

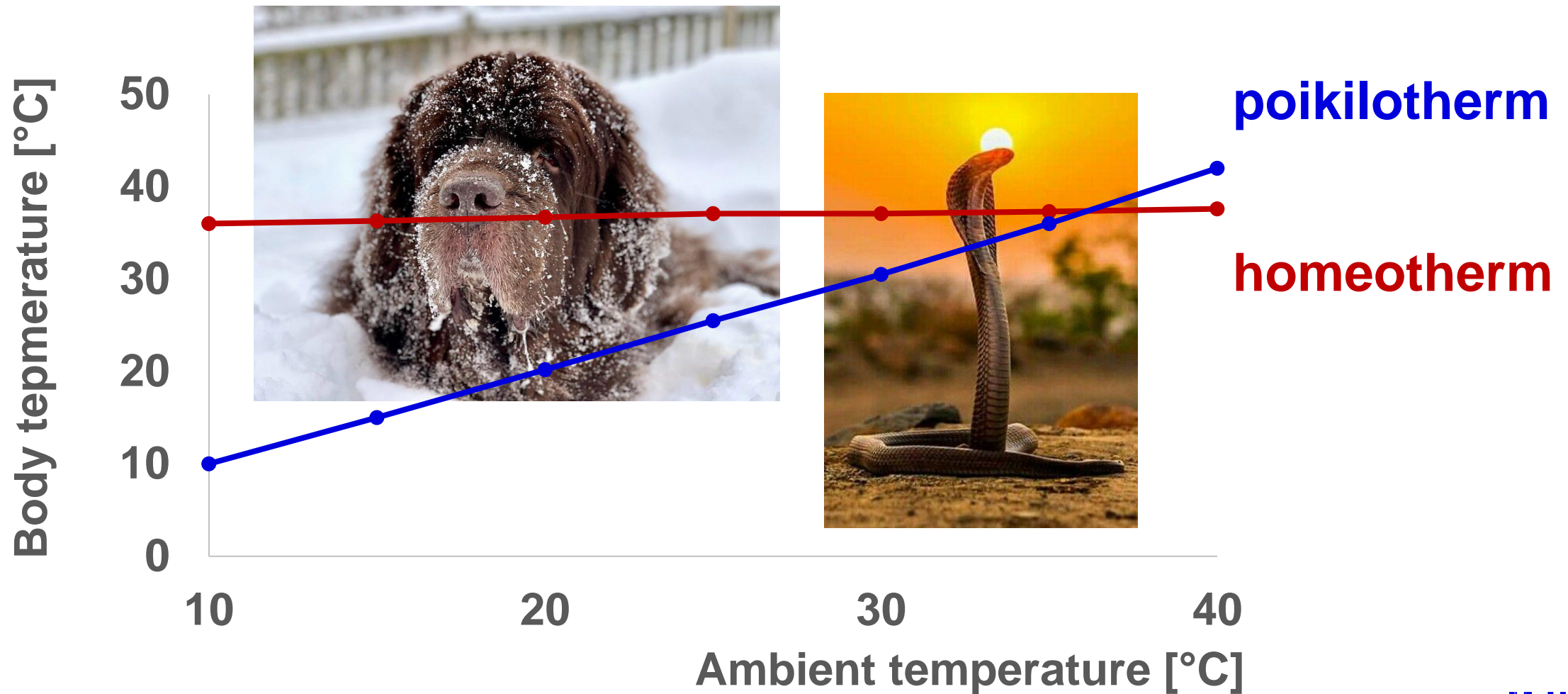
# **A role of the sympathetic nervous system in thermoregulation**

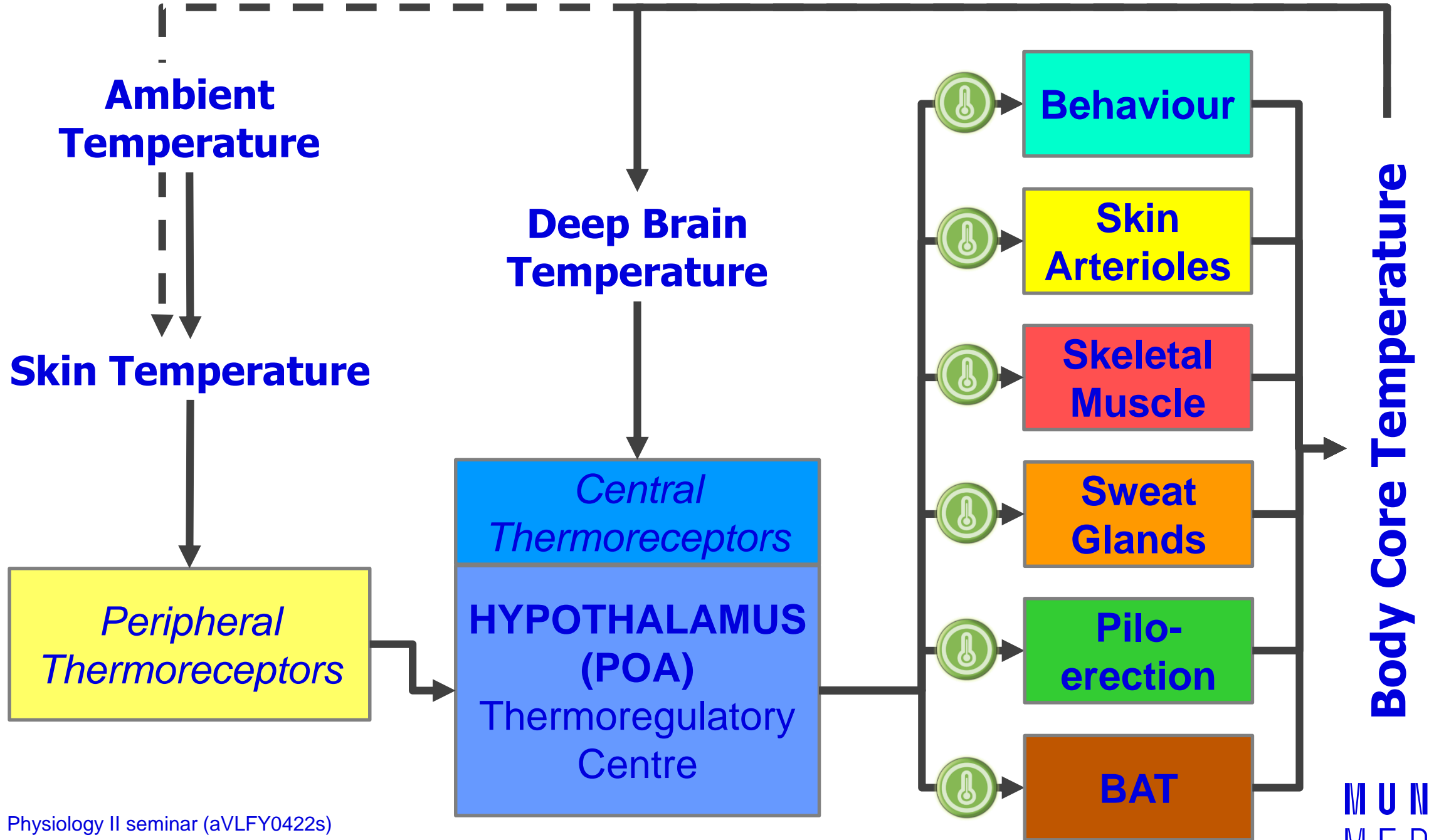
Physiology II seminar (aVLFY0422s)

**Tibor Stračina**

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# Homeotherms vs. poikilotherms





# Sympathetic pathways to thermo effectors

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

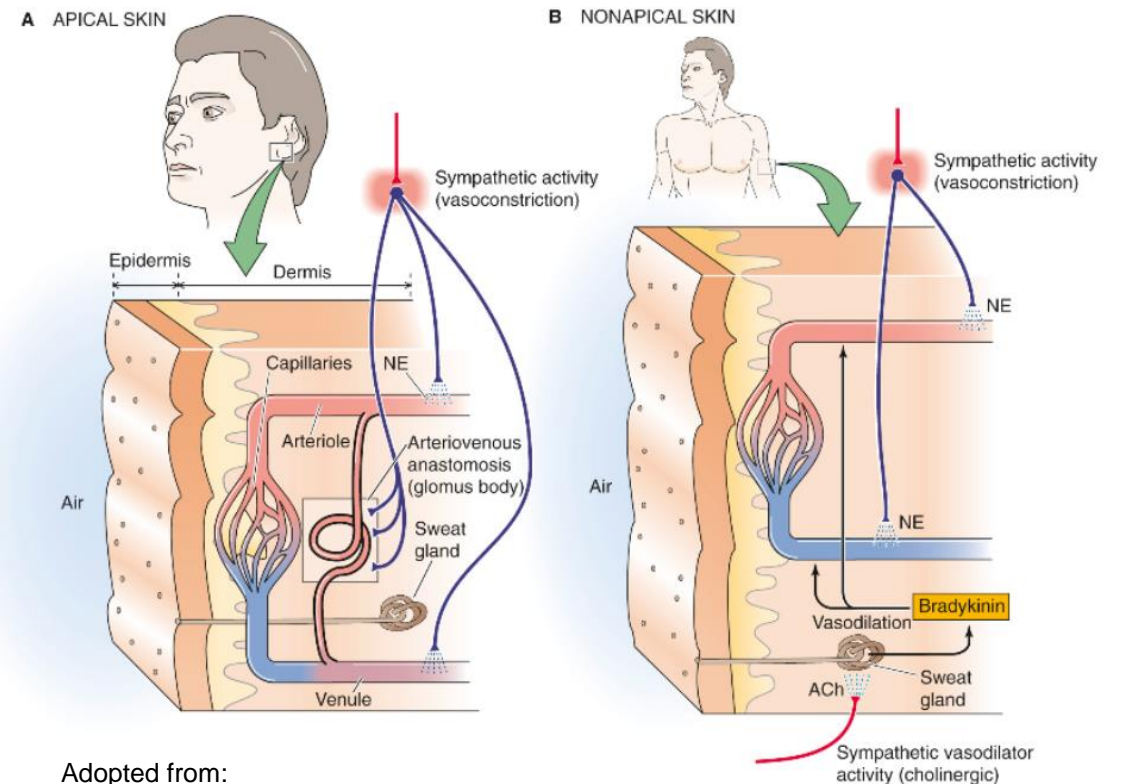
# Skin circulation – apical vs. non-apical skin

