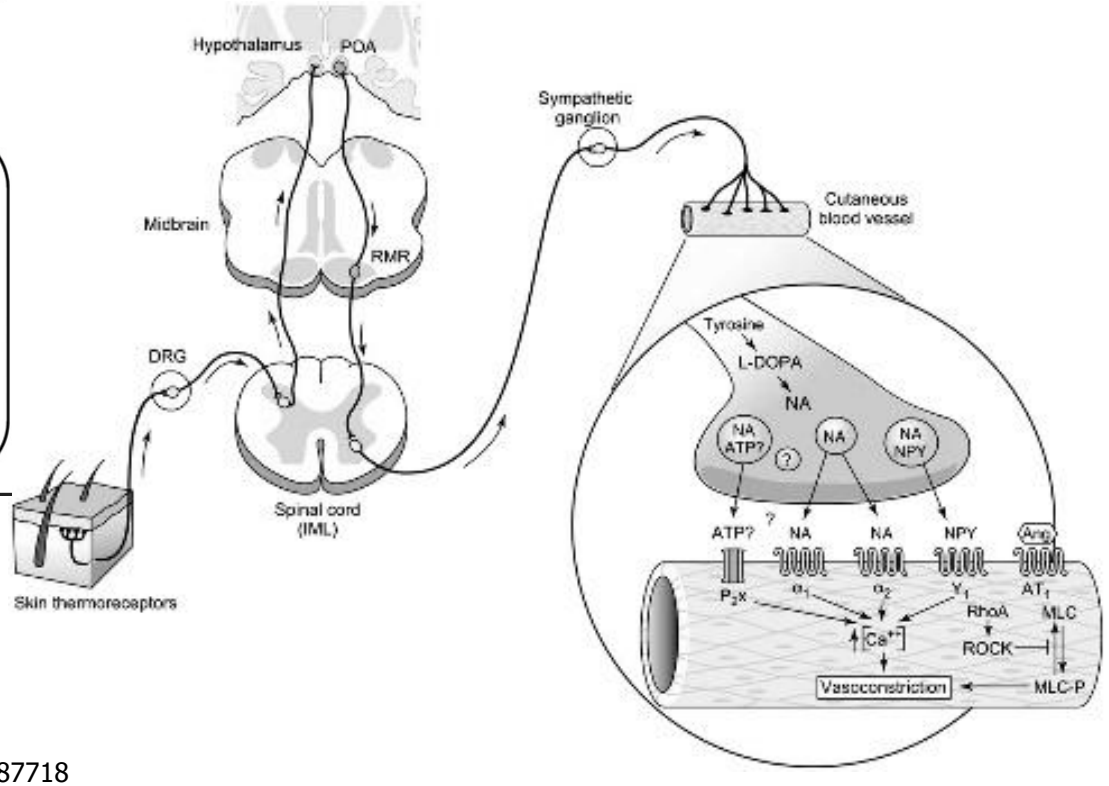
Cold-induced skin vasoconstriction





Adopted from: doi.org/10.1113/EP087718

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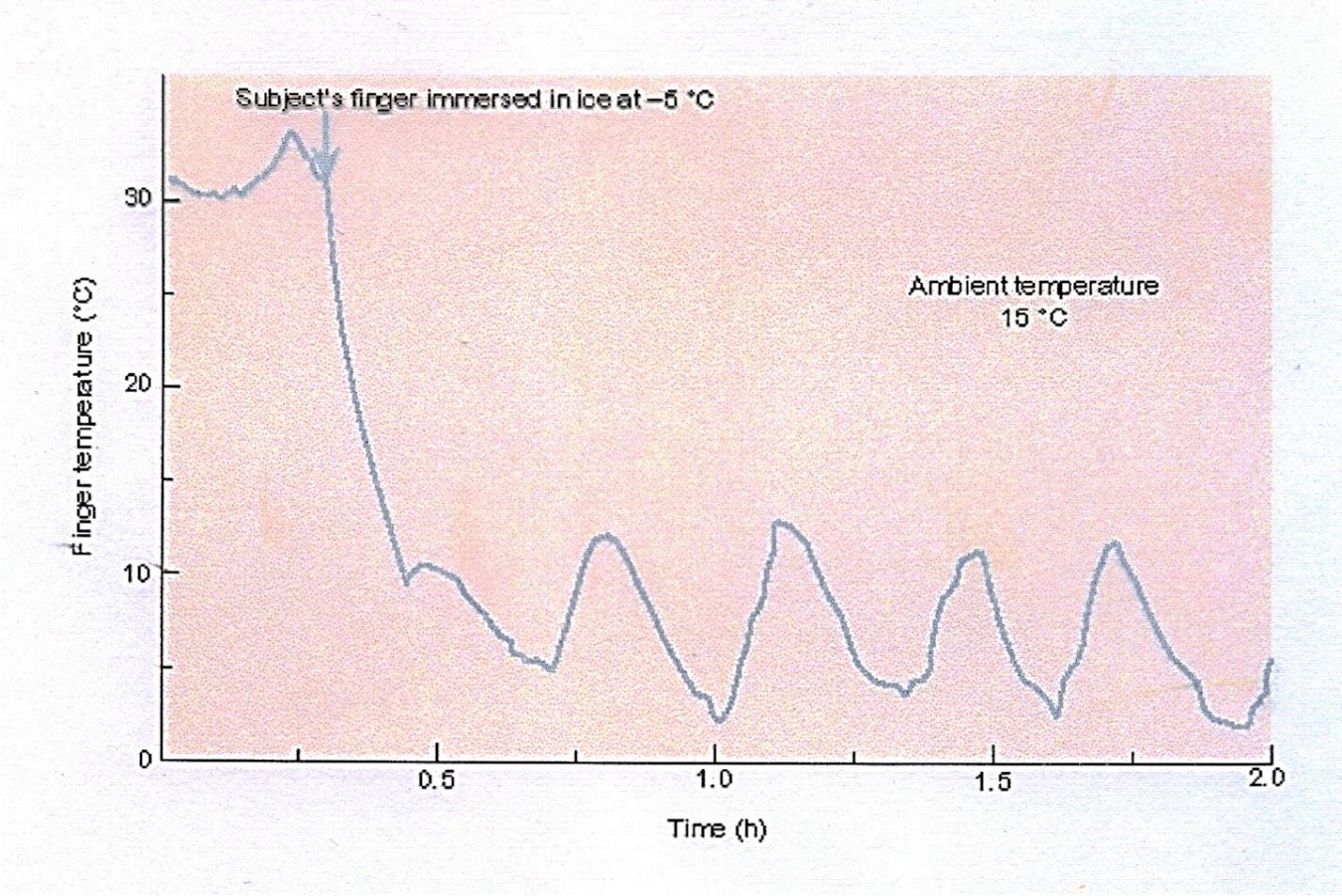
Cold-induced vasoconstriction vs. hypoxia: Hunting reaction (Lewis, 1930)



