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I'm here to talk about extreme physiology and how to get your paper published. I'm Mike Tipton, Professor of Human & Applied Physiology at the University of Portsmouth and Editor-in-Chief of Experimental Physiology. AMA!

MIKE_TIPTON R/SCIENCE

Only 15% of the surface of the Earth is not water, desert, ice or mountain. For humans, a tropical, low altitude, air-breathing animal, this means most of the planet represents a hostile or extreme environment. Extreme environmental physiology covers a wide range of topics including: physiologically preparing groups such as elite athletes to try and maintain high level performance in hot and cold environments, using strategies such as acclimatisation; considering using altitude training and heat acclimation as ergogenic aids to enhance performance in temperate sea level conditions; determining the benefit of cross-adaptation between one extreme environment and another; protecting, via technological solutions (e.g. personal protective equipment), those who, as part of their work or play, enter extreme environments (e.g. astronauts, divers, firefighters, sailors, the military).
Our habitation of the planet has been largely enabled by technological advances (clothing, shelter, heating) founded on intellect. But sometimes this technology goes wrong requiring extreme environmental research related to accidental exposures and the consequent pathophysiology of heat illness, cold injury, hypothermia; hypoxia, barotrauma and drowning. These are not just “niche issues”; forty-three people around the globe drown each hour. These are mostly young people and this figure is an under-estimation. Finally, research in extreme environments such as microgravity and hypoxia is also shedding new light on areas such as ageing, body tissue wasting and outcome in critical illness. If any of the above interests you, let’s chat on the 19th December 4-6pm (GMT).

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Welcome professor Tipton and thanks for coming by to chat.

Is Global Climate Change changing how we think of extreme environments? In particular, how does increased **variability** in environments affect humans **vs.** increases in just the **average** values?

Jobediah

Yes, global warming will lead to bigger extremes of climate. Average increases less important for humans, more important for plants and sea levels. Flooding and drought increasing. In the UK flood rescue becoming common place. Intentionally may result in climatic ethnic cleansing as large number of people have to move away from their homeland. 19,000 drownings in Bangladesh last year, 16,000 of them children.

Hey thanks for doing this AMA.

I was wondering what literature or resources you would recommend for a human with an average

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education in the public to best prepare themselves or others (ie family) to handle an unplanned extreme situation such as drowning, heat illness, hypothermia etc.

SethPsych

There are lots of nice lay texts on Extreme/Wilderness Environments. For immersion I, unsurprisingly, recommend our book "The Essentials of Sea Survival" - still available as an ebook I think. Life at Extremes is another by Frances Ashcroft. Happy reading!

Do you know of any really good resources on for how lung function works in extreme conditions e.g. microgravity, diving, high altitude? I actually do a whole module on this topic as part of my physiology degree. Also - what do you think the real frontiers of extreme physiology are? What do we not know a whole lot about?

haiseadha

We just published two papers that might help you on your way: Tipton, M. J., Harper, A., Paton, J. F. R. & Costello, J. T. (2017) The human ventilatory response to stress: rate or depth? Journal of Physiology. DOI: 10.1113/JP274596. The extreme frontiers for physiology differ in different environments. Hypoxia often the end pathway. Our ability to tolerate extremes more to do with our intellect and technology than physiological adaptation. Lots of work remains to be done in all extreme environments especially cross adaptation between different environments and lessons from extreme environments for conditions like ageing, outcome on intensive care, +++

Thank you very much for doing this! I do a PhD in physiology, concentrating on cold water exposure on triathletes. Recent years we have had more and more cases with SIPE (Swim Induced Pulmonary Edema) in Open water swimming and triathlon. In your experience, what do we need to do to learn more about this? As for now, we know of a few case reports. (We are producing one ourself)

melis222

80% of those that die in triathlon do so in the swim. SIPE has certainly been suggested as a mechanism. We suggest the alternative of Autonomic Conflict, particularity for sudden events. The other question to ask, is why do these occurring in competition, but much more infrequently in training? Have a look at: Tipton, M. J. (2013) Sudden cardiac death during open water swimming. British Journal of Sports Medicine. 48(15):1134-5. Good luck with your studies!!