## Apical skin

- a-v anastomoses
- Vasoconstriction: SNS (NA:  $\alpha 1R$ )
- Vasodilatation: passive

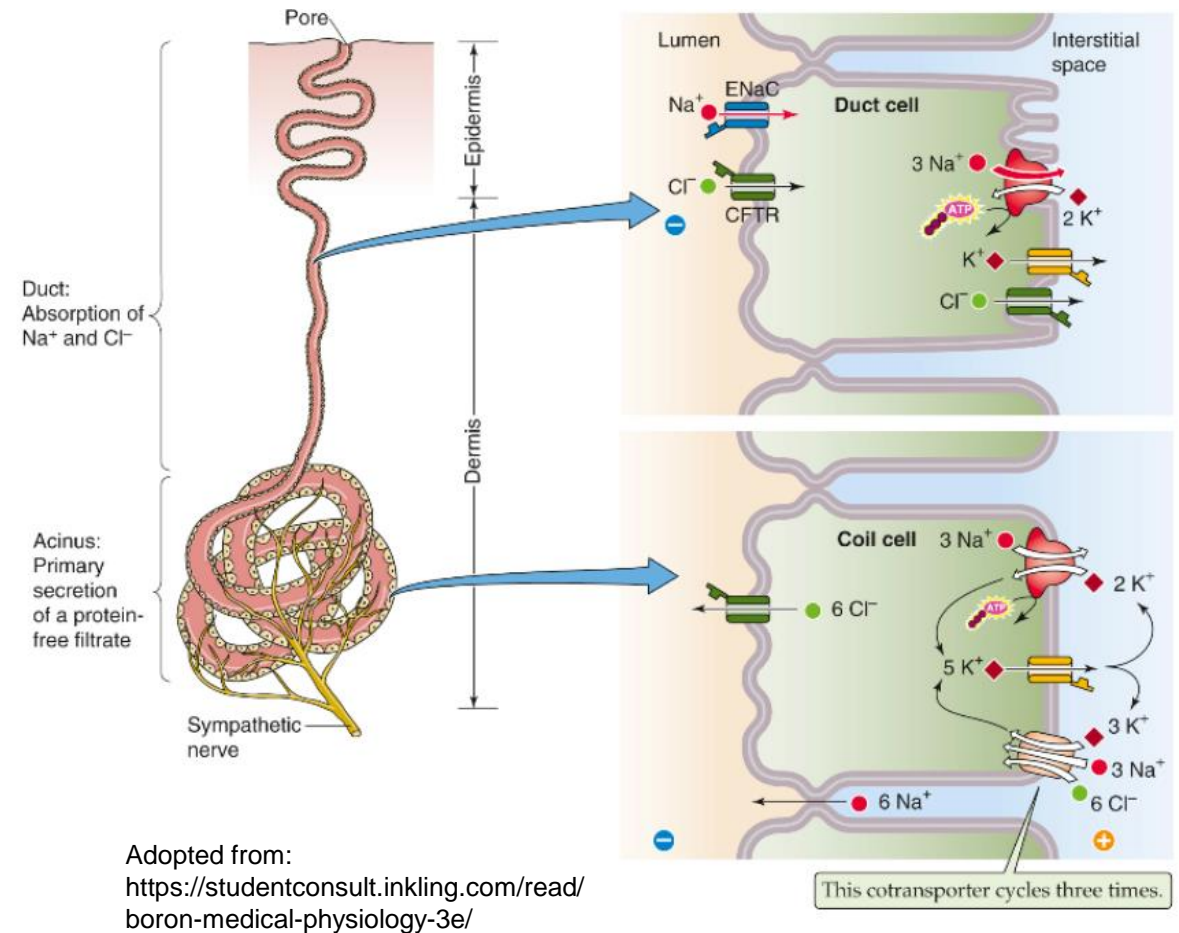
## Non-apical skin

- Vasoconstriction: SNS (NA:  $\alpha 1R$ )
- Vasodilatation: SNS (ACh-?)