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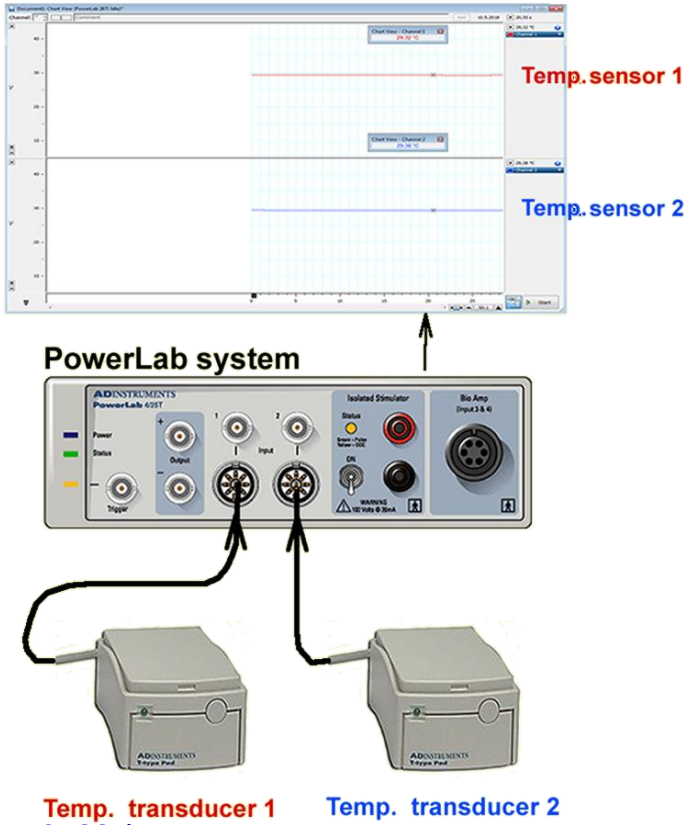
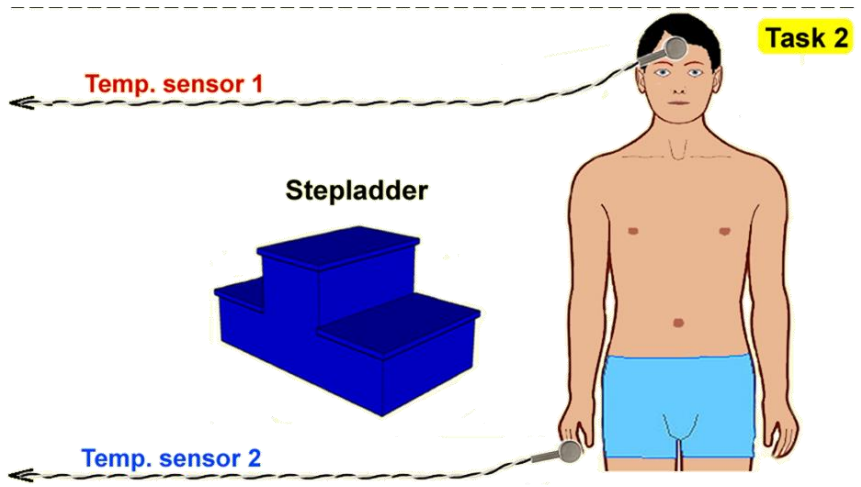
EXPERIMENT 2: „Central“ vs. „peripheral“ skin temperature during exercise





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Standardised workload

- Ergometry
- Exactly: W/kg
- Comparatively: MET – metabolic equivalent
  - Actual metabolic rate / resting metabolic rate in sitting position
  - 1 MET = consumption of 3.5 ml O2/kg.min
  - sleeping ≈ 0,9 MET; slow walking ≈ 3-4 MET; fast runnig, sprint ≈ 16 MET
  - (+) simplicity; (-) inaccuracy

