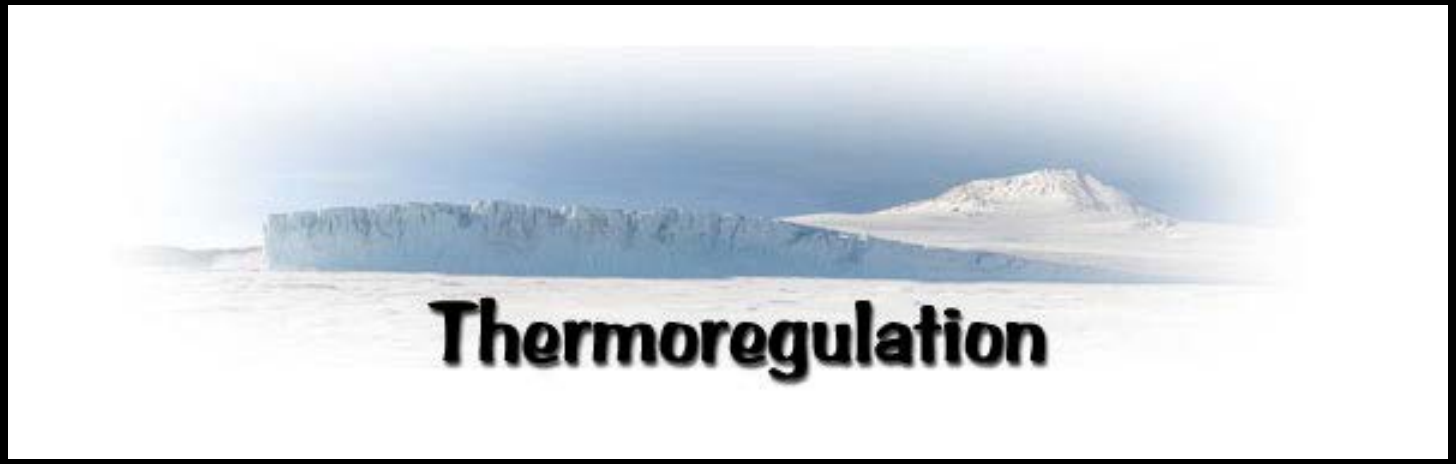

Sports participation in extreme (cold) environments

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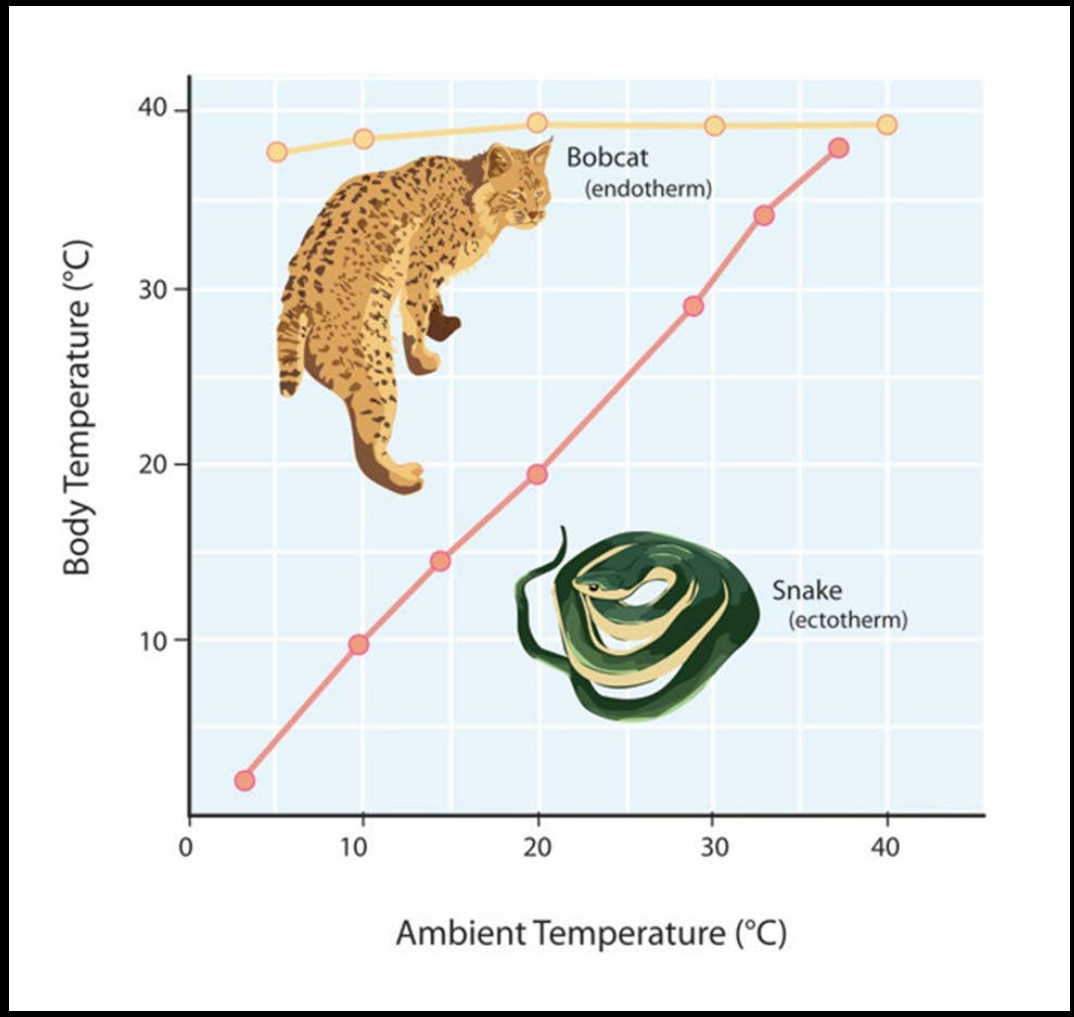
College of Education
Georgia State University
Atlanta, Georgia USA

