A lifetime inspired by the ocean:

marine environmental effects on human physiology

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BRADYCARDIA, VENTRICULAR PAUSES, SYNCOPE, AND SPORTS

H. ECTOR
M. VERLINDEN
E. VANDEN EYNDE
J. BOURGOIS
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Department of Cardiology, University Clinic St Raphael, Leuven, Belgium; and Department of Physical Education, University of Leuven

Summary 16 athletic patients were examined because of syncope, Stokes-Adams attacks, or both. The life-threatening condition required pacemaker implantation in 7 patients. 8 of the 9 other subjects became symptom-free after stopping heavy physical training. 37 top-ranking athletes underwent 24 h Holter monitoring. Pauses longer than 2 s occurred in 19% and resulted from sinus arrest. The longest pause lasted 2·5 s. Second-degree atrioventricular block was noted in 13%.

Introduction

PACEMAKER patients younger than 40 years old are rare. In our institution only 9 of 255 first implantations in 1981, 7 of 244 in 1982, and 6 of 222 in 1983 were done in patients younger than 40. In the past few years we have examined several young, healthy sportsmen and women with bradycardia, ventricular pauses, and syncope. We have compared these "athletic patients" with two out-of-hospital groups of "normal" athletes.

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A lifetime inspired by the ocean

"Deckmate on Cast Otter"

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“A lifetime inspired by the ocean”

Helmsman Admiral’s Cup, Transatlantic races and Whitbread Round the World Race

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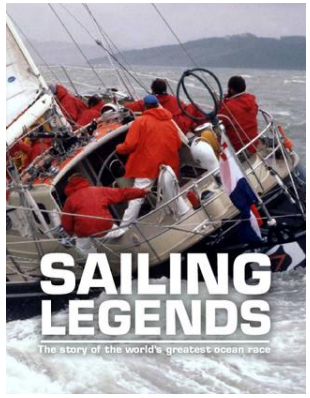
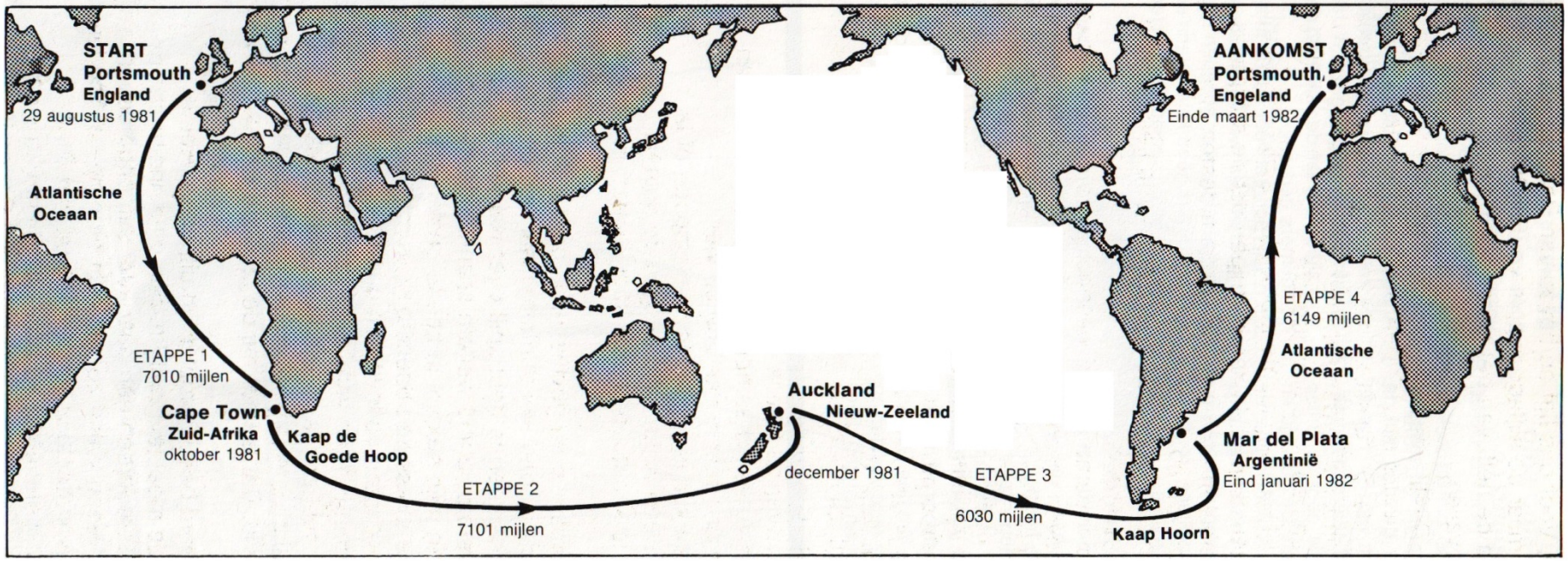


“A lifetime inspired by the ocean”

WHITBREAD ROUND·THE·WORLD RACE
1981 1982



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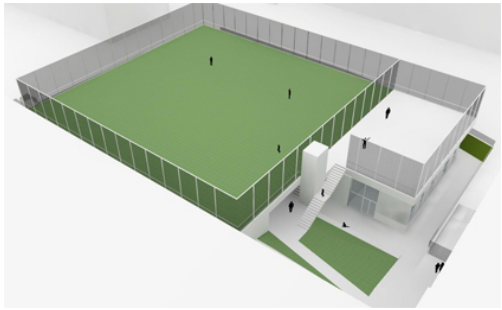
Faculty of Medicine and Health Sciences

Biggest Faculty: 6000 Students and 24 Departments



Department of Movement and Sport Sciences

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Research

“Cardiorespiratory and metabolic responses during exercise and microvascular oxygen extraction”

Gasanalysis

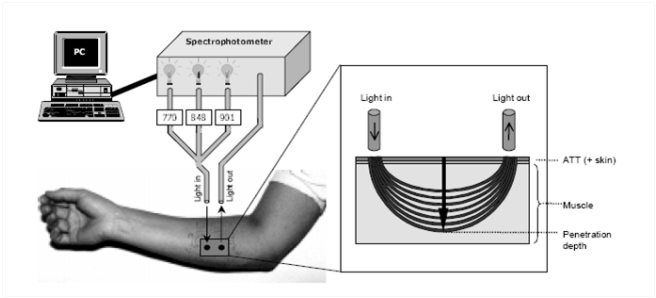
Ergospirometrie

Blood flow

Echo Doppler

Oxygen extraction

NIRS



Muscle activation

Electromyography

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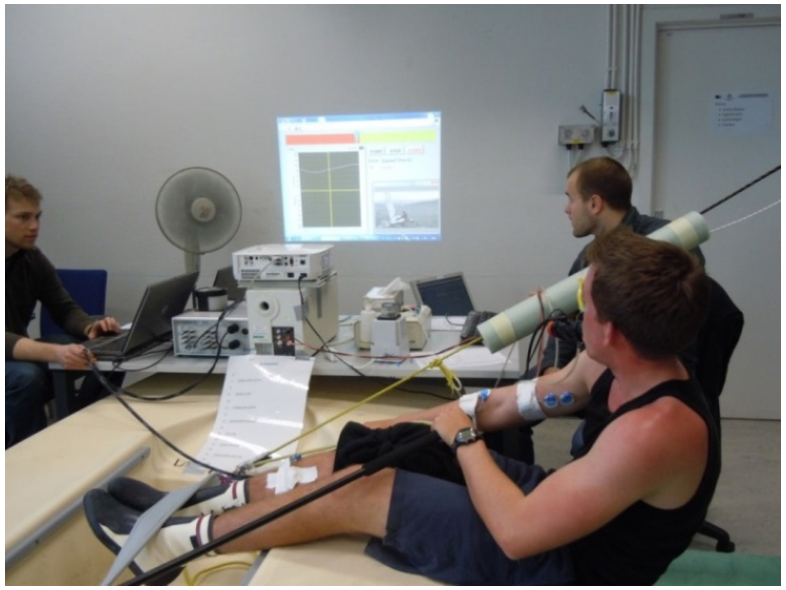
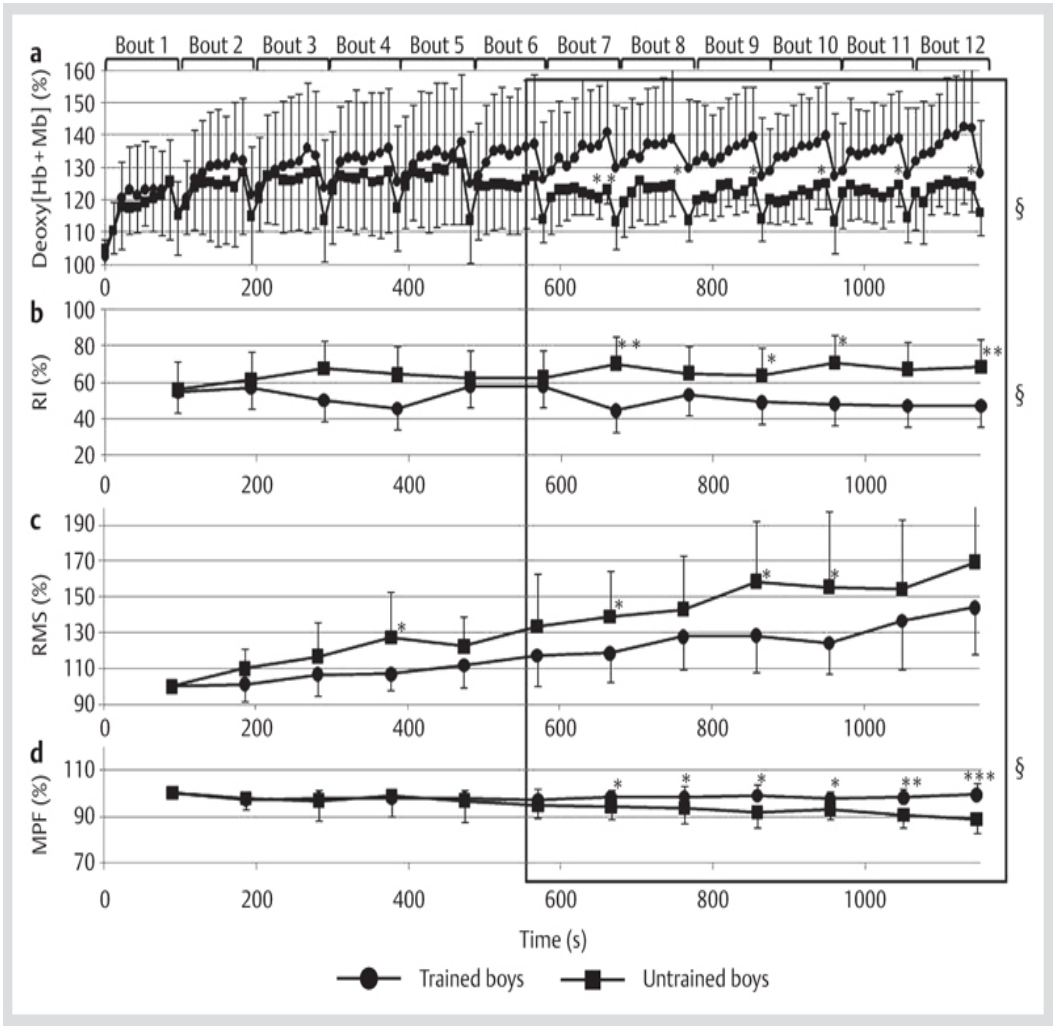
Research project “Olympic Dinghy Sailing”