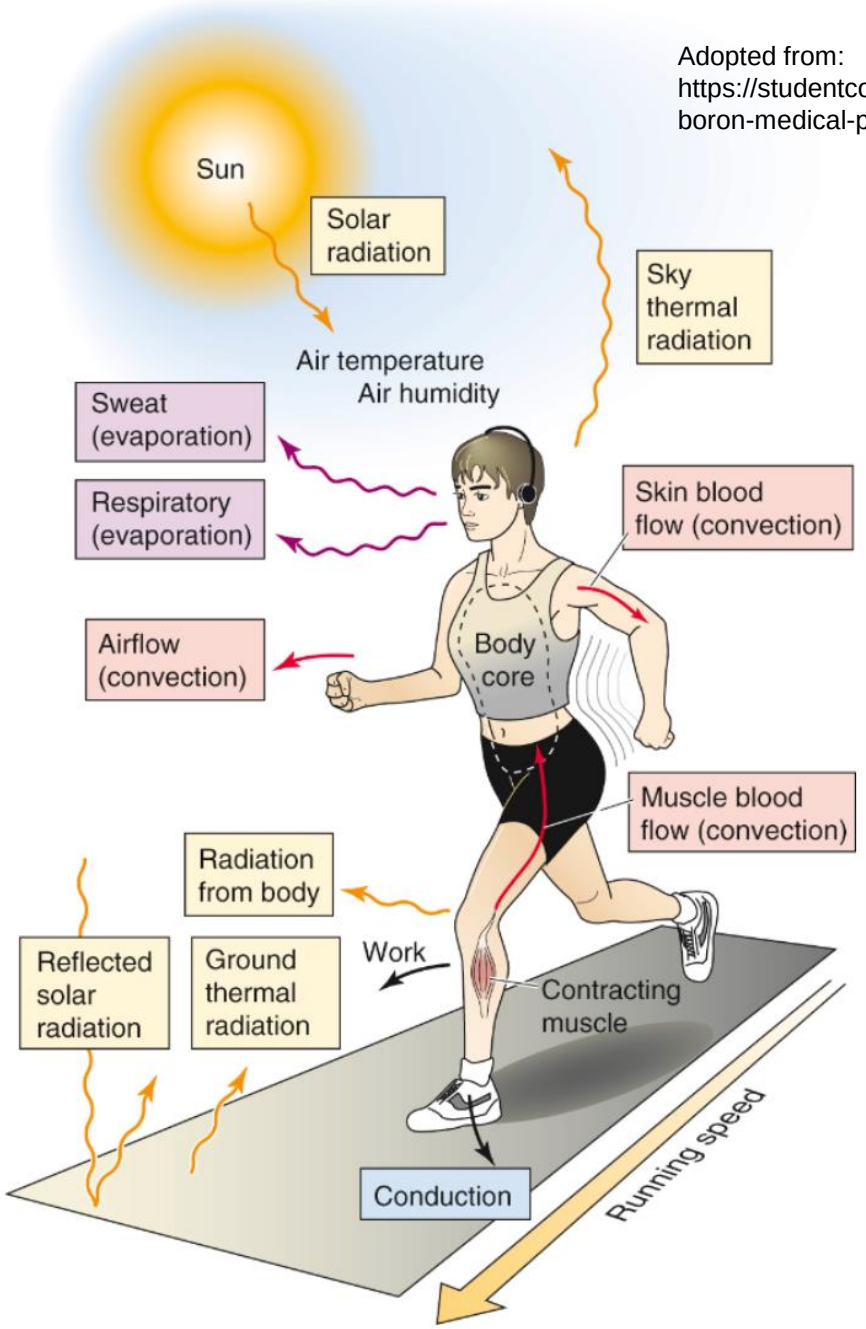
Indexes of fitness

- W_{170} [W/kg]
- $V_{O2\,max}$ [mL O_2 / (min x kg)]
- Aerobic / anaerobic threshold

Heat exchange during exercise

- Conduction
- Convection