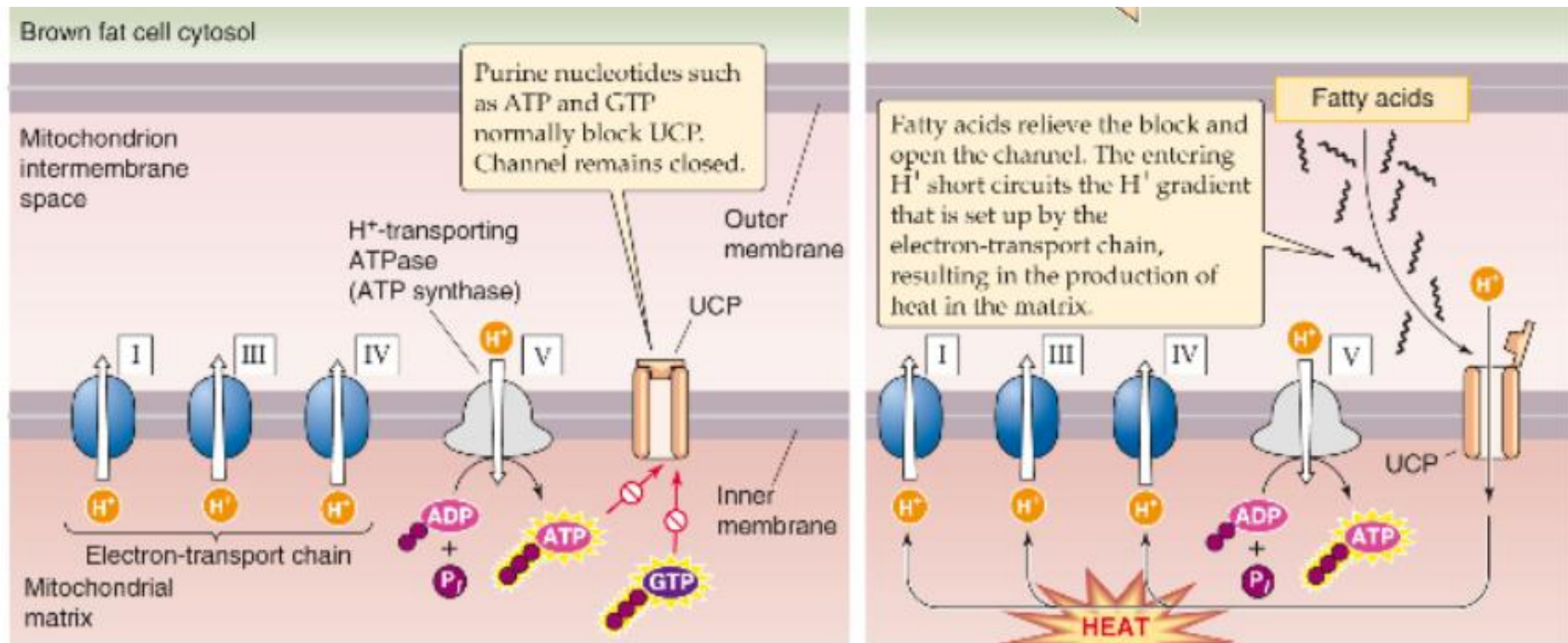
# Regulation of sweat secretion

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



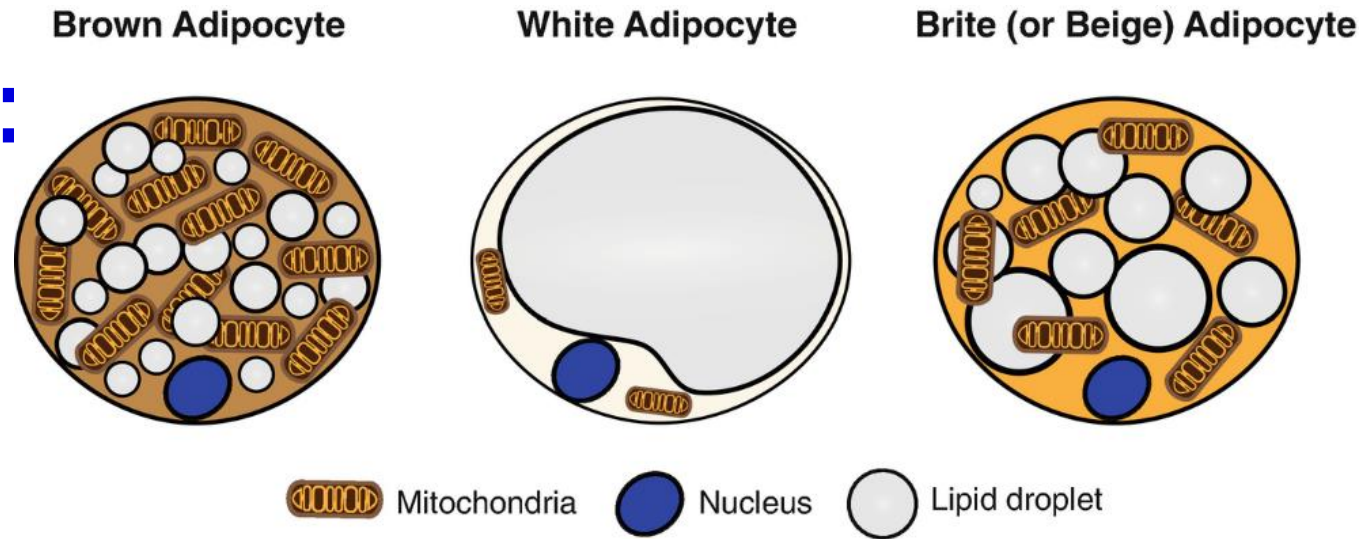
# Activation of brown adipose tissue

- SNS – NA:  $\beta$ 3R
- UCP1



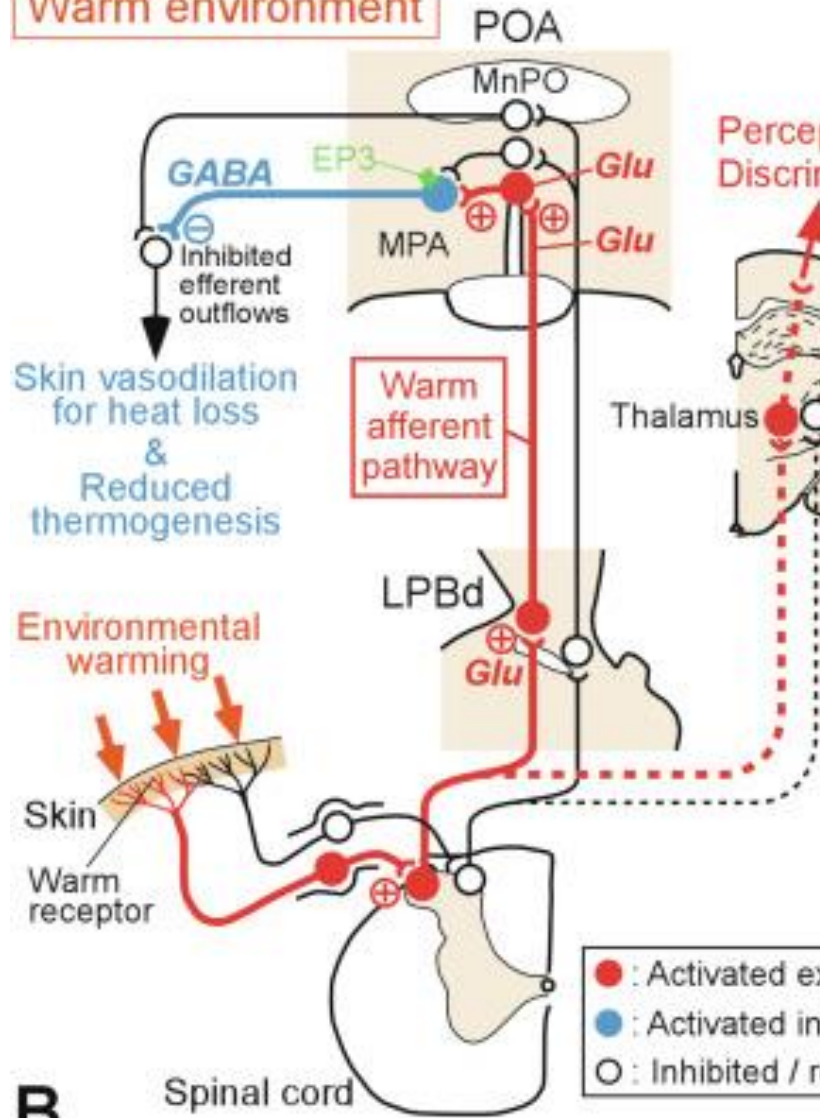


# Adipose tissue: brown, white and beige

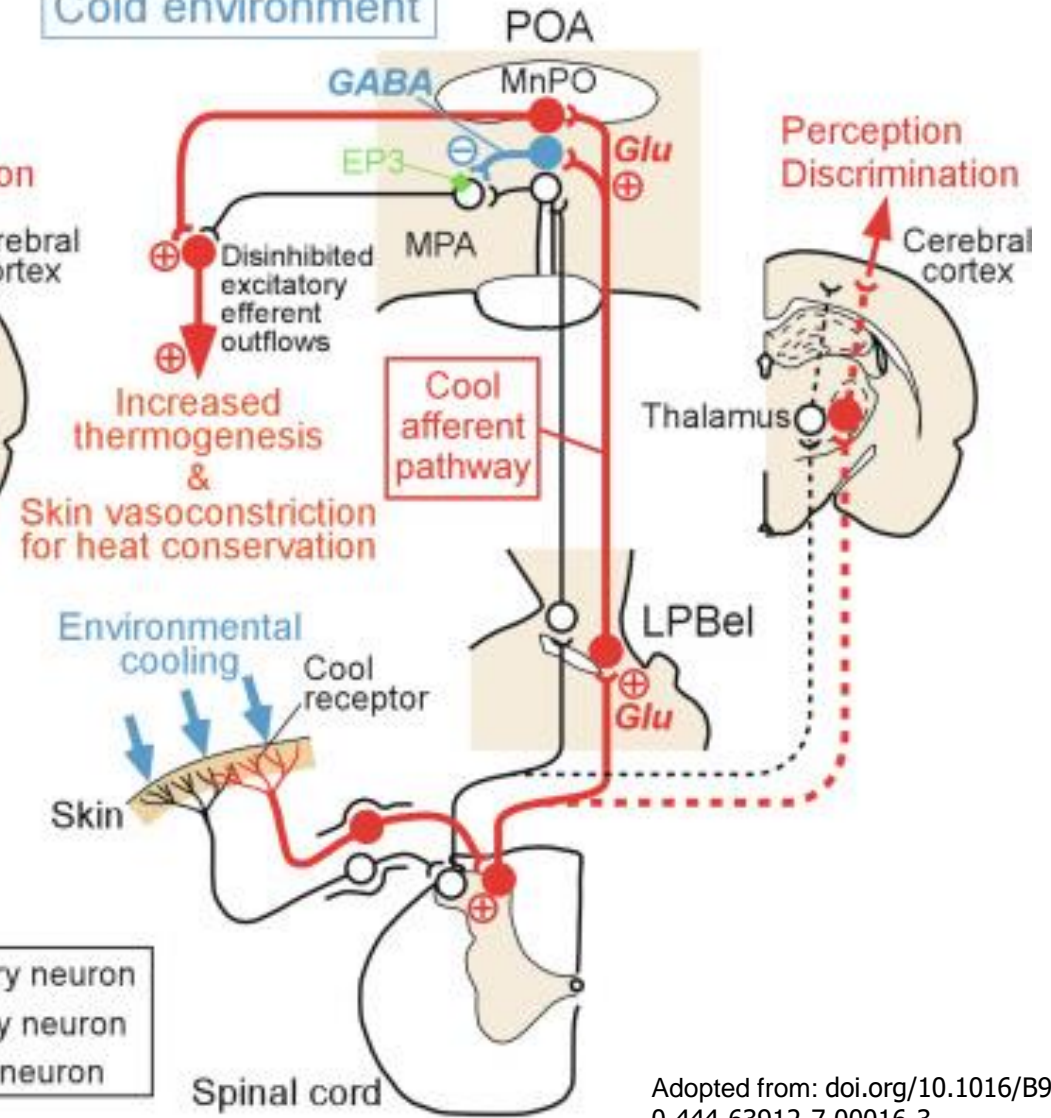


	<i>Brown</i>	<i>White</i>	<i>Brite/beige</i>
<b>UCP1 Expression</b>	Positive	Negative	Positive
<b>Mitochondrial Density</b>	High	Low	Medium
<b>LD Morphology</b>	Multi-locular	Uni-locular	Multi-locular
<b>Primary Function</b>	Thermogenesis Endocrine	Energy storage Endocrine	Thermogenesis? Endocrine?

