Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

TR060 – Biological and Biomedical Sciences
Foundation Scholarship 2025/26

Prof Áine Kelly: aikelly@tcd.ie

XSCH3388 Paper 1General Paper: Special Topic

Selected Theme: Hot Humans: The Physiology of Thermoregulation

Thermoregulation in humans is the process by which the body maintains a relatively stable core temperature, even in the face of changes in ambient temperature. In humans and other homeotherms, thermoregulation is a crucial aspect of homeostasis and thus maintenance of healthy function of all body organs. Heat stress places specific pressures on the body's homeostatic mechanisms, whether as a result of exercise-induced thermogenesis or rising ambient temperature. The body's physiological responses to heat stress are of specific relevance to the challenge of climate change and its negative consequences to human health globally. Those who are particularly vulnerable to heat stress include the very young, the very old, pregnant women and outdoor workers, among others.

For this special topic, we would like you to investigate and consider the physiology underpinning the sensation, perception and homeostatic and behavioural responses to increases in temperature in humans. In the examination, you will be required to answer two essay questions from a choice of three. In your answers, you should demonstrate a fundamental understanding of the mechanisms of thermoregulation and responses to various types of heat stress in humans of differing ages and both sexes. You should include relevant examples in your answers, supported by detailed information provided by recent research and citation of relevant articles. The topic is by nature quite broad and you cannot cover the entirety of the literature, but you should begin by reviewing the material on the reading list below and use it as a foundation and starting point for further reading and research. Some of your research into thermoregulation will cover adaptation or responses to cold, but your focus should be on responses to heat. Some reading will also cover discoveries made in non-human mammals or other animal species– while this information can be used to support your answers where appropriate, your primary focus should be on humans.

Relevant weblinks

https://www.physoc.org/policy/climate-change-and-health/heat-resilience-strategy/
https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health

Suggested Reading:

1. Absmeier E, Heyd F. Temperature-controlled molecular switches in mammalian cells. J Biol Chem. 2024 Nov;300(11):107865. doi: 10.1016/j.jbc.2024.107865. Epub 2024 Oct 5. PMID: 39374780; PMCID: PMC11570493.

   This article reviews cellular and molecular mechanisms of thermosensation. While it covers cold sensation and information derived from non-mammalian species, you should focus your attention on the aspects dealing with heat sensation in mammalian cells.

2. Debray A, Sardar S, Deshayes TA, Mornas A, Oubouchou K, Ouazaa Y, Gagnon D. Sex-related differences in temperature regulation during heat stress from childhood to older age. Auton Neurosci. 2025 Aug;260:103294. doi: 10.1016/j.autneu.2025.103294. Epub 2025 May 27. PMID: 40460598.

   This article is an excellent starting point to understand sex-related and age-related differences in thermoregulatory responses to heat, and especially the role of the autonomic nervous system in these processes.

3. Ebi KL, Capon A, Berry P, Broderick C, de Dear R, Havenith G, Honda Y, Kovats RS, Ma W, Malik A, Morris NB, Nybo L, Seneviratne SI, Vanos J, Jay O. Hot weather and heat extremes: health risks. Lancet. 2021 Aug 21;398(10301):698-708. doi: 10.1016/S0140-6736(21)01208-3. PMID: 34419205.

   This article from *The Lancet* highlights the dangers to health, up to and including death, resulting from increases in ambient temperature. It discusses the underpinning physiology and the risks to vulnerable populations. .

4. Périard JD, Eijsvogels TMH, Daanen HAM. Exercise under heat stress: thermoregulation, hydration, performance implications, and mitigation strategies. Physiol Rev. 2021 Oct 1;101(4):1873-1979. doi: 10.1152/physrev.00038.2020. Epub 2021 Apr 8. PMID: 33829868.

   This is quite a long and detailed article that provides an excellent and comprehensive review of our current understanding of the human responses to exercise under conditions of heat stress, the impact on exercise performance, and the strategies that can be used to counteract negative physiological outcomes and improve performance. Independent of the material that covers exercise, it provides an excellent primer on thermoregulation in humans in the resting state.

5. Ravanelli N, Gendron P, Gagnon D. Revisiting the evaluation of central versus peripheral thermoregulatory control in humans. Am J Physiol Regul Integr Comp Physiol. 2021 Aug 1;321(2):R91-R99. doi: 10.1152/ajpregu.00321.2020. Epub 2021 Jun 2. PMID: 34075801.

   This article summarises current knowledge and theories on the regulation of temperature in humans by central (ie nervous system) and peripheral (ie temperature sensors in and effector outputs from peripheral organs) mechanisms.