- Radiation

- Evaporation



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Heat exchange during exercise

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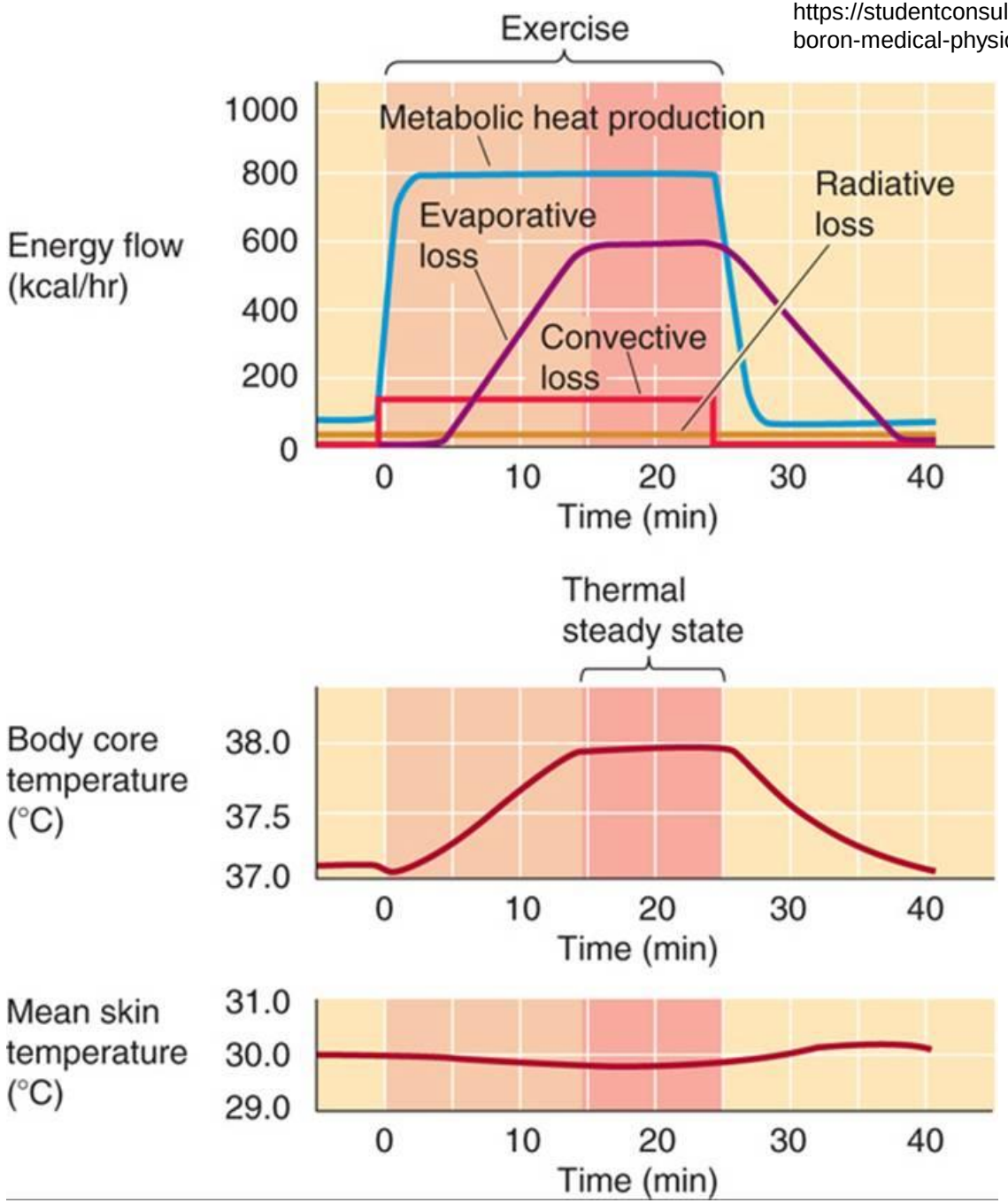