Warm environment



Cold environment



● : Activated excitatory neuron  
● : Activated inhibitory neuron  
○ : Inhibited / resting neuron

B

Spinal cord

Spinal cord

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

# 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
  - Non-shivering thermogenesis (brown adipose tissue, NA,  $\beta$ 3R, UCP1)
  - Hunger (increase of food intake)

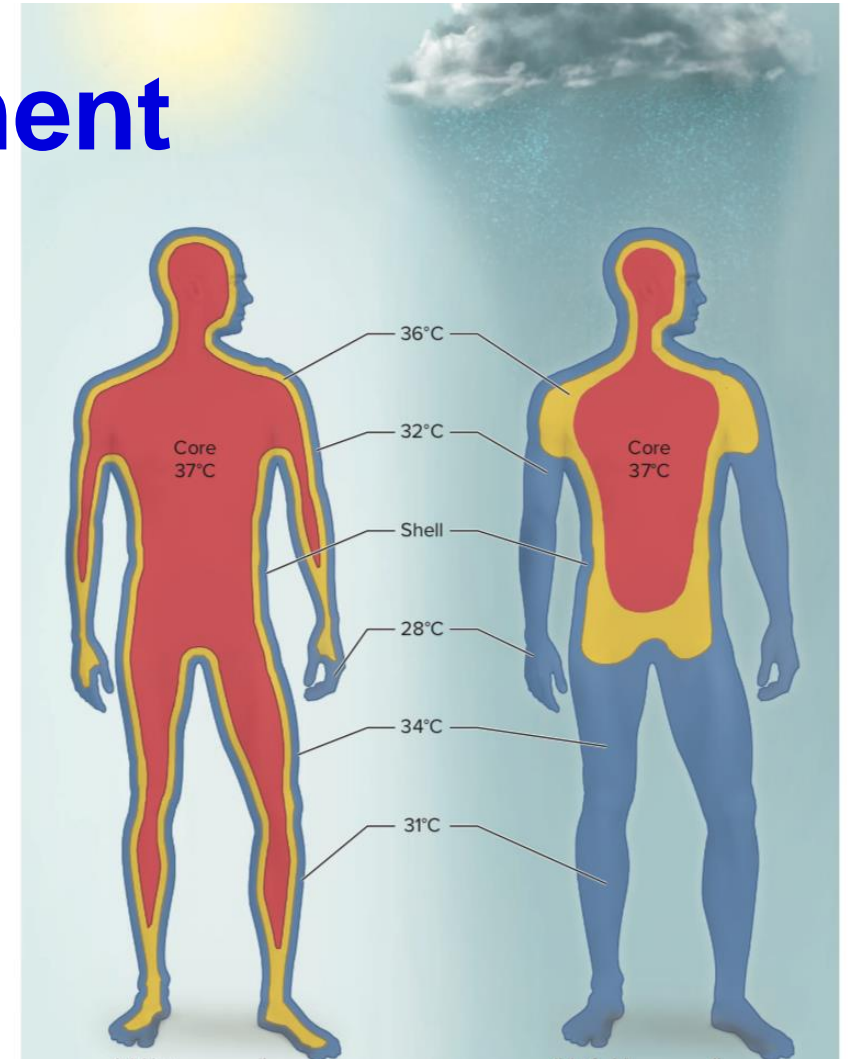
# Warm-induced thermoregulatory mechanisms

- 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

# Body temperature measurement

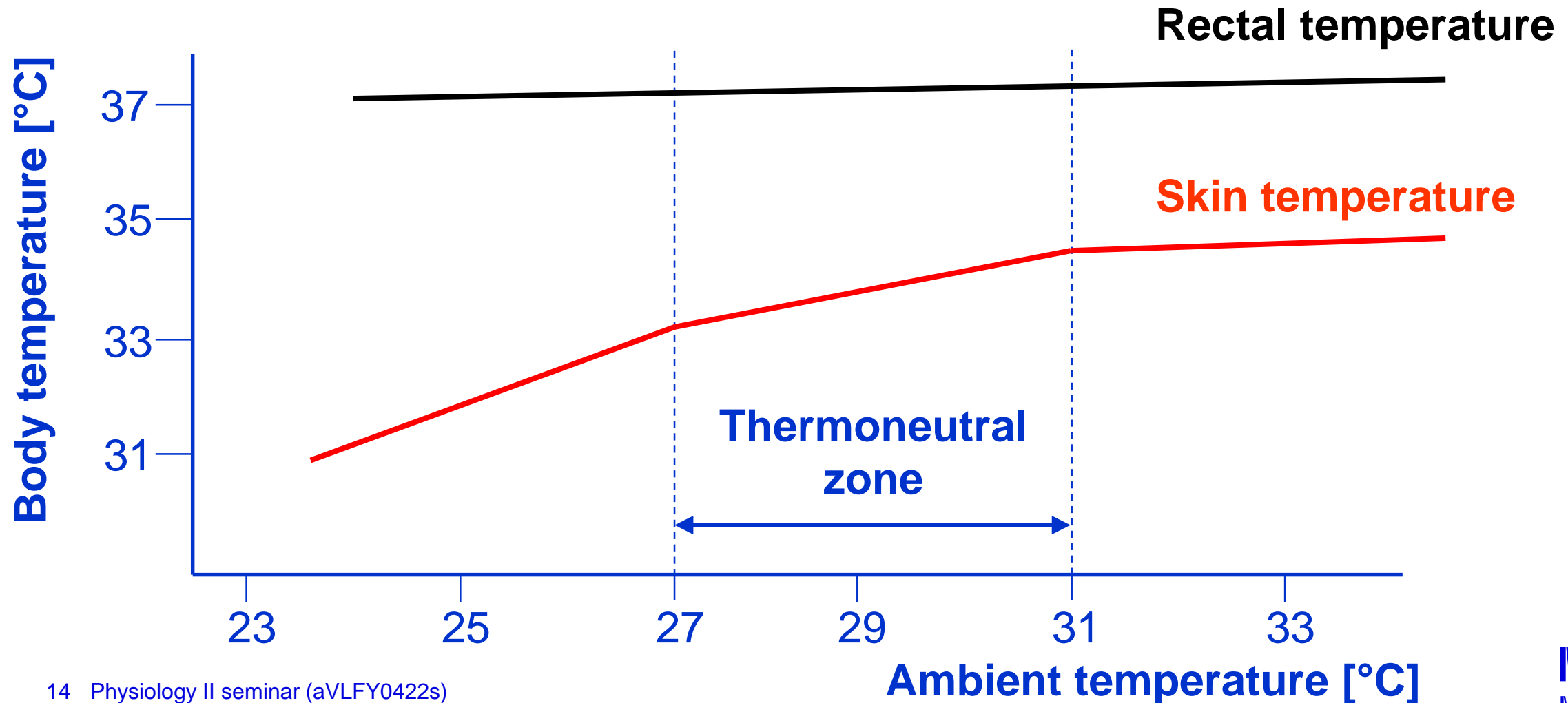
## Where and how?

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

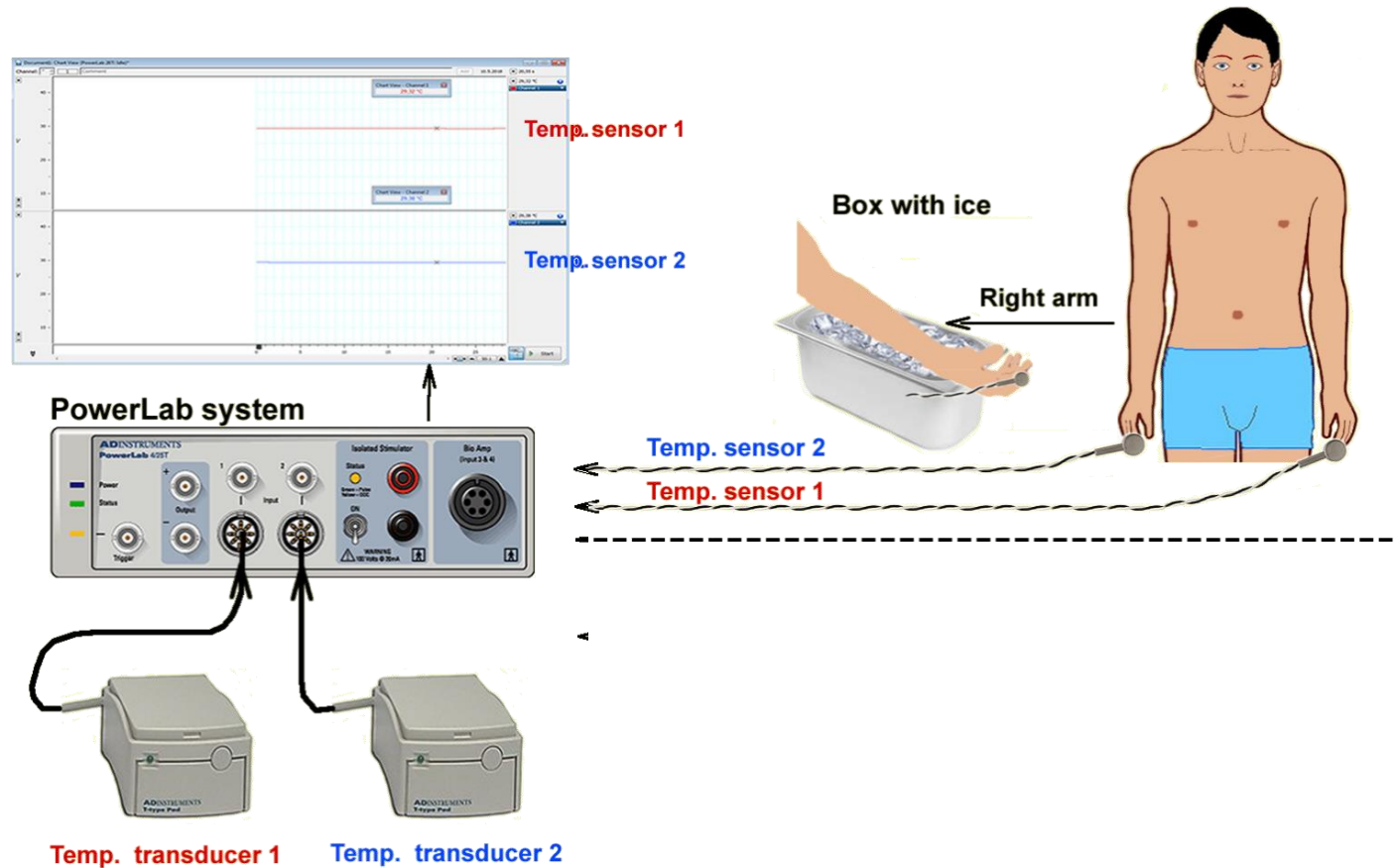


Adopted from: K.S. Saladin, *Anatomy & Physiology—The Unity of Form and Function*, 8th ed. (McGraw-Hill, 2018)