(Callewaert et al. 2013))

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PUBLICATIONS 2013 – 2014

M. Callewaert, J. Boone, B. Celie, D. De Clercq, J. Bourgois. Quadriceps muscle fatigue in trained and untrained boys. International Journal of Sports Medicine. 34, 14 – 20: 2013

M. Callewaert, S. Geerts, E. Lataire, J. Boone, M. Vantorre, J. Bourgois. Development of an Upwind Sailing Ergometer. International Journal of Sports Physiology and Performance. 8, 663 – 670: 2013

Boone J and Bourgois J. Morphological and physiological profile of elite basketball players in Belgium. International Journal of Sports Physiology and Performance. 8, 630 – 638: 2013

Bourgois J., Boone J., Callewaert M., Tipton Mike, Tallir I. Biomechanical and physiological demands of kitesurfing and epidemiology of injury among kitesurfers. Sports Medicine. 44, 55 – 66: 2014

Boone J, Celie B, Barstow T, Barstow T, De Bleecker J, Smet J, Van Lander A, Van Coster R, Bourgois J. The deoxy [Hb + Mb] response during and following arterial occlusion in mitochondrial myopathy. Respiratory Physiology & Neurobiology. 190, 70 – 75: 2014

M. Callewaert, J. Boone, B. Celie, D. De Clercq, J. Bourgois. Cardiorespiratory and Muscular Responses to Simulated Upwind Sailing Exercise in Optimist Sailors. Pediatric Exercise Science. 2014 – In press

Bourgois, J., Steyaert A., Boone J. Physiological and anthropometric progression in an international oarsmen: a 15 year case study. International Journal of Sports Physiology and Performance. 2014 – In press

M. Callewaert, J. Boone, B. Celie, D. De Clercq, J. Bourgois. Indicators of sailing performance in dinghy sailing. European Journal of Sport Science. 2014 (Accepted for publication)

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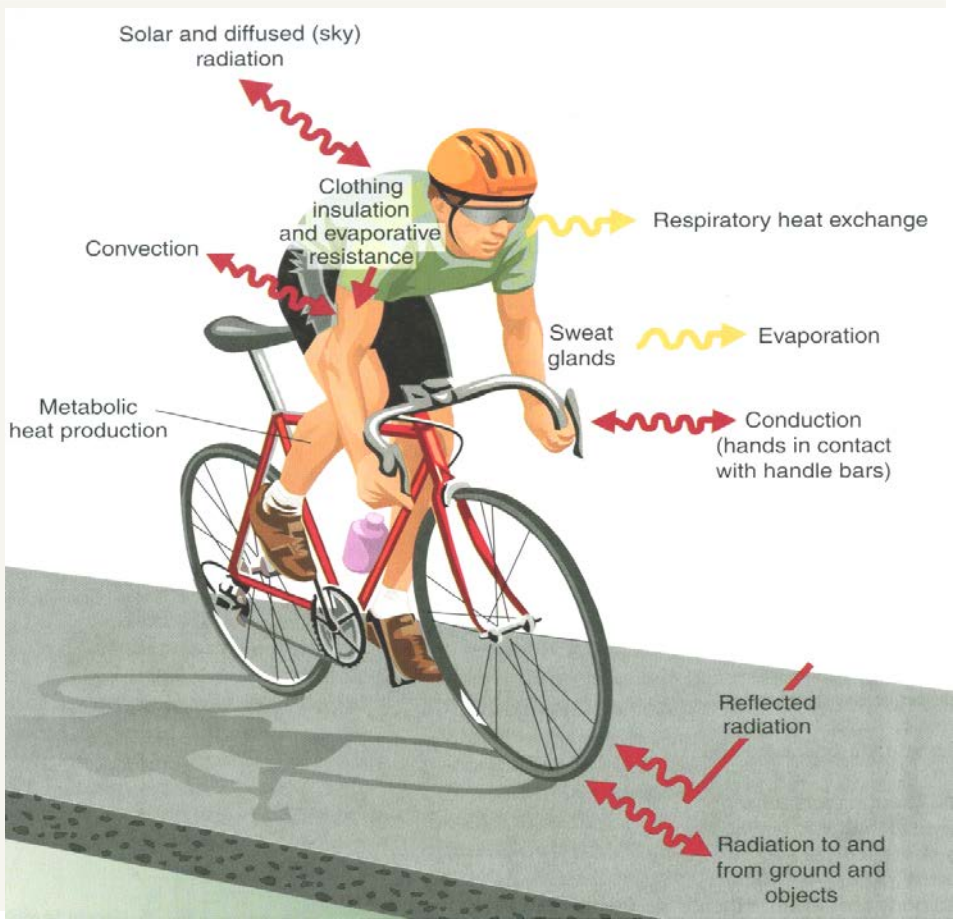
Expertise of our research group



(Wilmore, Costill & Kenney, 2008)

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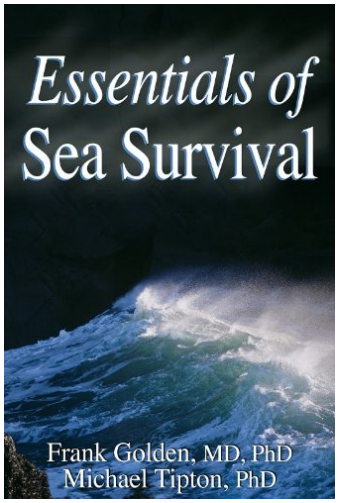
Marine exercise physiology

Professor Mike Tipton
Qualifications: PhD
Role Title: Professor of Human & Applied Physiology
Area: Environmental and occupational physiology
Department: Department of Sport & Exercise Science
Laboratory: Extreme Environments Laboratory
Faculty: Faculty of Science
University: University of Portsmouth (UK)



Golden F., Tipton M., (2002). Essentials of sea survival Human Kinetics ISBN 9780736002158

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Marine exercise physiology: a new research line

Beach lifeguarding

Performance of cardiopulmonary resuscitation in beach lifeguards

Van Den Berghe D, Deblaere I, Tallir I, Wyler B, Mpotos N, Vandamme E, Bourgois J, Herregods L. The rescuer during a 30 minutes BLS-Sequence. Resuscitation. 83, Supplement 1, e44 - e44: 2012

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Marine exercise physiology: a new research area

Safety in watersports

Safety Management (SAM)

Bourgois J., Boone J., Callewaert M., Tipton M., Tallir I. Biomechanical and physiological demands of kitesurfing and epidemiology of injury among kitesurfers. Sports Medicine. 44, 55-66: 2014

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Marine exercise physiology: a new research area