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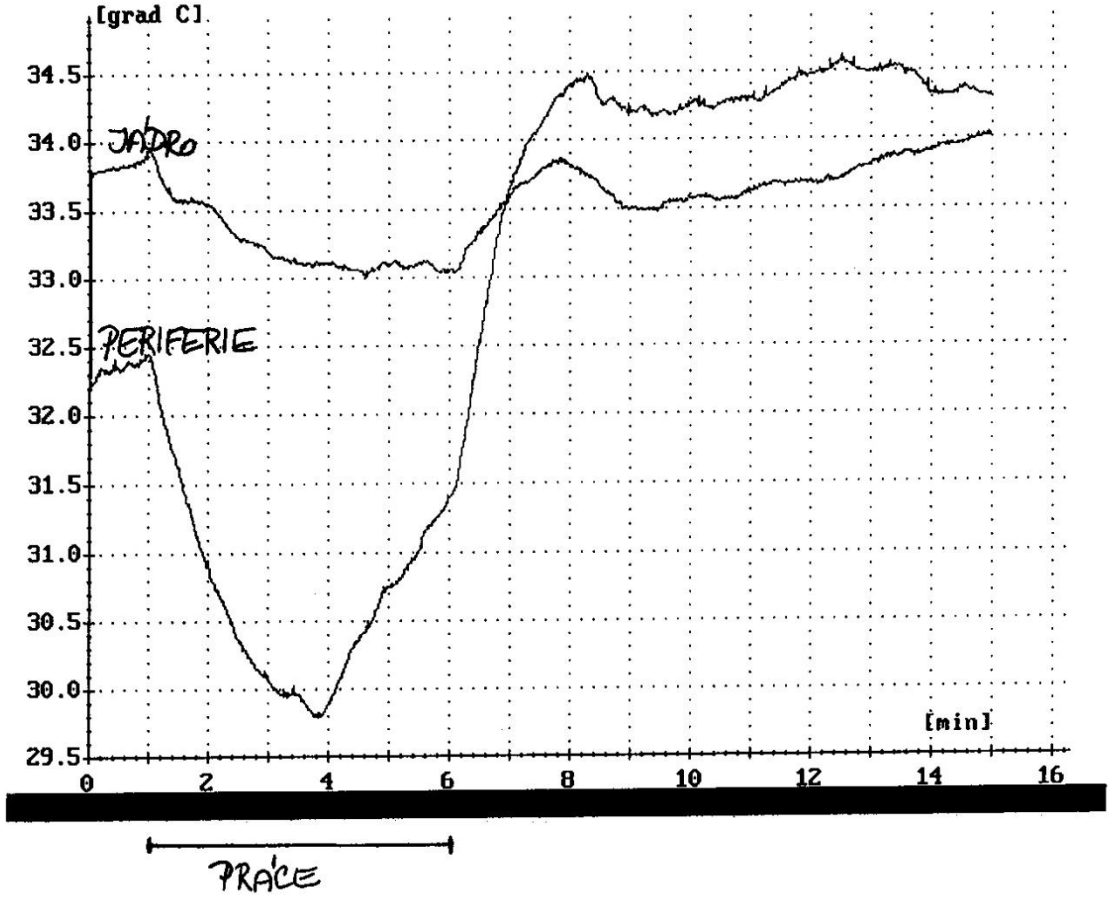