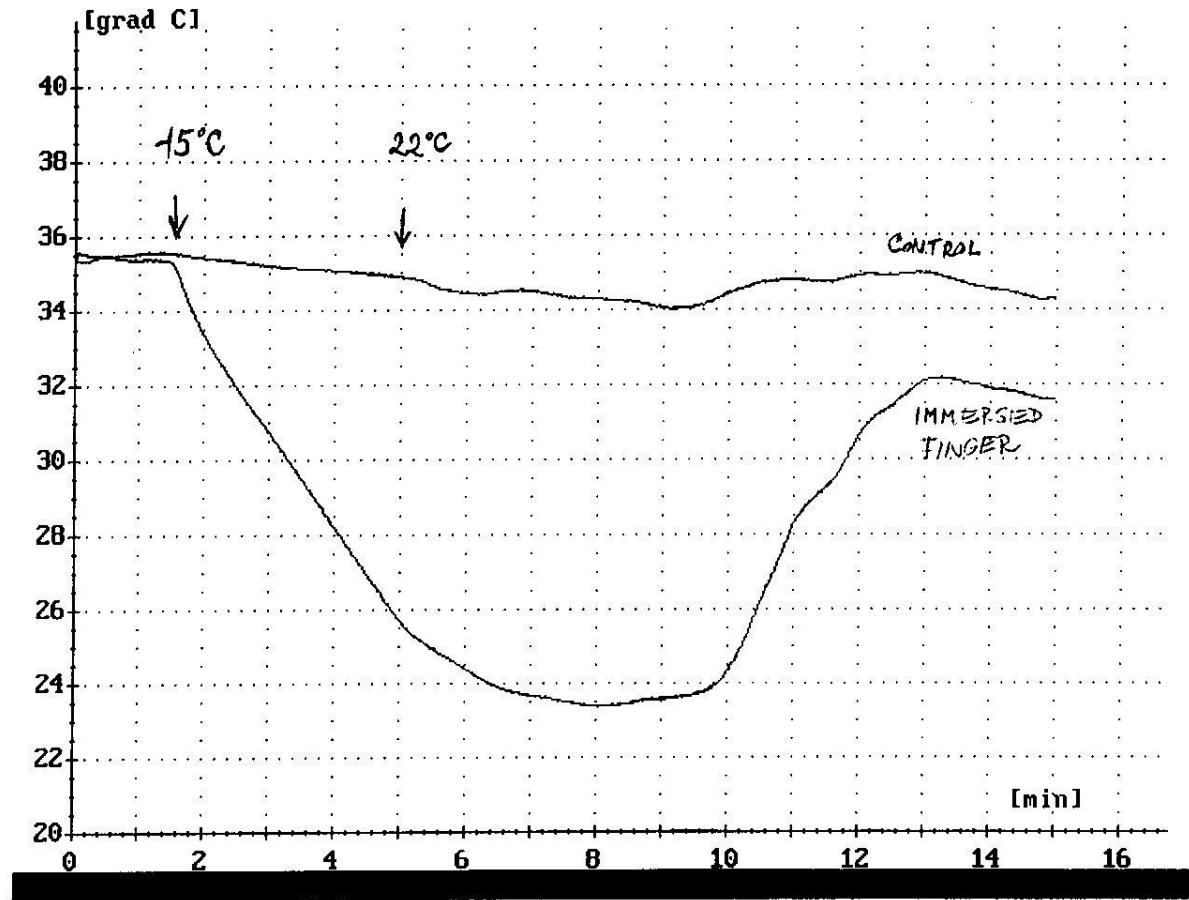
# Rectal vs. skin temperature



# EXPERIMENT 1: Local cold exposure affects skin temperature

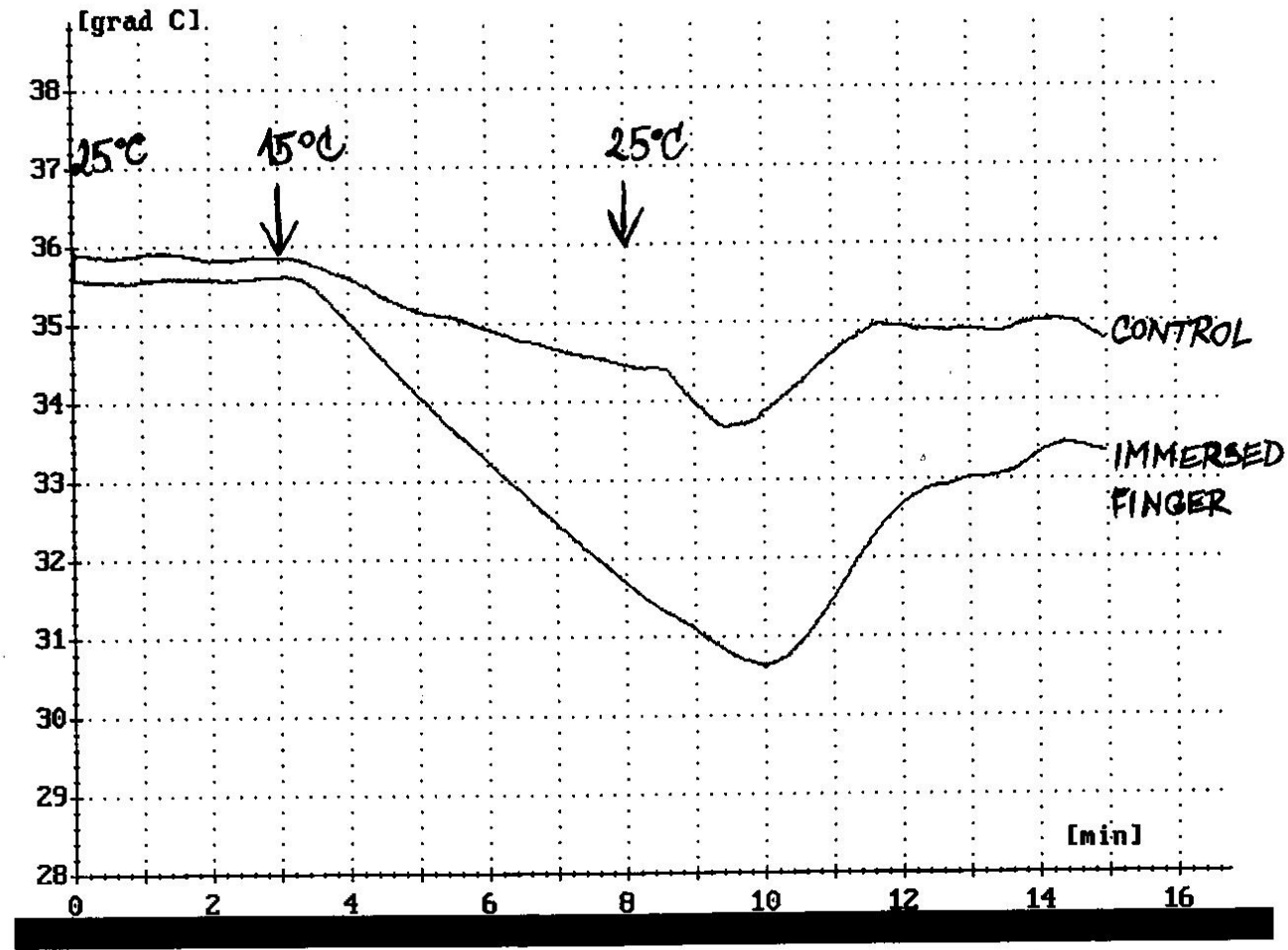


# Result 1

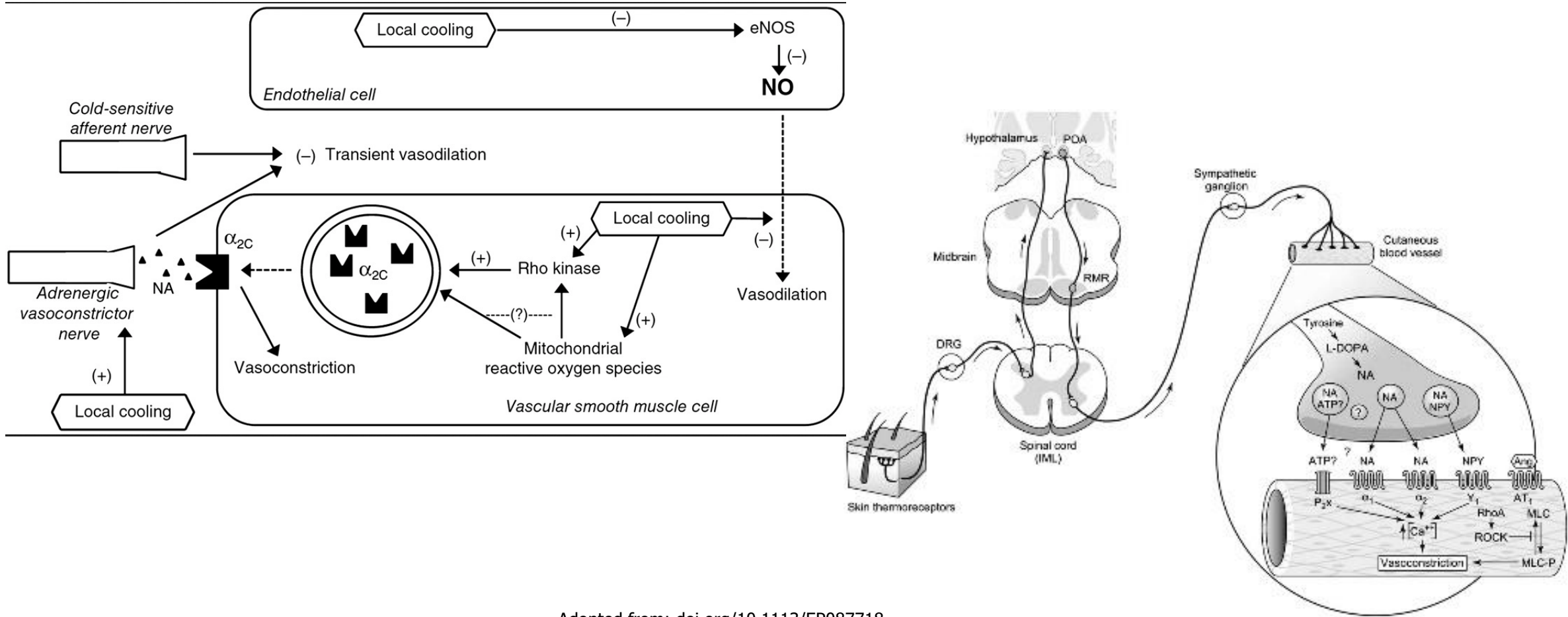