Thanks for stopping by, Dr. Tipton,

How long until we can live forever?! Slightly kidding. The description of your work makes me thing of those somewhat crazy people that run ultra marathons in desertlike areas for days on end. Surely that has a significant detriment to the body, no?

scienceaccount103040

There are 15,000 people in the UK over the age of 100 years. You now have a choice in most card shops of "Happy 100th Birthday Cards". It is estimated that the person who will live to 150 years has been born. The well-being paradox is that these longer lives will accelerate the destruction of the planet. In terms of exercise, the "holy grail" is the balance between training and over-training (range of problems associated with this). Most people don't need to worry - they do not do enough! There are now good correlations being produced between the number of steps (too few) being taken each day by people and a range of illnesses.

what a brilliant area of research, and one i hadn't ever really considered before.

my question is, do you think these advances will ultimately have some effect on the projected evolution of humans? if so, how?

i would also like to ask if you know/hold an opinion on what the most versatile species is, in terms of tolerance of various extreme environments.

thank you so much for all your incredible work.

TrivialBudgie

Thank you. It is also pretty important, for example it covers drowning, the 2nd most common cause of death in many countries (1st in children). 43 people drown world-wide each hour (WHO figures) - this is an underestimation. In the UK one person drowns every 20 hours, one child a week drowns. Historically humans have evolved avoided climatic extremes by using their intellect. The first hominid-built building was a wind-break! I do not see this changing. Problem is when the technology goes wrong we are ill-equipped and in a survival situation very quickly. There are lots of contenders for versatile animals, some fish can tolerate freezing water, the feet of gulls do not suffer freezing cold injury (unlike humans). My favourite at the moment because of the work we are doing in high altitude physiology (para gliding) are Bar-headed geese that can fly over Everest (check out the work of Dr Matt Wilkes and Dr Lucy Hawkes).

Hello Professor Tipton and thank you for taking the time to answer our questions.

Being that astronauts inhabiting the ISS are prone to cardiovascular issues and bone and skeletal muscle deterioration, what does the research point towards being the most optimal way of programming exercise for the crew? I know that they follow a concurrent training protocol — utilizing both aerobic and anaerobic modalities of exercise; however, I was hoping for more specifics.

Thank you!

austinauclair

Yes, the countermeasures include exercise. Have a look at my GL Brown lecture paper - the references will take you down the road of strength training to avoid bone demineralisation and the relevance of this work for osteoporosis, ageing and bed rest in critically ill patients - fascinating area. Tipton, M. J. (2015) GL Brown Lecture: “Extreme Threats” Environmental extremes: origins, consequences and amelioration. Experimental Physiology. DOI: 10.1113/EP085362.

It's rather difficult to conduct research on these types of injuries and exposures I would imagine. How do you overcome that?

adenovato

We write detailed protocols, these are scrutinised by ethics committees. We have put people in temperature ranging from +400°C to -25°C and into water as cold as 2°C. This is fine as long as you are measuring critical variables (skin temps, deep body temps, ECG) and you have tight withdrawal criteria. You can also see, in a mild form many of the problems that occur in more extreme environments by exposing people to milder conditions.

What are your thoughts on the alleged benefits of hyperbaric chambers?

adenovato

You have to be specific about what you think you are doing with them. For example, there is little doubt they are beneficial/life saving for carbon monoxide poisoning when the only way of getting oxygen to the tissues is by dissolving it in the blood (Hb sites unavailable). However, for many conditions (e.g. DOMs, angiogenesis) I would like to see experiments with the proper controls of normobaric, 100% oxygen. This doesn't require a chamber!

Welcome!