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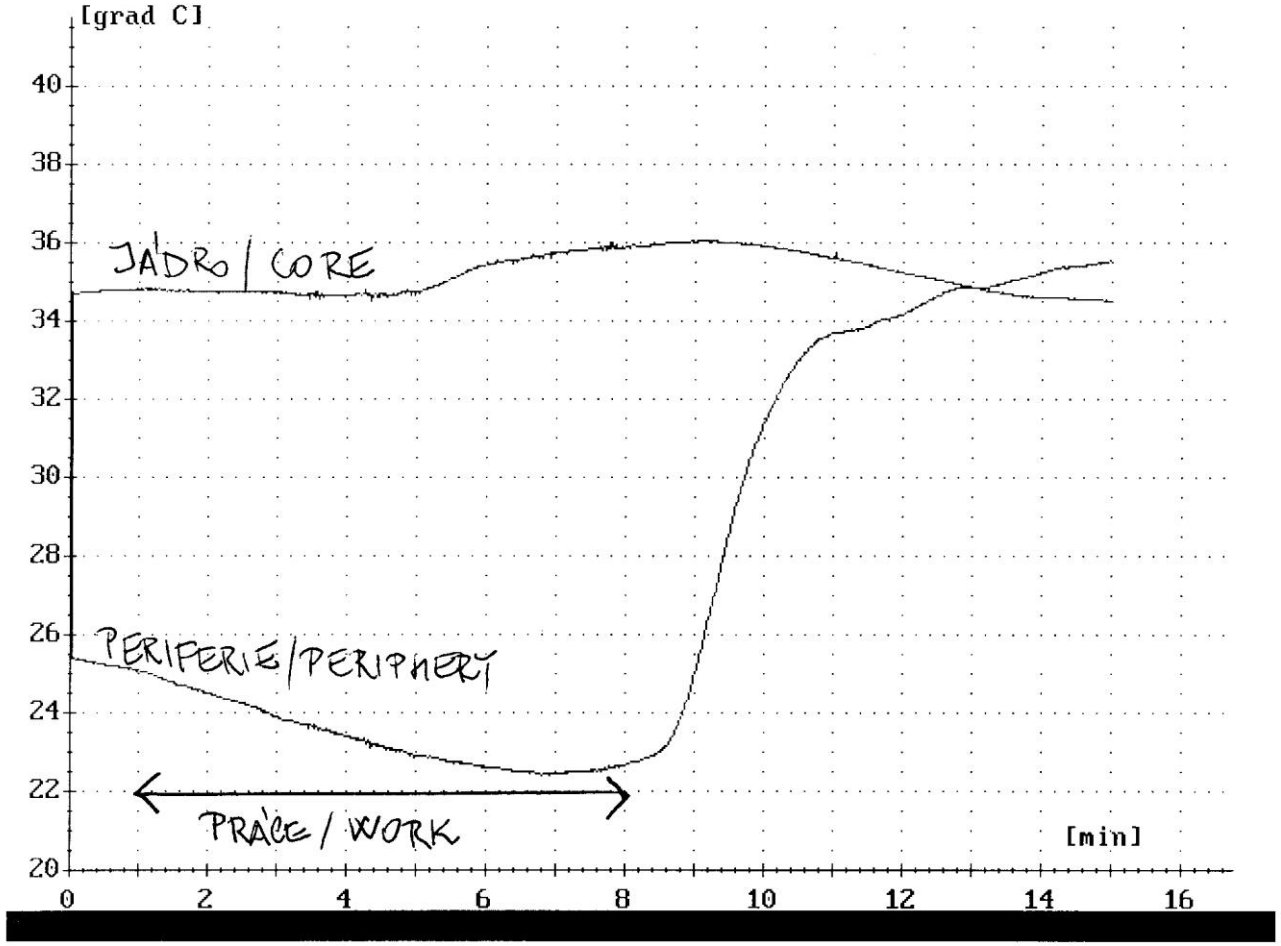
Result 2