# Result 2

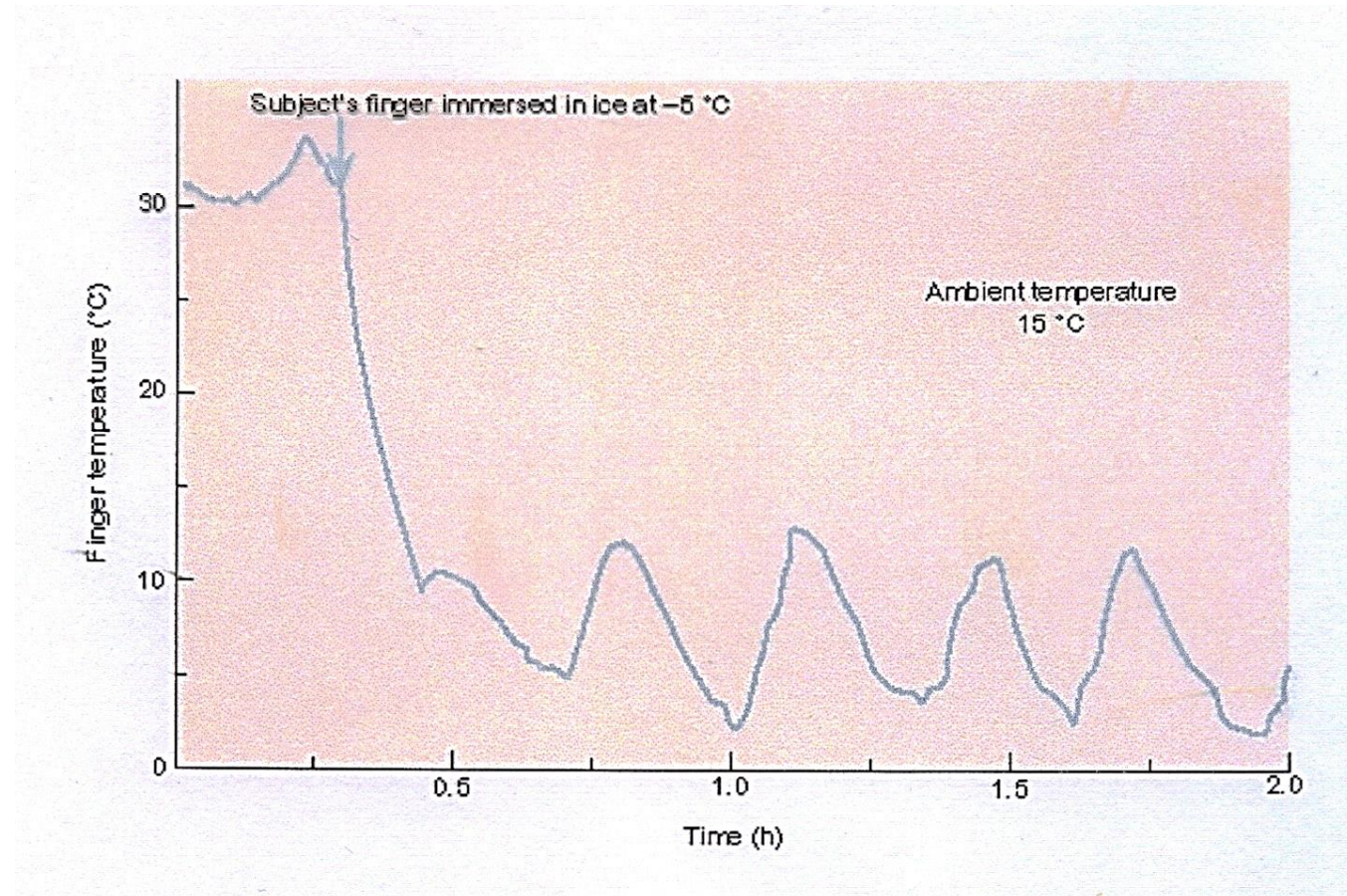


# Cold-induced skin vasoconstriction



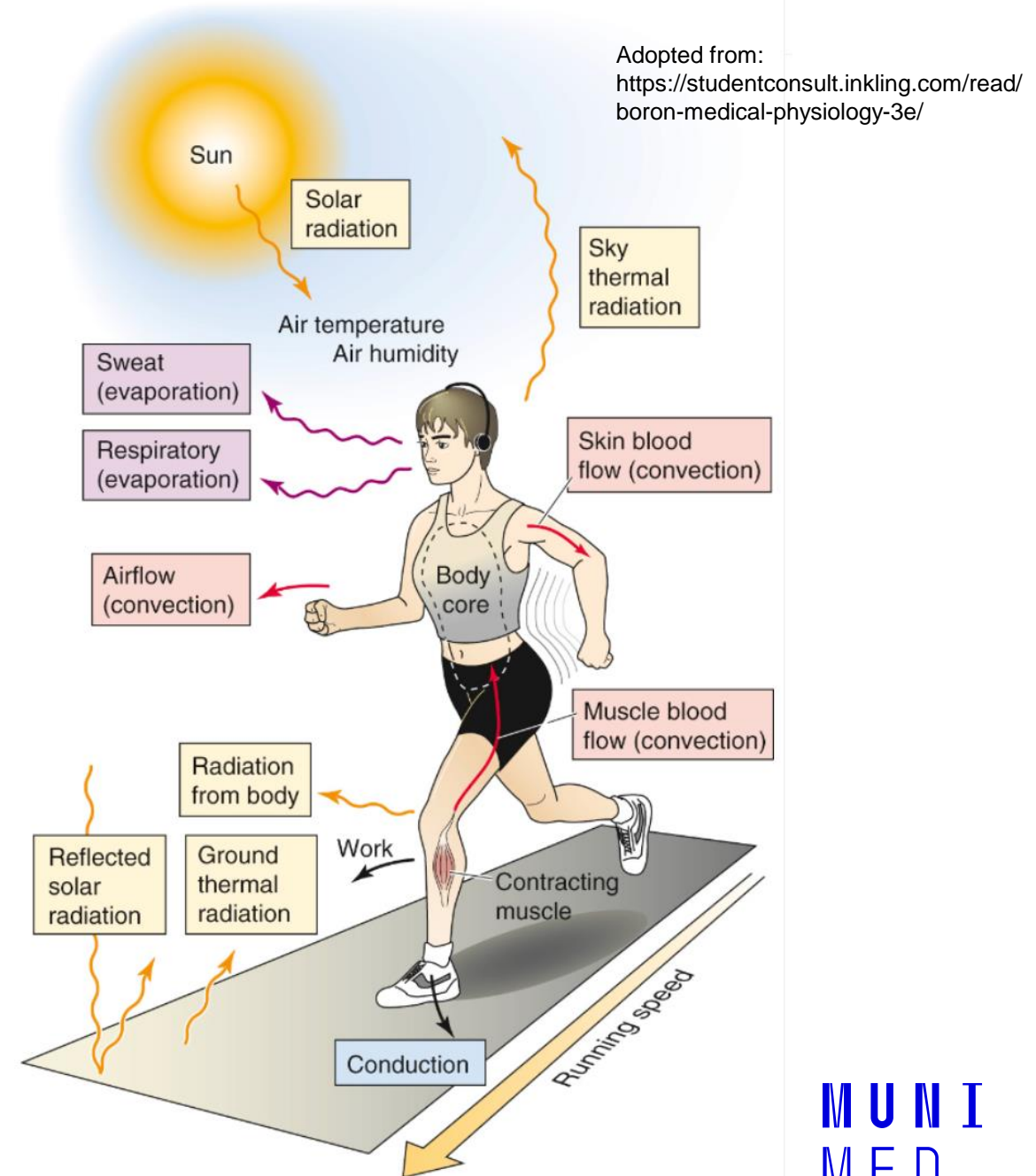
Adopted from: [doi.org/10.1113/EP087718](https://doi.org/10.1113/EP087718)