Are some people better adapted to handle the stresses of something like open water swimming?

sciencereader3455

There is definitely are genetic variation in the ability of people to tolerate heat, altitude. Over generations physiological/biochemical, anatomical and morphological changes incline people to do better in some environments than others. Cold water is a special case in that we have not been exposed to it for generations (unlike heat and altitude) and, as a tropical animal, we avoid it like the plague. Fat helps; it has the same insulative properties as cork. Animals in cold water lay down blubber. As a species we (in the 1st world) are becoming fatter but this will only coincidentally help in cold water. We can, with repeated exposure adapt to heat, altitude and cold water. In cold water the adaptation is an habituation e.g. 5 x 2 min exposures in cold water will halve the cold shock response to cold water. The shivering response is also reduced and comfort increases. So, people do vary due to genetic factors and previous exposure. In fact, give me a big, muscly, decent swimmer and I will produce a polar swimmer in a couple of weeks (as long as they only stay in for 20 min). For more info read: Tipton, M. J., Pandolf, K., Sawka, M., Werner, J. & Taylor, N. A. S. (2007) Physiological adaptation to hot and cold environments. Chapter in: Physiological bases of human performance during work and exercise. Editors: Nigel A.S. Taylor, Herbert Groeller and Peter L. McLennan.

Where is our understanding of body tissue wasting at this time? How close are we to stalling cellular aging?

sciencereader3455

Not really my area. Personally I am some way from avoiding it! Having said that, recent theories link inflammation to ageing and we know cold exposure is anti-inflammatory. This is one of the mechanisms that looks open water swimming/cold habituation to improvements in inflammatory-induced depression. Check out the TV programme "The Doctor who gave up drugs" http://www.bbc.co.uk/programmes/b07w52tp

How does microgravity affect the human body? Also, are you familiar with the Kelly twin study they conducted with astronauts Scott and Mark Kelly?

scienceaccount103040

The response is essential one of deconditioning. Actually it is an adaptation to the absence of gravity. This is fine when still in that environment but a problem when returning to 1G. (Similar occurs if immersed in water - the adjustments to the hydrostatic pressure means you can then get post-immersion collapse on being lifted from the water).

I was lucky to originally be taught this subject by Prof Heinz Wolff who died on the 15th December (this week). A great man, I still remember his lecture from 1982 and the fact that astronauts like to have blankets/sleep stations to help them sleep (in theory they could just float about) and the story of whether a spider can spin a web in space (not without help and then it is a very fine web): There have been 3 space "spider experiments" the first in Skylab in 1973. In the last, Gladys and Esmerelda, two Golden orb spiders, had a go at spinning a web. Golden orb spiders normally use gravity when building to create the long lines that radiate from the centre

Christmas-related fact: the pressure exerted by one atmosphere at sea level is 14.7 pounds per square inch. 14.7 pounds is the weight of the average Christmas turkey. Image having one of those on every square inch of your body when eating your Christmas lunch.

Yes, I am aware of the twin study: https://www.nasa.gov/twins-study/about

Hello there. Can the 2 hour marathon be attained in our lifetime, or ever? How do conditions, such a geographical or atmospheric, contribute to this attainability?

theinfamousbard

I do not know if a 2 hour marathon time can be achieved. I do know that the ideal conditions for it will be an air temperature of about 11°C, no wind, low humidity and no radiant heat load. If the conditions change too much from these performance suffers, so most if the time you are trying to minimise the decrement to performance caused by the environmental conditions. We have spent many years helping the English Institute of Sport assist our Olympic athletes prepare for competition, particularly in the heat. The current concern is the Tokyo 2020 where the conditions could be 30°C and 80% relative humidity i.e. hot. Hydration, acclimation, thermal issue will determine the medal haul.

Hi Professor Tipton,

Body compensatory mechanisms to extreme conditions is such a fascinating topic. Most interesting to me is the adaption to microgravity and the muscle wasting that results.

I know the pharmaceutical route is a common research area for attenuation of muscle wasting and genetic engineering is rising as well. However, I wonder if there is any progress in the creation of artificial gravity as a means to attenuate muscle wasting?

I am aware of the current methods which largely use centripetal acceleration, but the problem with that is the large differential in force the body experiences if parallel to the radius. Are there any alternatives to this method of producing artificial gravity that do not have this same problem?

P.S. To attract more posts it may be helpful to post an American time-zone

insanelylogical

I will have to be brief I am afraid as I am being dragged away. I know of no specific work on artificial gravity, but it is not my main area. Lower body positive pressure and strength training seem to be alternatives. Check out as a start the GL Brown paper I referenced above. Thanks for the time zone advice.