Survival at sea: human factors of surviving

1. Minimum occupational fitness requirements for rescue services

2. Minimum occupational fitness standards for offshore industry, pilot boats and research vessels

3. Marine environmental effects on human physiology!

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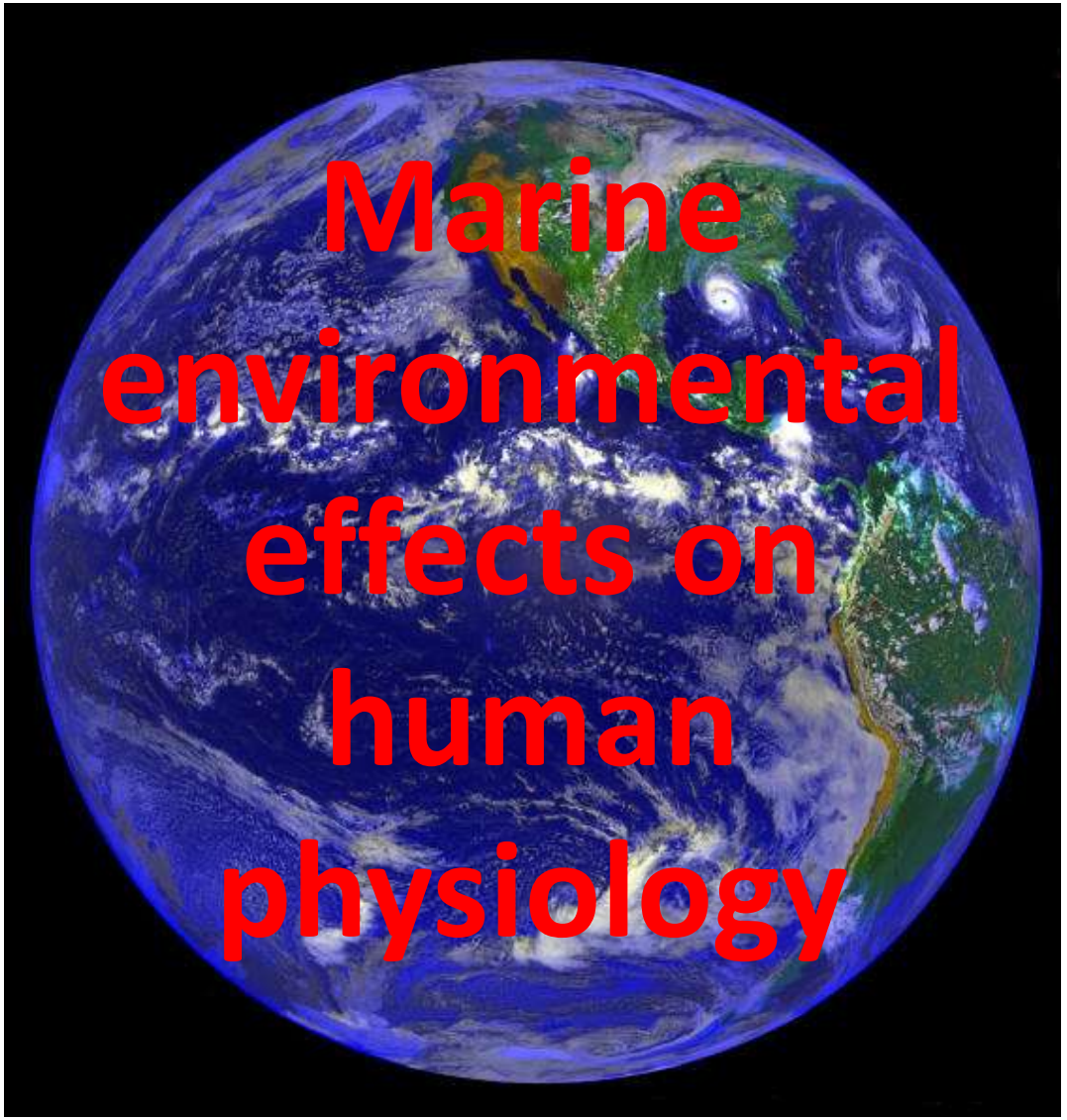

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Oceanography

An Invitation to Marine Science

Tom Garrison, 7th Edition, Brooks/Cole Cengage Learning, USA, 2010

Appendix X: Working in Marine Science (page 543)

"A marine science worker is paid to bring a specific skill to a problem. If that problem lies in warm, tropical water or in a marine park, fine. But more likely, the problem will yield only to prolonged study in an uncomfortable, cold, or dangerous environment."

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Working in extreme environments

Human thermoregulation

→ Heat and humidity

→ Cold and wind

Physiological responses

Health issues

Preventive strategies

"Physiology of cold water immersion"

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'Humans' **belong to a group of animals called** ***'homeotherms'*** ***and*** **can be thought of as** ***'tropical animals'*****.**