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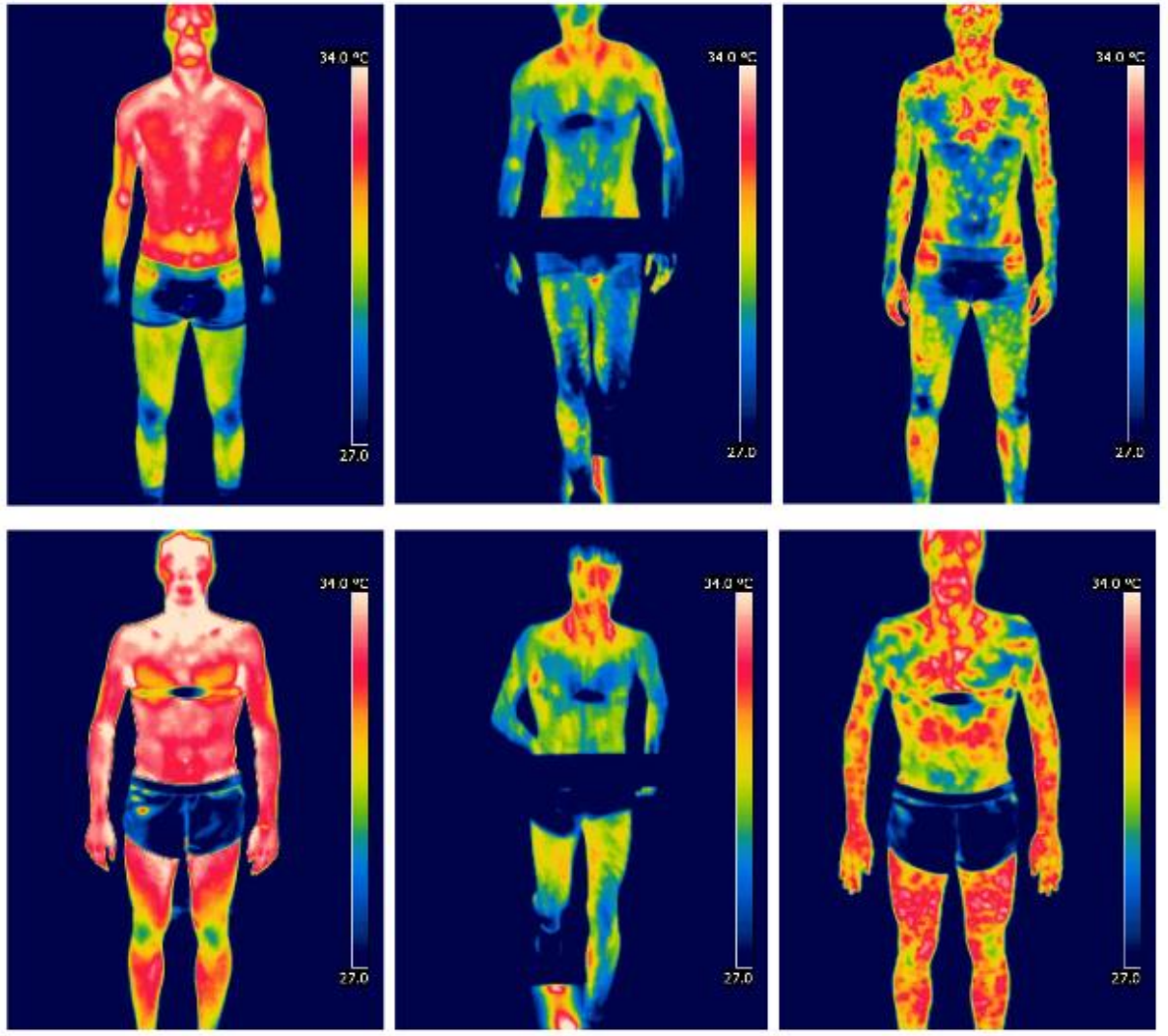
Skin temperature before, during and after exercise

- Infrared thermography



Adopted from:
doi:10.1088/1742-6596/655/1/012062

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