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

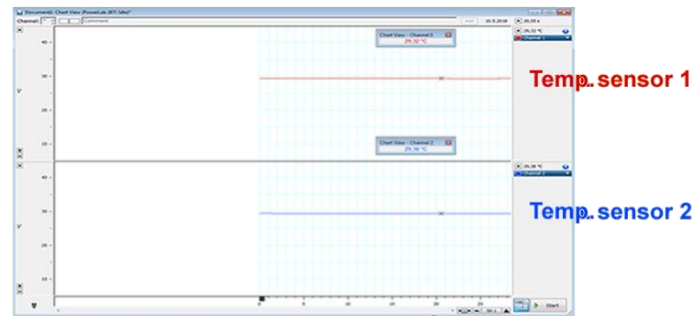


# Heat exchange during exercise

- Conduction
- Convection
- Radiation
  
- Evaporation



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



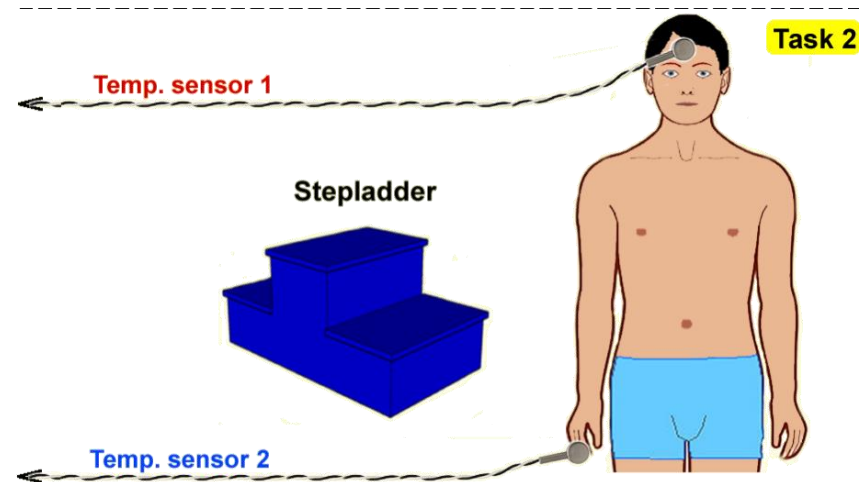
PowerLab system



Temp. transducer 1



Temp. transducer 2



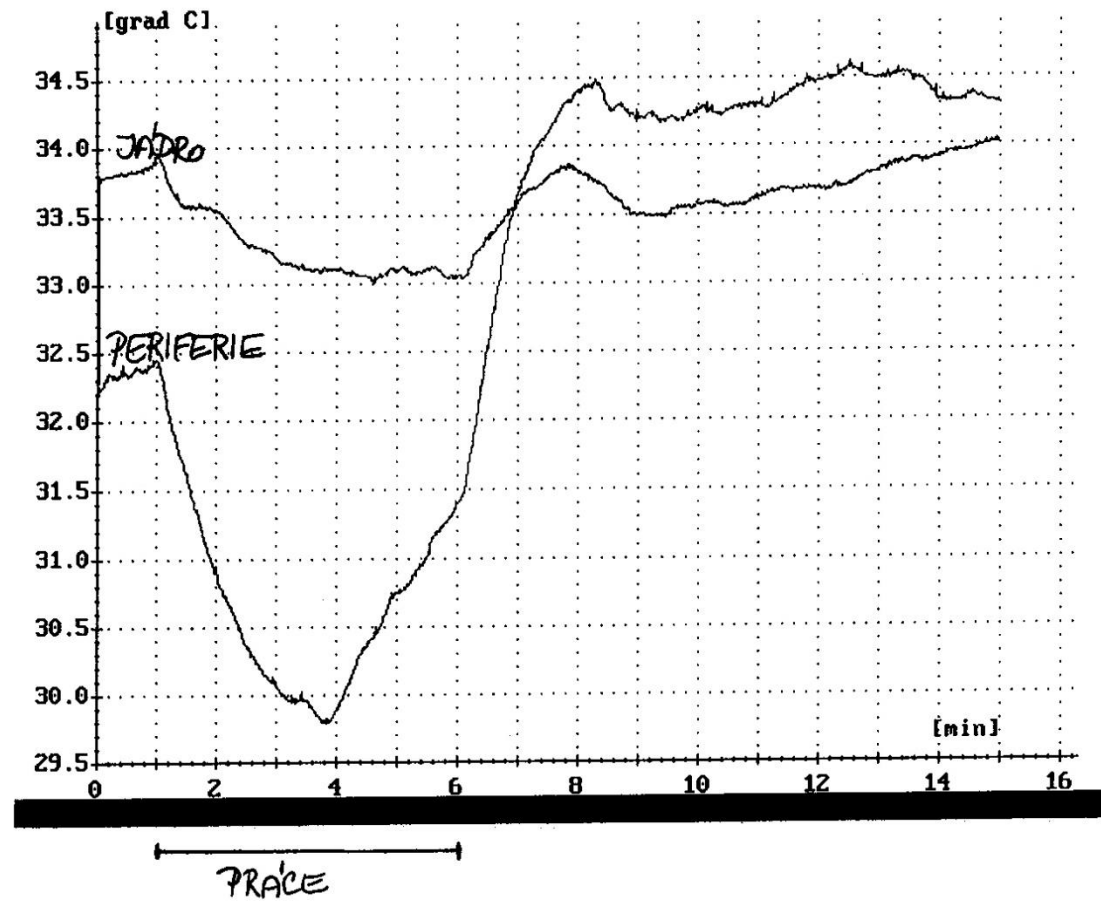
# Standardised workload

- Ergometry
- Exactly: W/kg
- Comparatively: MET – metabolic equivalent
  - Actual metabolic rate / resting metabolic rate in sitting position
  - 1 MET = consumption of 3.5 ml O<sub>2</sub>/kg.min
  - sleeping ≈ 0,9 MET; slow walking ≈ 3-4 MET; fast running, sprint ≈ 16 MET
  - (+) simplicity; (-) inaccuracy

# Indexes of fitness

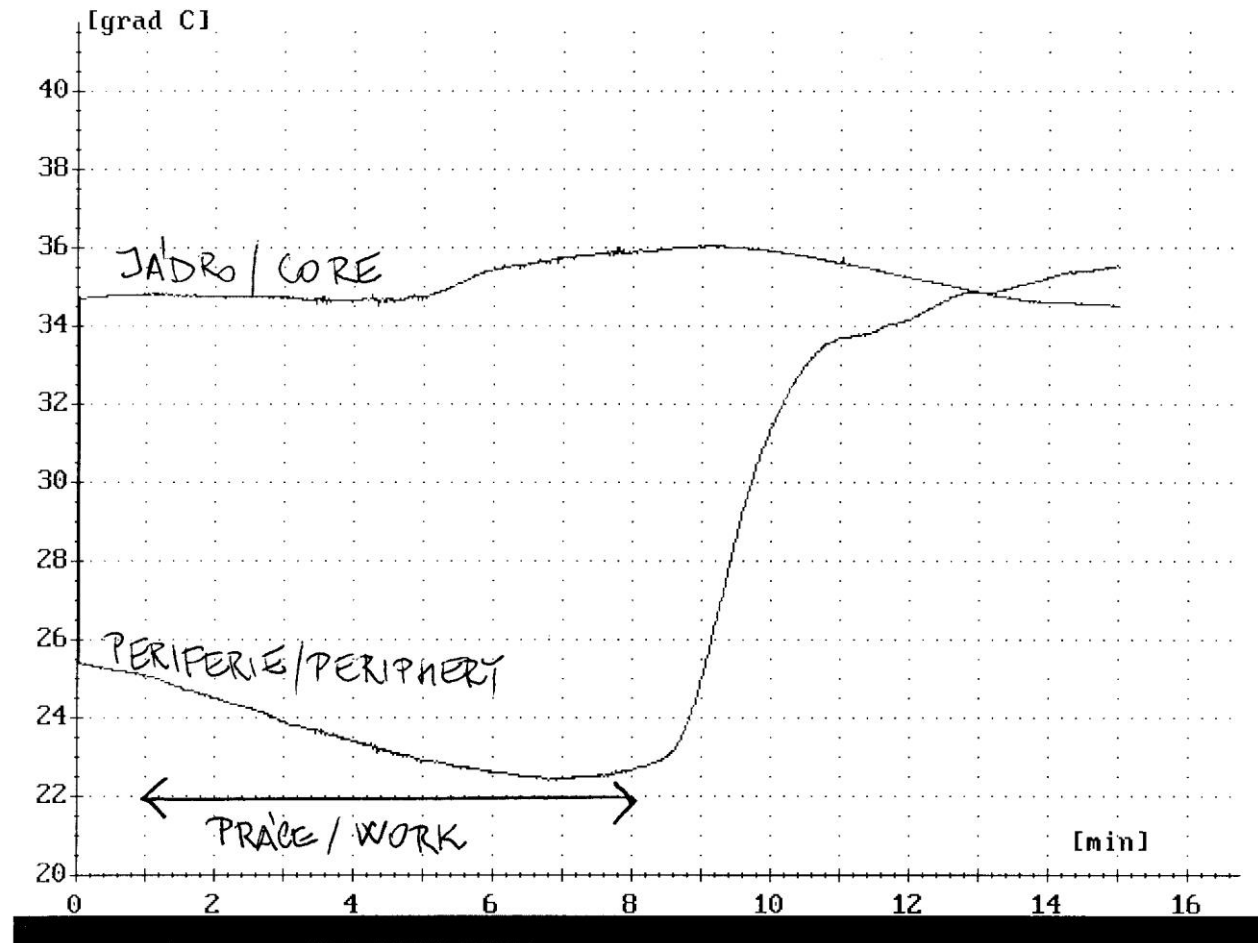
- $W_{170}$  [W/kg]
- $V_{O_2 \max}$  [mL  $O_2$  / (min x kg)]
- Aerobic / anaerobic threshold
  