HEAT GAIN ≈ HEAT LOSS

Adjustments to hot environments
≈ ***'Physiological' thermoregulation***

Adjustments to cold environments
≈ ***'Behavioral' thermoregulation***

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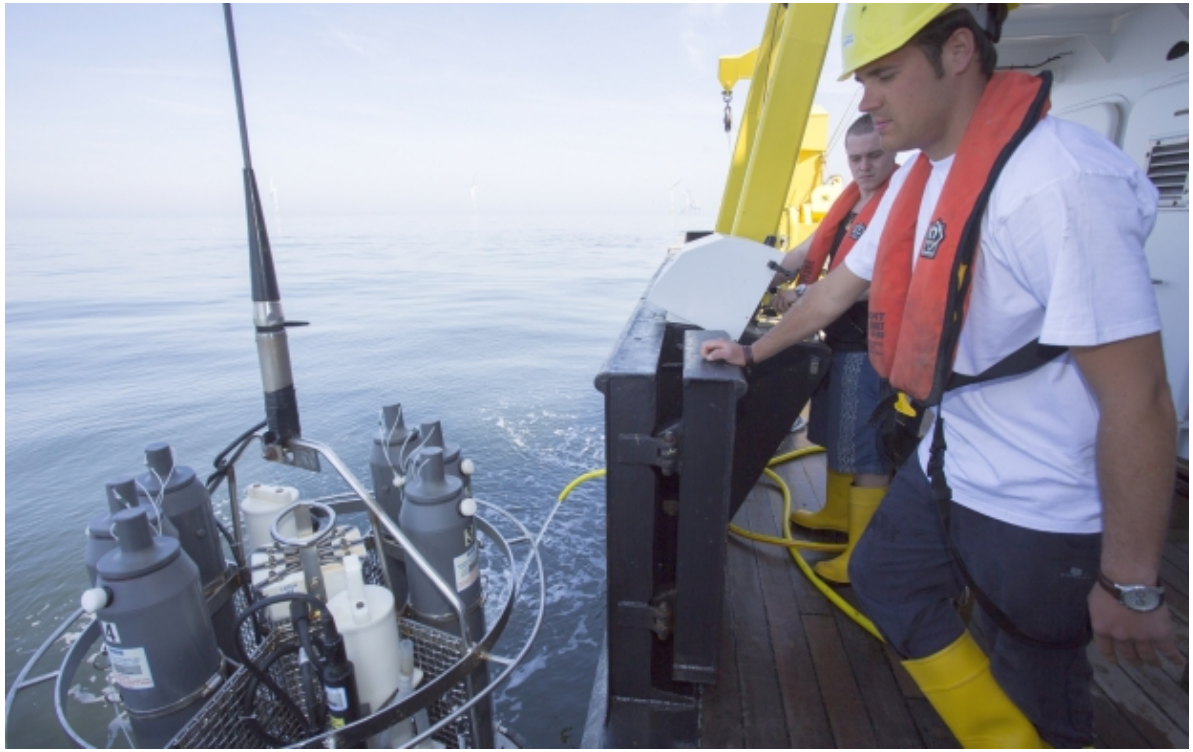
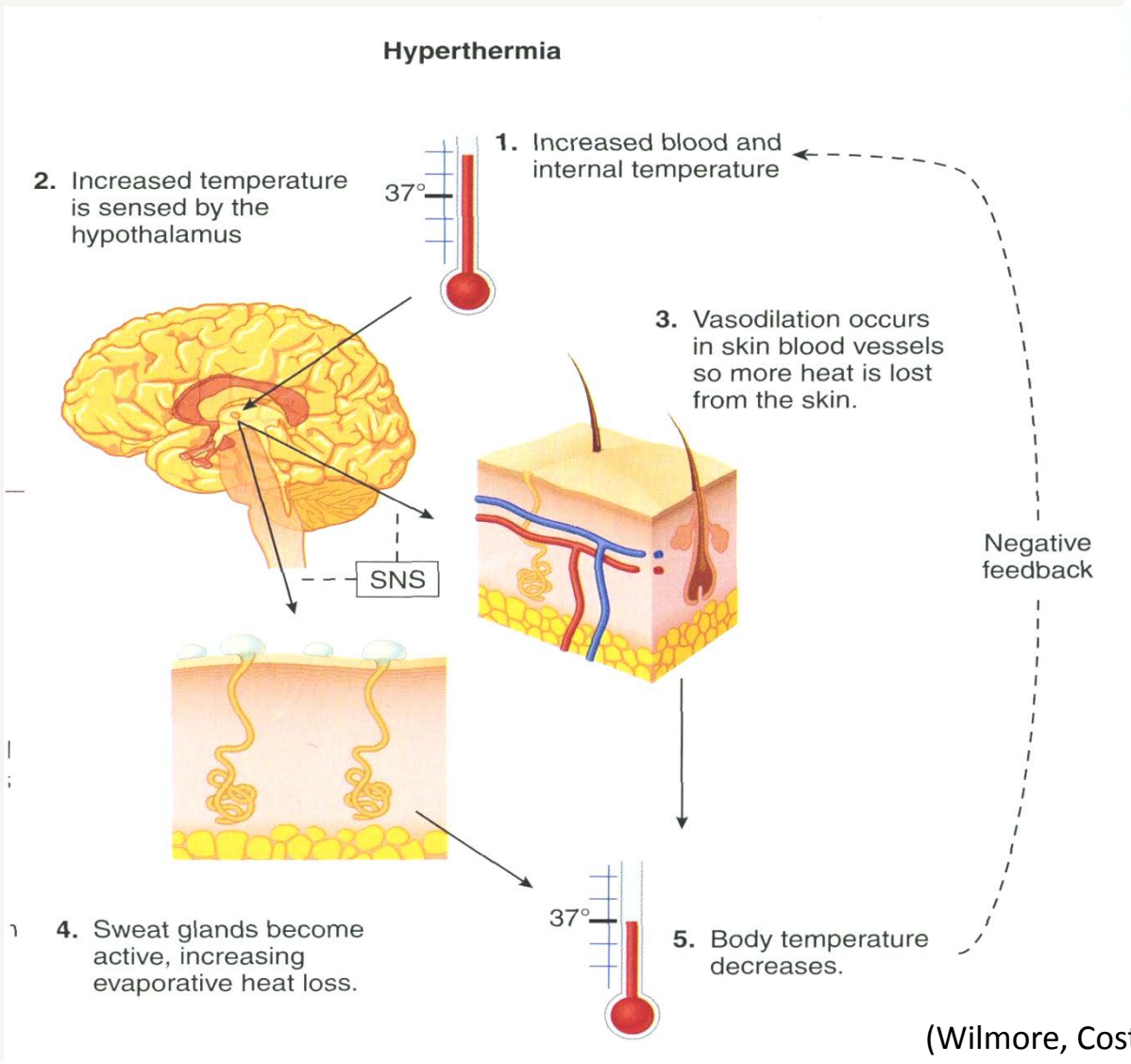
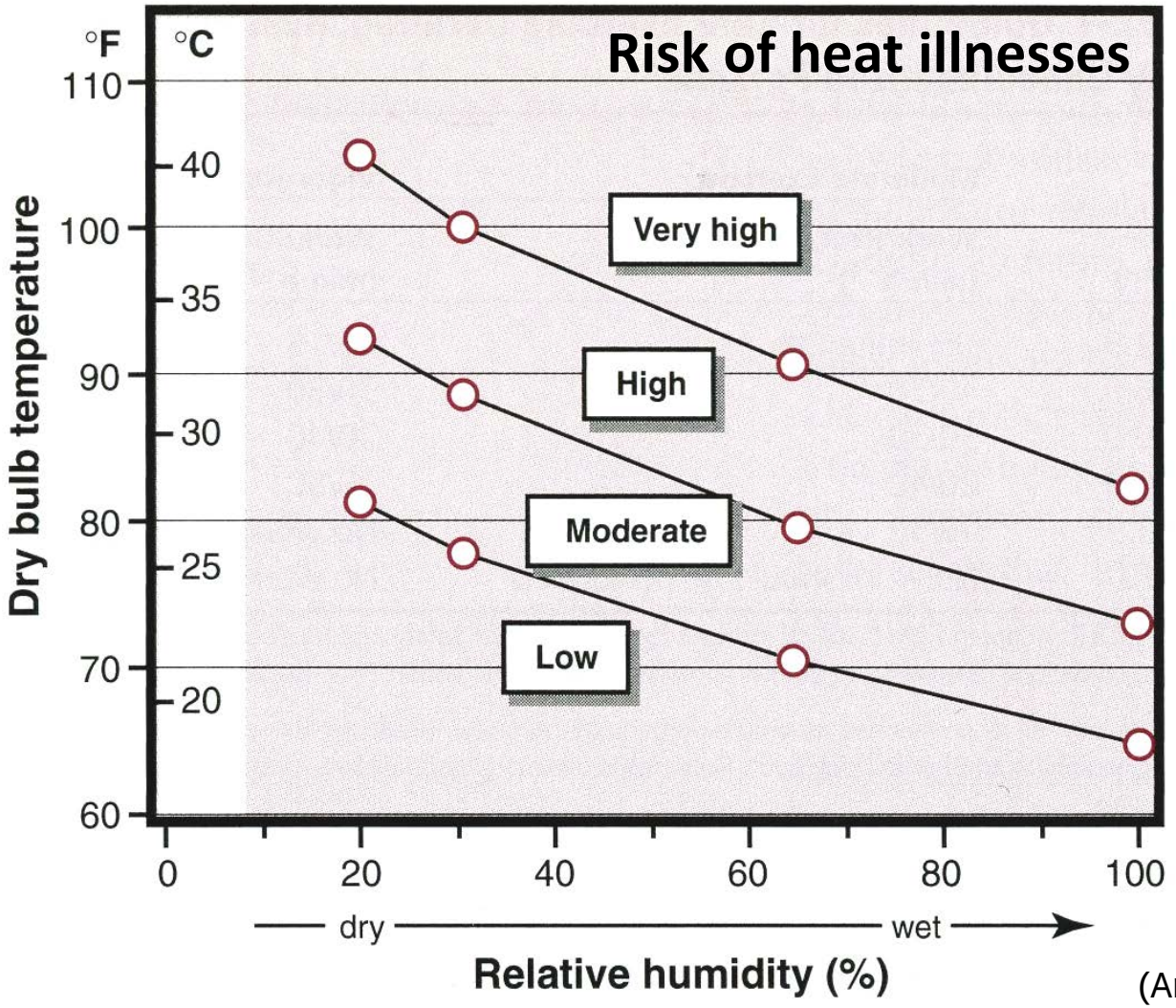
Heat and humidity

Heat stress can be defined as any environmental condition that causes gain of body heat that threatens homeostasis.

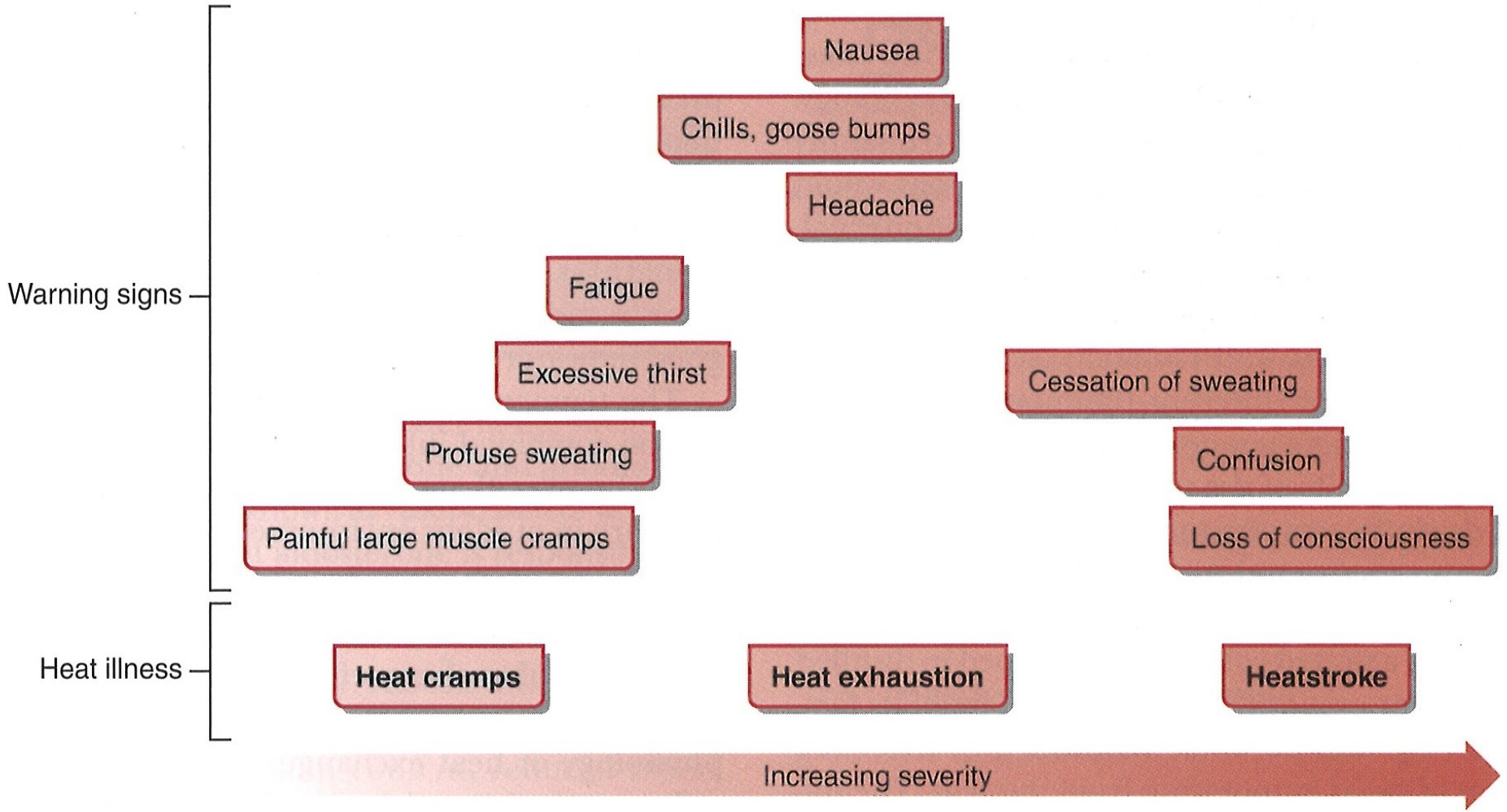




(Wilmore, Costill & Kenney, 2008)



(Armstrong, 2000)



(Wilmore, Costill & Kenney, 2008)

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Recommendations for Counteracting Heat and Humidity

→ Consult weather reports: air temperature and humidity.

