Week 7: exercise in hot and cold environments; exercise in altitude

- Acclimation: short term adaptation to environmental stressors (9-14 days; days to weeks)
- Acclimatization: long term adaptation to environmental stressors (weeks to *years*)
- Metabolic heat production (M): less than 25% of ATP breakdown goes to cellular work (W) and over 75% of ATP breakdown becomes metabolic heat
- Heat is transferred from the body and environment through skin via blood. When the heat reaches the skin it can be eliminated in three ways: radiation, conduction, convection and evaporation
- Heat gain: metabolic heat and environmental heat (conduction, convection and radiation)
- Heat loss: radiation, conduction, convection, evaporation
- Conduction: transfer of heat from one solid object to another through direct molecular contact. Example: sitting on metal chairs would warm the metal up
- Convection: heat transfer by movement of *liquid or gas* across the surface (increased movement of skin surface will therefore increase heat exchange). Convection is a major thermoregulatory factor
- Radiation: heat loss from *infrared* rays. Body can both receive and give off radiant heat.
- Evaporation: heat loss via phase change from liquid to gas. Primarily lost through exercise (80%). Clothing hinders evaporation
- Humidity and heat loss (affects evaporation): high humidity reduced the heat lost through evaporation and sweating
- Sweating: air temperature could be higher than skin temperature, in which case convection will not work. Therefore, in these conditions we rely on sweat
- Effect of exercise on the body: humans are homoeothermic (have a tightly regulated temperature). *Critical temperature theory* – brain shuts down at around 40 to 41 degrees. This explains the limitation of even well acclimated athletes. Moreover, during exercise, the skin arterioles vasodilate, blood volume decreases (sweat loss) so HR increases to maintain CO
- During we can lose 1.6L to 2L (2.5% to 3.2% body weight) each hour through sweat during exercise. Can decrease cardiac output. Severe dehydration can lead to onset of three heat related diseases: heat cramps, heat exhaustion and heat stroke
- Heat cramps: least serious of the three heat illnesses. Severe, painful cramping in major muscles. Occurs when there is excess sodium and water excretion. It is most common in heavy sweaters and is prevented by maintaining sodium and water levels (replenishment)
- Heat exhaustion: caused when there is severe dehydration from sweating, which means that the blood flow needs of the muscles and skin are not being met (because of low blood volume). In this stage the thermoregulatory systems are still working but not fulfilling duty. Accompanied by nausea, dizziness, vomiting, fatigue, weak, rapid pulse and fainting.
- Heatstroke: life threatening and most dangerous of the three. Failure of thermoregulatory system. Core temperature above 40 degrees. Accompanied by confusion, disorientation and unconsciousness. Can lead to coma or death if untreated. Treatment is to cool whole body e.g. ice bath
- Preventing hyperthermia: no outdoor activities when WBGT is over 28 degrees, practice in evening or early morning, never restrict fluid intake and minimise clothing
- Acclimation to exercise in heat: repeated training in heat will make us adapt to it for better performance in the heat. Things that happen: CV functioning optimised, change in sweat content as well as sweating rate and sweat distribution. This results in a lower core temperature during exercise. Moreover, plasma volume increases in the initial stages (up to 10 days) then returns to normal. This buys the body time to adapt on other areas. After acclimation, the heart rate decreases and cardiac output increases to support increased skin blood flow, reduce core temperature (greater heat loss), sweating earlier (optimising evaporation heat loss) and sweat that is more dilute (conserving our sodium levels)
- <u>Cold stress</u>: any environmental condition causing loss of body heat
- a decrease in core temperature causes physiological and behavioural mechanism actions. It is hard to identify a *dangerous* (hypothermia inducing) environmental condition
- increase of insulation with increase in inactive peripheral muscle and increase in subcutaneous fat
- heat loss if there is a low body surface area to mass ratio
- windchill: air movement (NOT temperature) can affect heat loss. The index is based off cooling effect of wind and it increases core heat loss. It basically indicates the cooling power of environment. An increase in windchill increases the risk of freezing tissues
- water has a thermal conductivity 26 times higher than air
- cold water vs air affects heat loss: cold water heat loss is four times faster than cold air heat loss. Unless the water temp falls below 32 degrees, the core temperature is controlled at a regular temperature. The core temperature decreases by 2.1 degrees per hour in 15-degree water. Heat loss