- Fatigue
- Failure

# Result 1



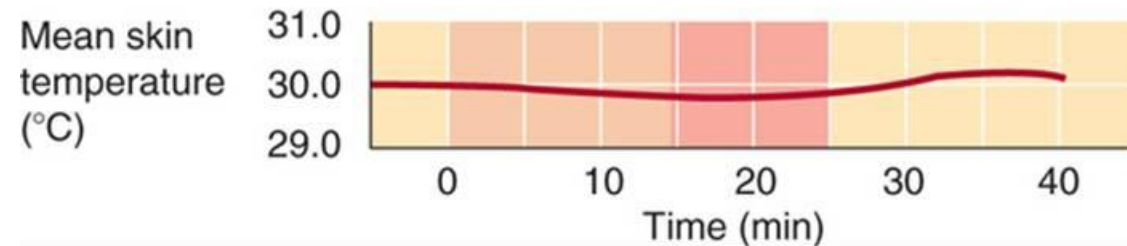
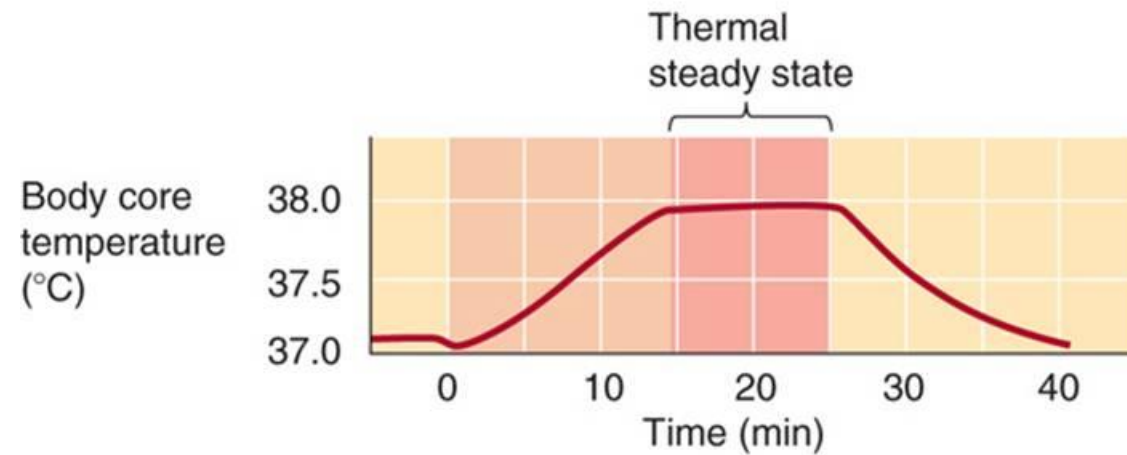
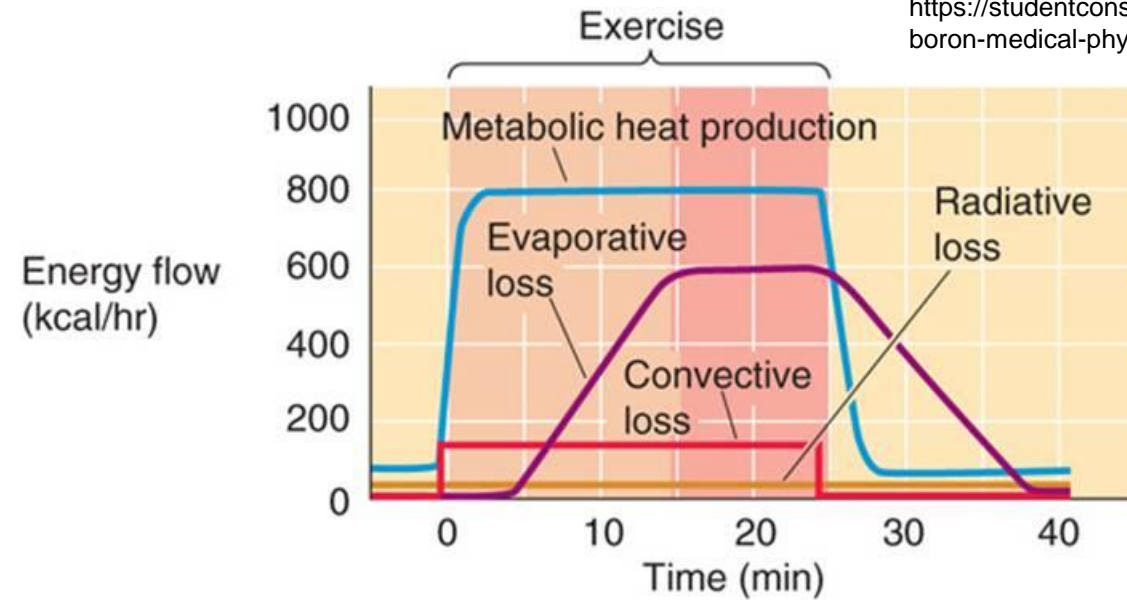


# Result 2



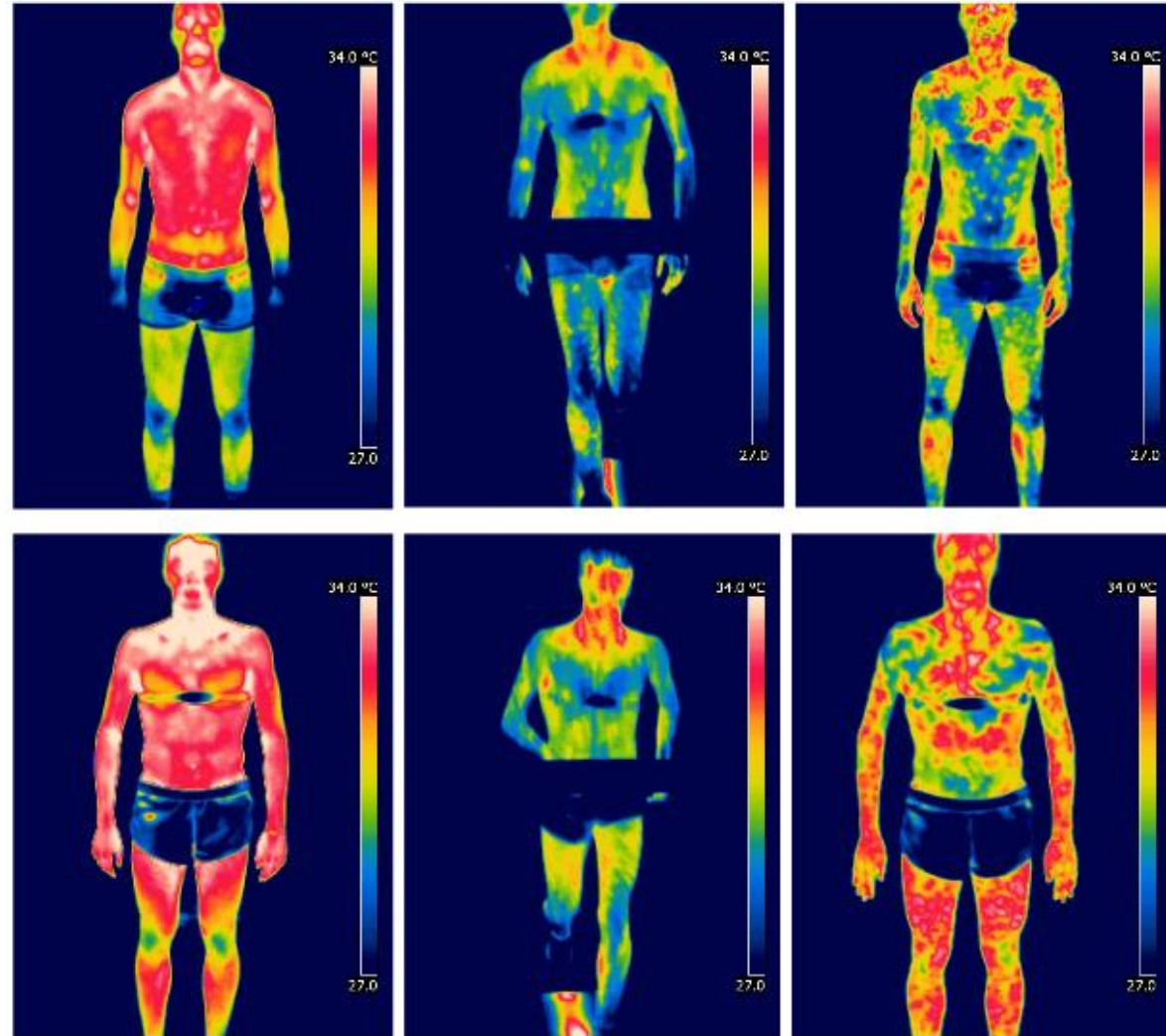
# Heat exchange during exercise

Adopted from:  
<https://studentconsult.inkling.com/read/boron-medical-physiology-3e/>



# Skin temperature before, during and after exercise

– Infrared thermography



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

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