→ Limit duration and severity of exposures to heat and humidity.

→ Wear lightweight clothing, loose-fitting and porous to allow skin cooling via evaporation of sweat and dry heat loss (radiation and convection).

→ Look for sun protection (porous cap, sun glasses, high quality protection cream,…)

→ Prevent water depletion and salt depletion:
- check hydration status: body weight and urine color*** (morning after waking);
- select foods and beverages for NaCl replacement.

→ Avoid alcohol.

→ Recognize warning signals of heat illnesses and look for appropriate treatment.

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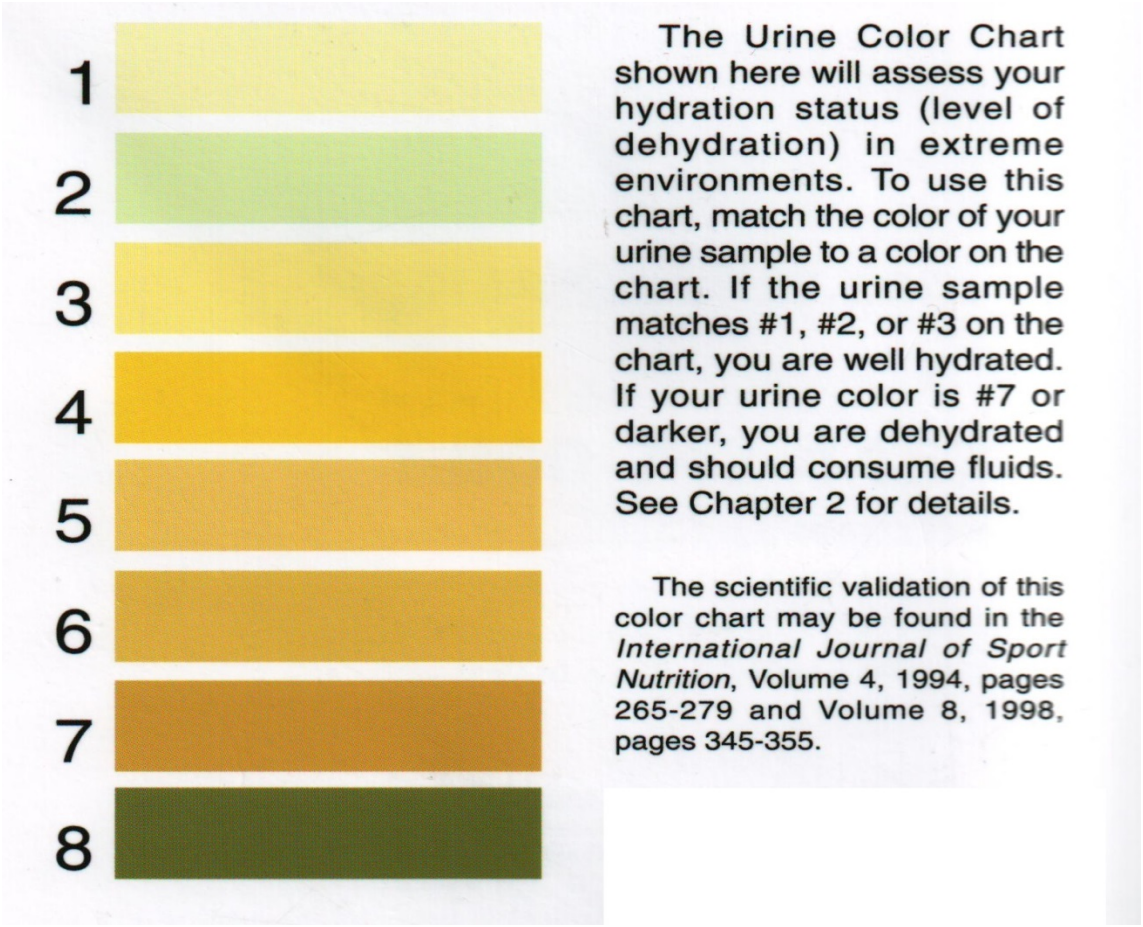
Recommendations for Counteracting Heat and Humidity



(Armstrong, 2000)

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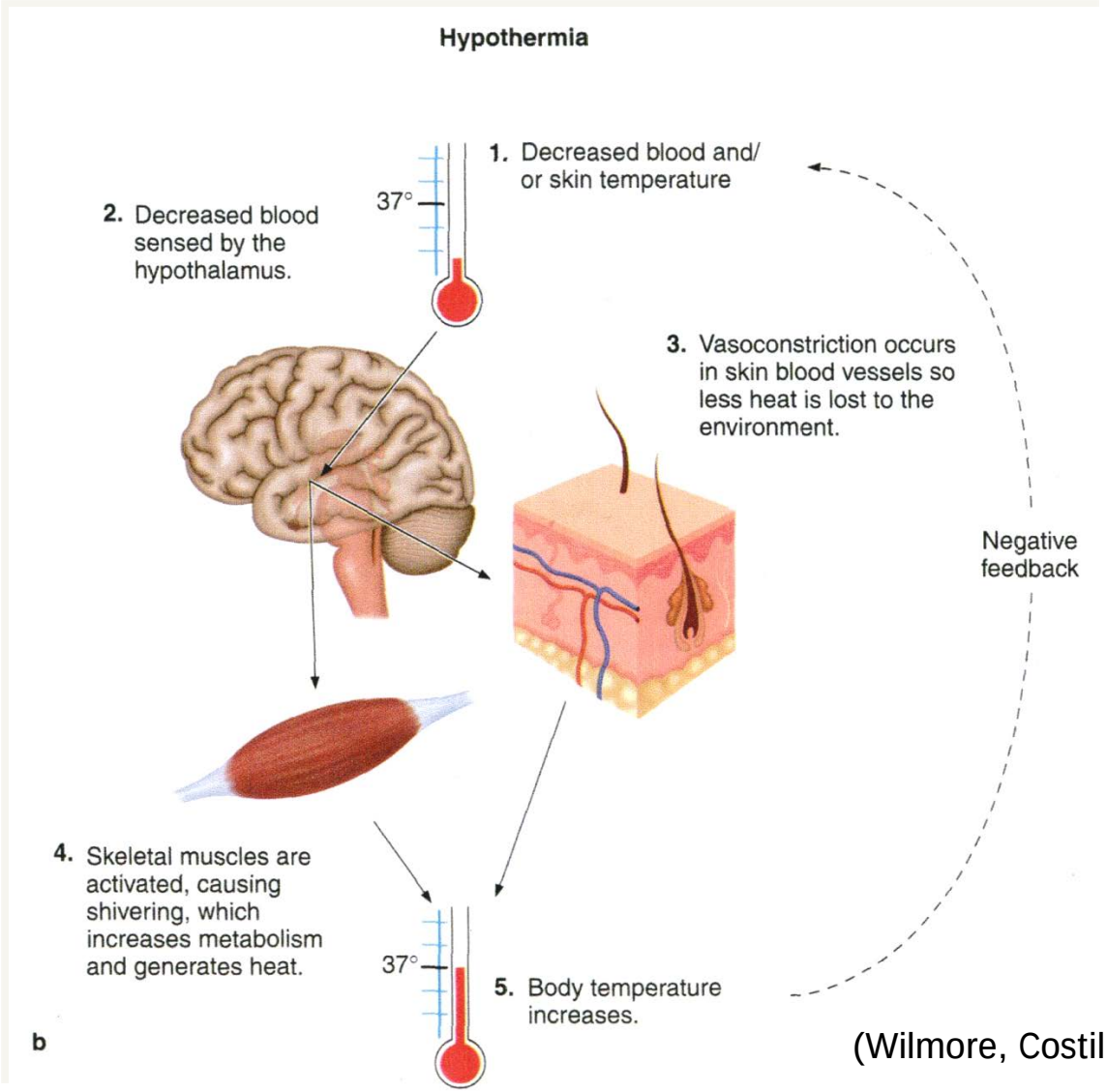
Cold and wind

Cold stress can be defined as any environmental condition that causes loss of body heat that threatens homeostasis.



(Wilmore, Costill & Kenney, 2008)

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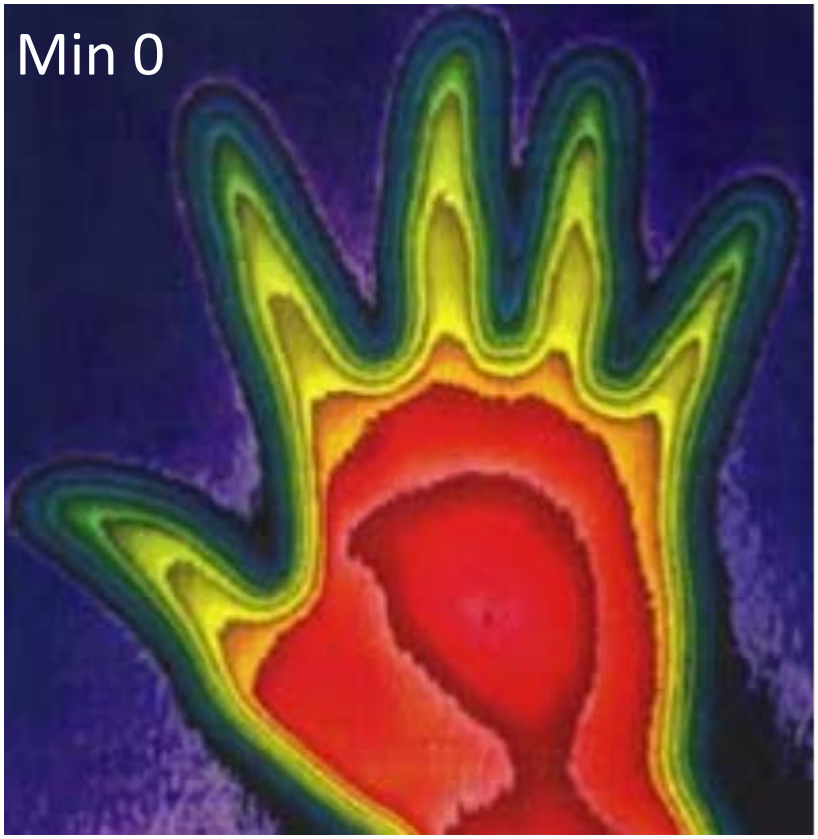
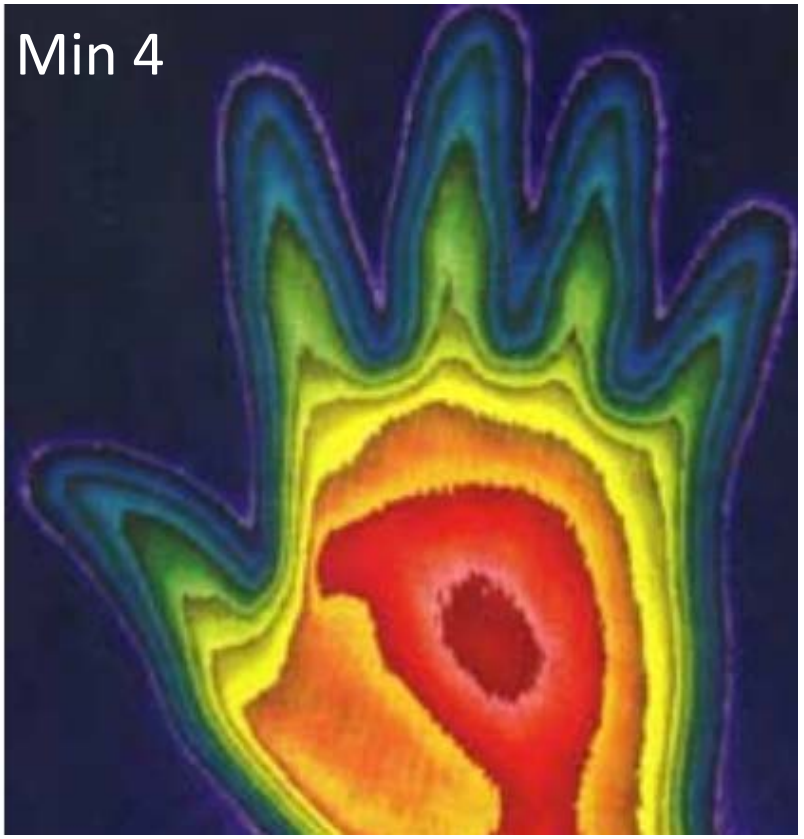
Vasoconstriction in the hand: manual function and sensitivity?

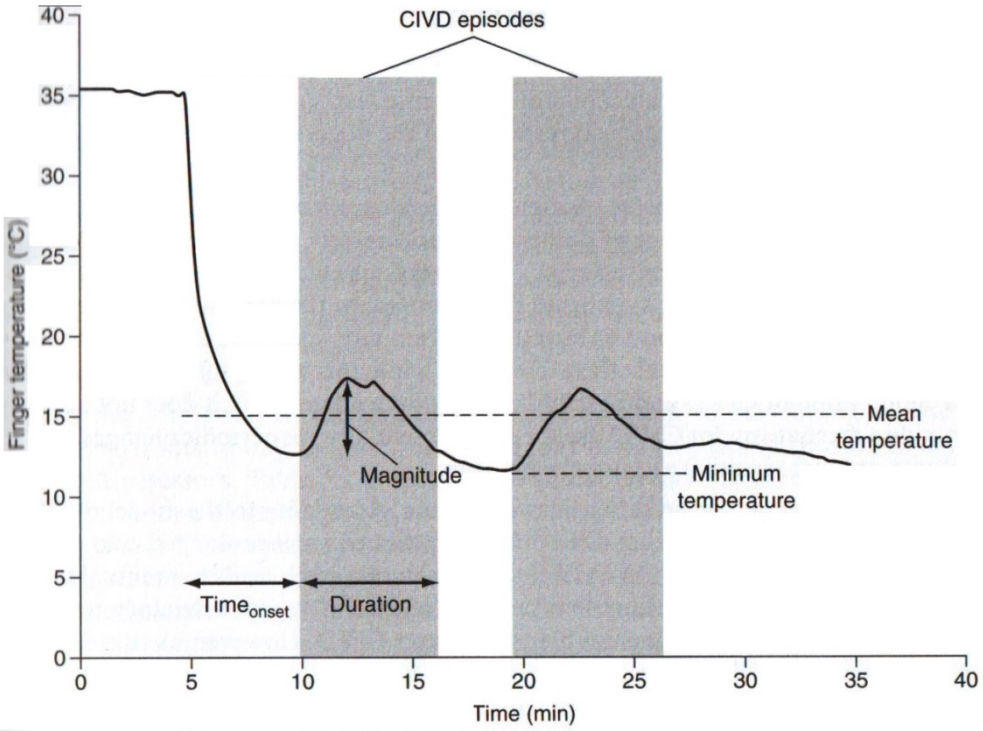




T = 9°C

Infrared image → Peripherical temperature

Cold induced vasodilatation (CIVD) of finger vessels causes rises in tissue temperature



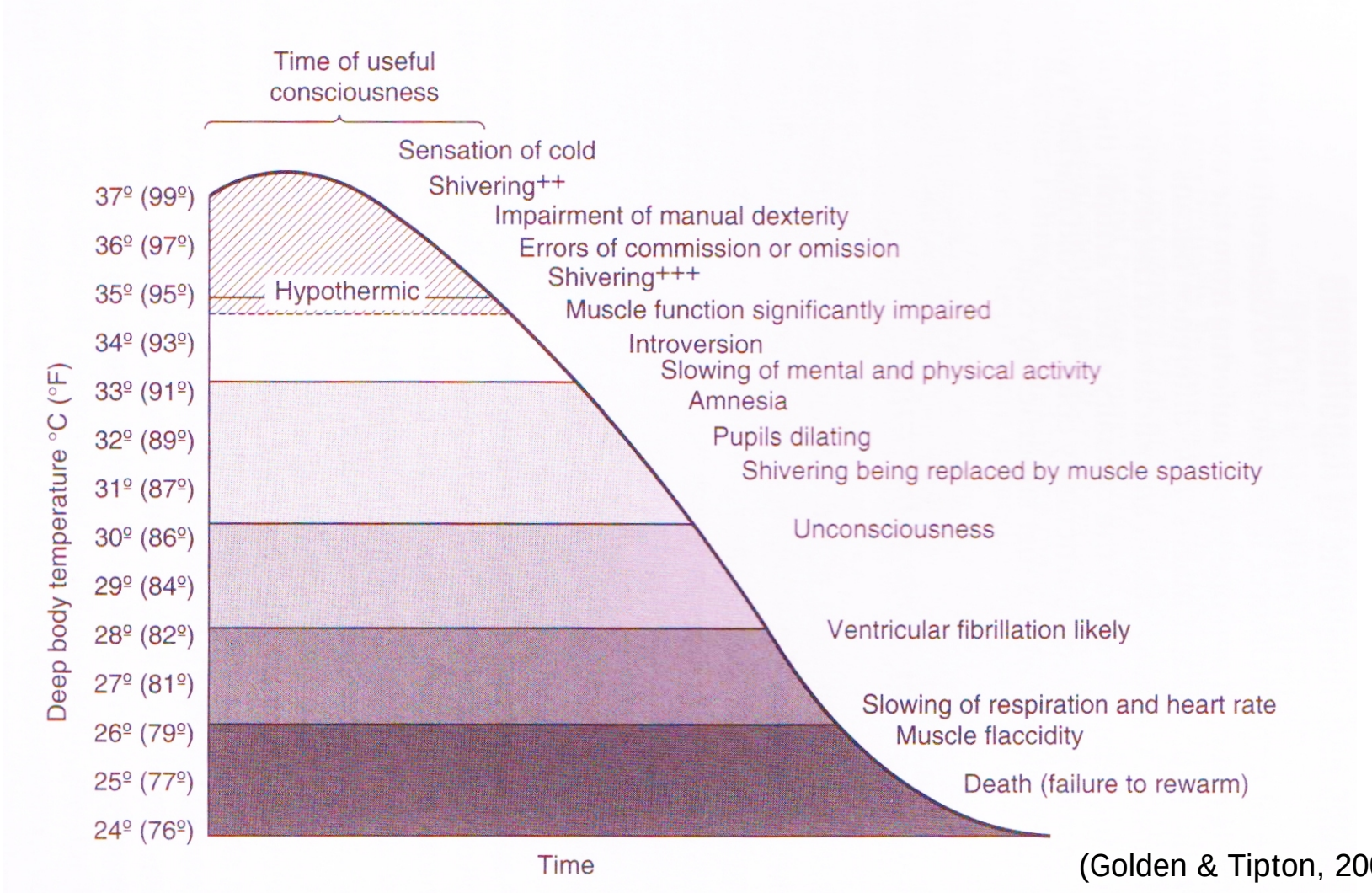
(Cheung, 2010)

→ Mechanisms of CIVD?
- Axon reflex?
- Vasodilatory substances in the blood?
- Control via norepinephrine?
- Direct effect of cold on cutaneous vasculature (AVA's)?

→ Trainability of CIVD?
- No.

→ Requirement CIVD?
- Maintaining deep body T°.

Cold injury: hypothermia



(Golden & Tipton, 2002)

Cold-Dry injuries (especially extremities)

Frostnip

Outer layer of the skin is frozen.

Source: www.mounteverest.net

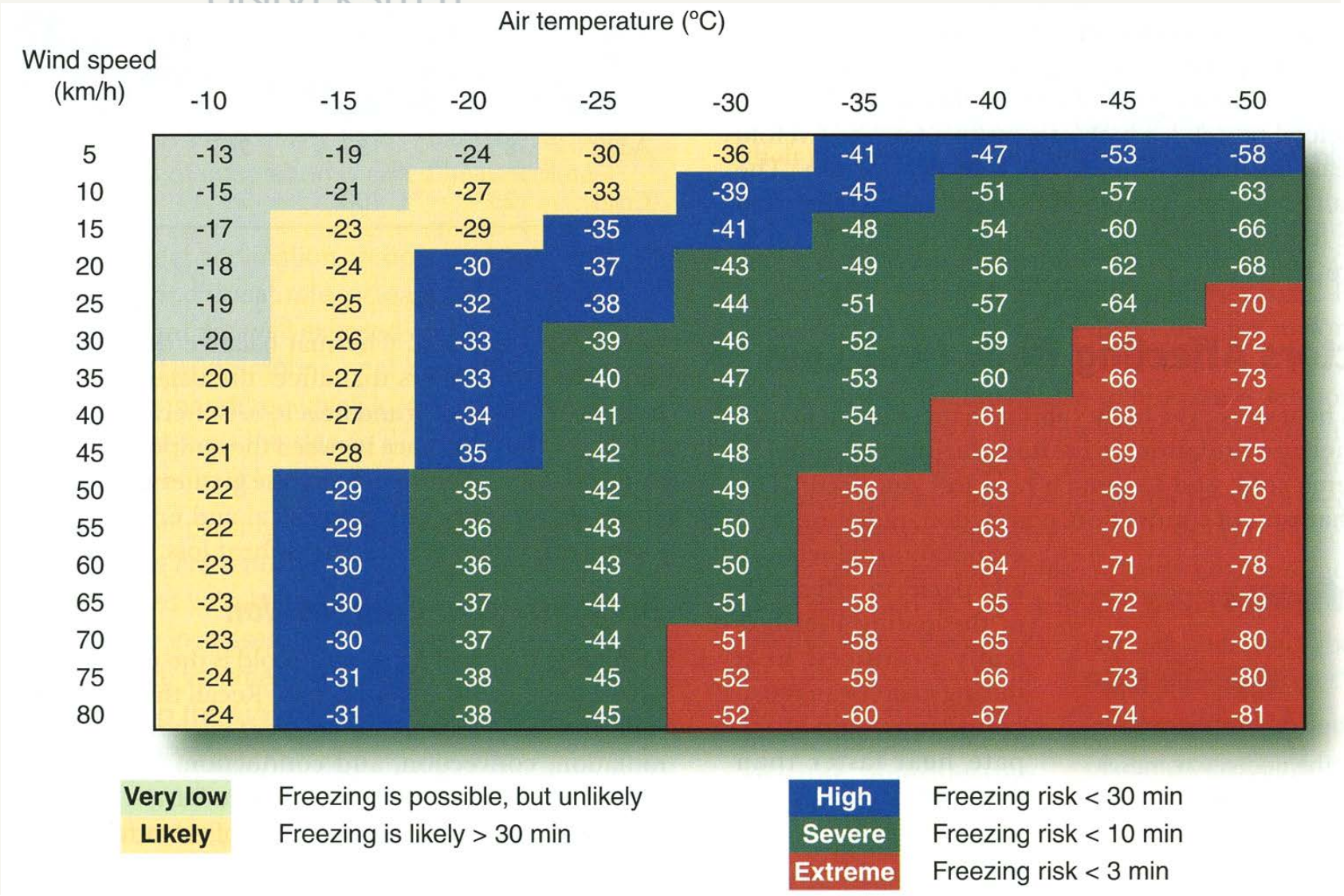
Frostbite

Continued cooling and freezing of cells, leading to tissue death.

Source: www.theadventuremedic.com

Causes of frostnip and frostbite:

- low air T° & windchill;
- exposed skin, moisture on skin;
- poor insulation, moisture in clothing, tight clothing;
- direct contact with supercooled metal or liquid...



(Wilmore, Costill & Kenney, 2008)

Cold-Wet injuries (especially extremities)

Chilbain

Source: www.homeopathyworldcommunity.com

Damage to superficial blood vessels.
Local edema and inflammation.

Pernio

Source: dermis.multimedica.de

Continuation chilblain.
Initiation of skin necrosis.

Trench/Immersion foot

Source: adenosinetriesphosphate.tumblr.com

Severe damage to local vasculature and likely nerves.

Causes of chilblain, pernio and trenchfoot:

- prolonged immersion in cold water;
- trenchfoot: exposure (>12h) of wet feet to T° 0,5 – 10°C.

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Recommendations for Counteracting Cold and Wind

→ Consult weather reports: air temperature and windchill.

→ Limit the duration and severity of exposures to cold air.

→ Wear multiple layers of light, loose-fitting and breathable clothing:***
- that insulates the skin with trapped air;
- that provides protection from wind and rain.

→ Oil-based lotions (i.e. vaseline,…) can protect face, hands and ears from exposure. Don't use water-based lotions (wet the skin and increasing likelyhood of cold injuries).

→ Proper hydration and carbohydrate rich diet.

→ Avoid alcohol.

→ Recognize cold injuries and look for appropriate treatment.

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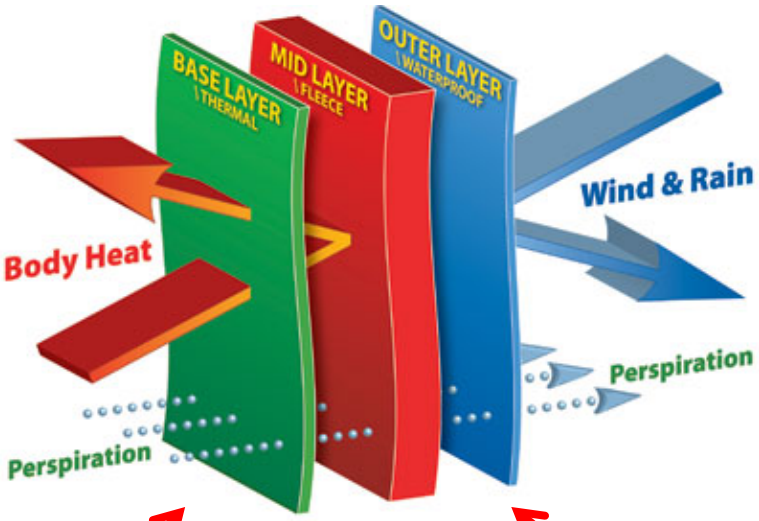

Polyester /Polypropyleen Merino wool

Fleece – Wool – Polyester

NEW

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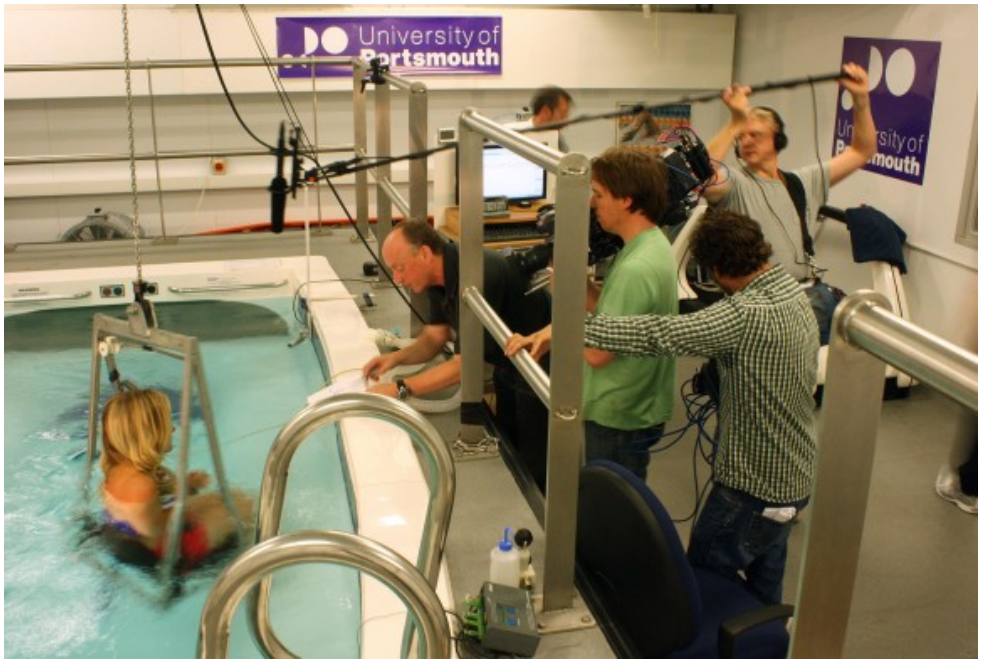
Cold water immersion



Source: www.lifesaving.us

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Did you ever fall into cold water?

Source: coldwaterbootcampusa.org

Source: kayakdave.com

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Get out of the water before you die!!!

Source: www.lifesaving.us

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"Public Knowledge Regarding Cold Water Immersion"

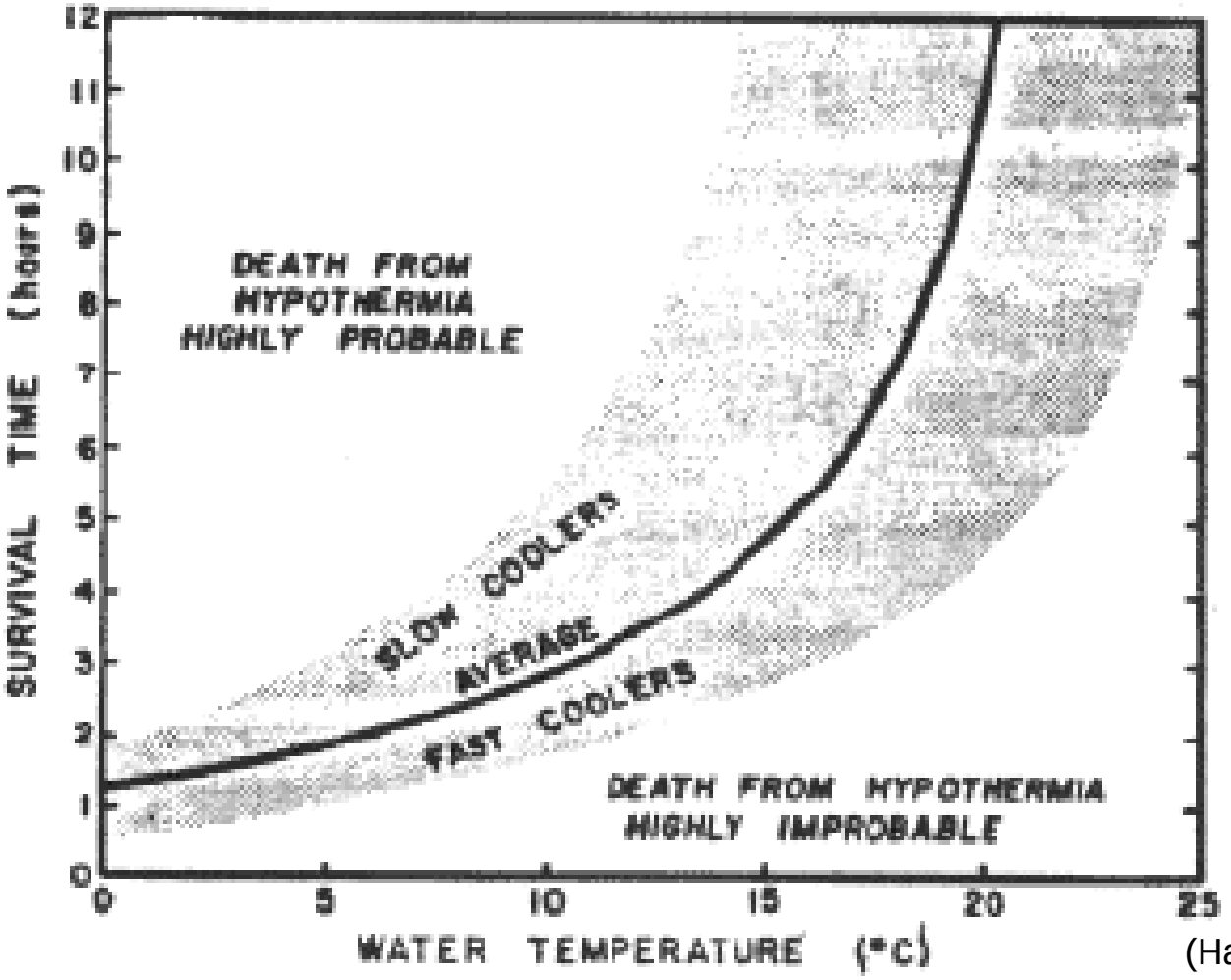
Questions

1. "If you fall into ice water, with regular winter clothing on, how long do you think it would take to become hypothermic?"

2. "How long until cold water immersion is life threatening?"

(Giesbrecht & Pretorius, 2008)

Survival time: hypothermia



(Hayward, 1975)

“The shocking reality”

Think you’re a good swimmer? It may not matter if you suddenly and unexpectedly end up in the frigid coastal and inland waters. Every year, dozens of swimmers and boaters drown in lakes, rivers and coastal waters.

But it may surprise you that many victims don’t die as a result of poor swimming skills or the effects of hypothermia, but from the immediate effects of cold water immersion, or cold water shock

(Coast Guard News, 2007)

Physiological considerations: humans are homeotherms

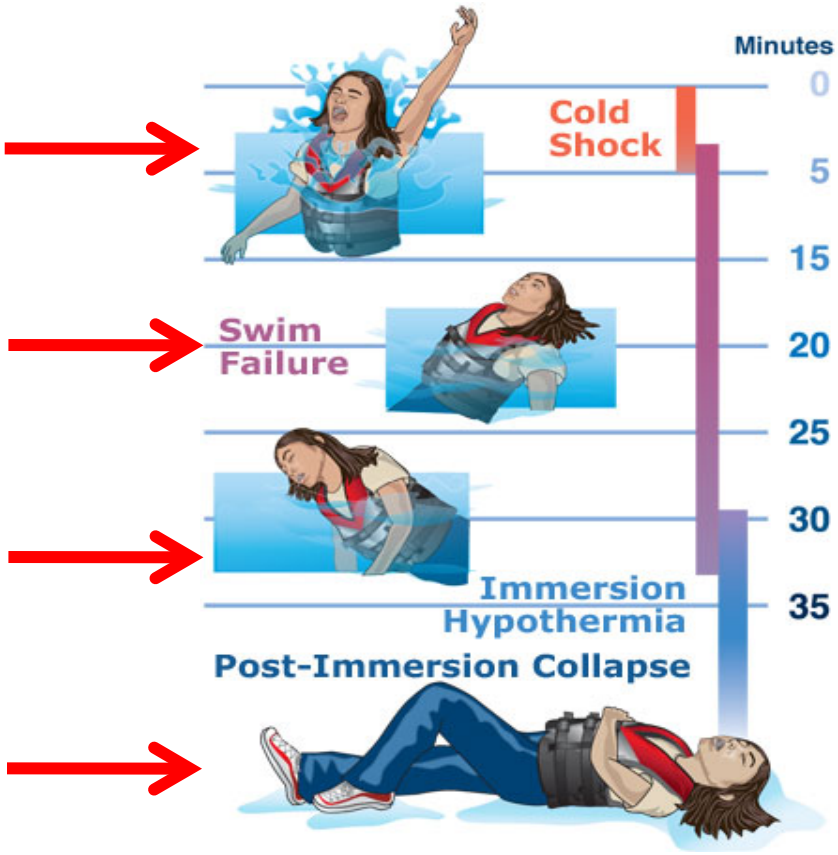
→ **Thermoneutral water temperature** (naked person): 35 – 35.5 °C
= environmental temperature at which the body can simply maintain normal deep body temperature

→ **Thermal conductivity**:
= **individuals cool 4 – 5 times faster in water compared to air at the same temperature.**

→ **High density of water:**
= head-out immersion in thermoneutral water can produce profound physiological alterations in the circulation, heart, lungs (respiration), and the gut.

Cold water immersion/submersion

- **Initial responses: 3 – 5 minutes**
  Skin cooling
- **Short term responses: 5 – 30 minutes**
  Superficial nerve and muscle cooling
- **Long term responses: > 30 minutes**
  Deep tissue cooling
- **Post immersion:**
  Deep tissue cooling



(Golden & Hervey, 1981; Golden & Tipton, 1981 & 2002; Tipton et al., 1999; Tipton & Golden, 2006; Mantoni et al., 2007; Shattock & Tipton, 2012)

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Recommendations for Surviving Cold Water Immersion

→ Cold shock protection:

- protective clothing;
- auto-inflating lifejacket;
- habituation (physiological & psychological [anxiety]);
- aerobic fitness.

→ Prevent swimming failure:

- make your decision to swim or not early during immersion, directly after cessation of the cold shock responses.

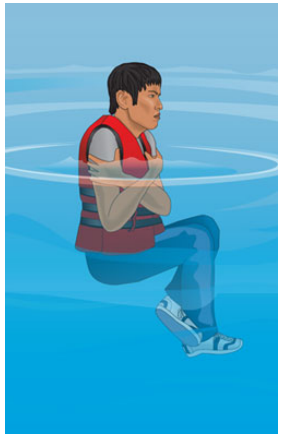
→ Decrease the rate of heat loss*** to prevent hypothermia by:

- heat escape lessing position (HEAT);
- huddling in small group(s).

→ Avoid rescue collapse during rescue and transportation***.

Recommendations for Surviving Cold Water Immersion

Decrease the rate of heat loss!



Source: www.hunter-ed.com

“HELP”

“HUDDLE”

Avoid rescue collapse during rescue and transportation!

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Working in extreme environments

Thermoregulation

Sleep

Seasickness


A lifetime inspired by the ocean:
marine environmental effects on human physiology
Thank you!