2014 NPC Team Physician Workshop
Sochi, Russia


My paws are freezing!
Buddy, you think you've got problems!

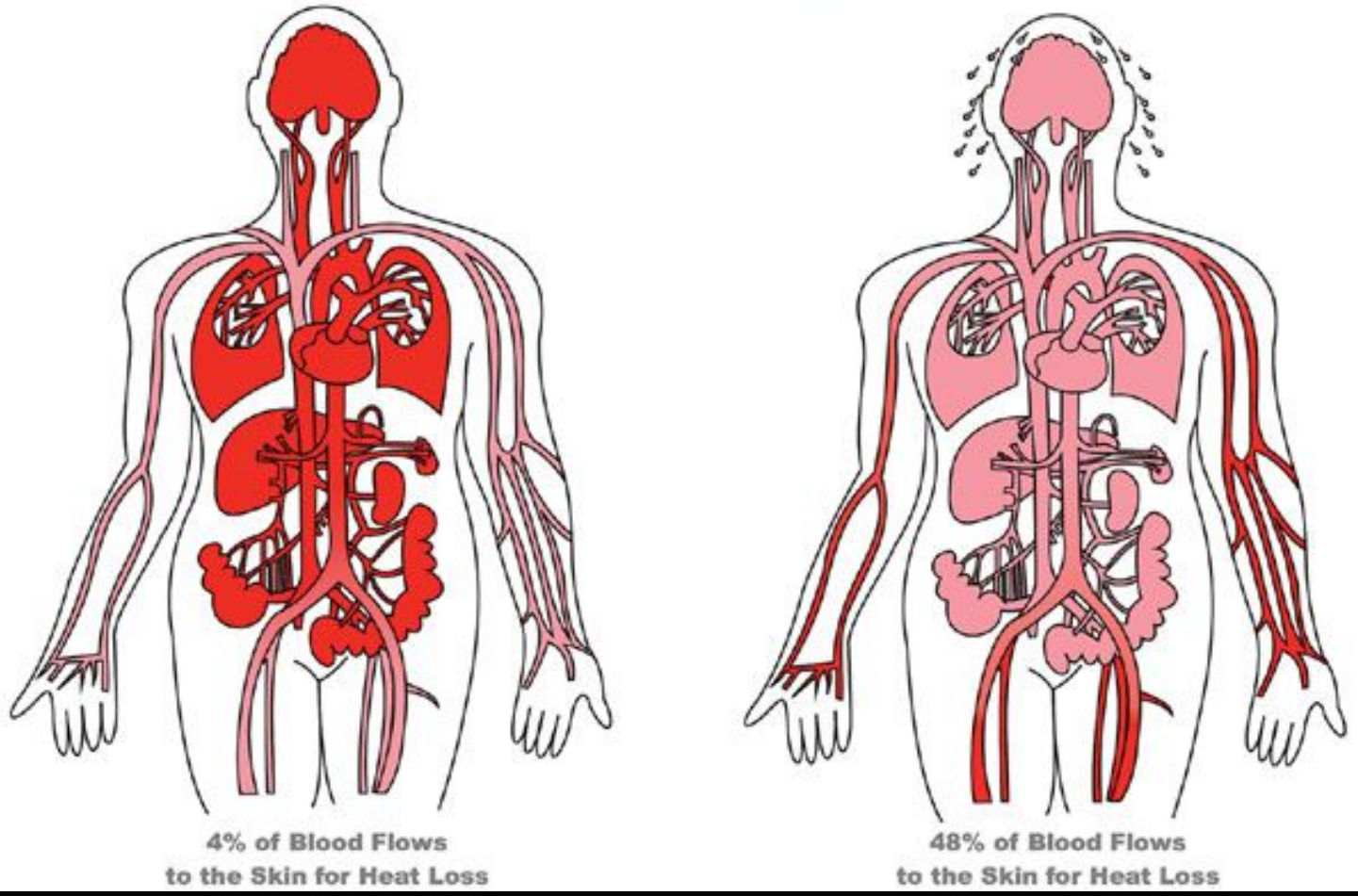
There are two primary responses to fluctuating ambient temperatures exhibited by animals: ectotherms (poikilothermy) and endotherms (homeothermy). Because ectotherms lack the physiological means to generate heat, the body temperature of these animals tends to conform to that of the outside environment in the absence of any behavioral intervention.

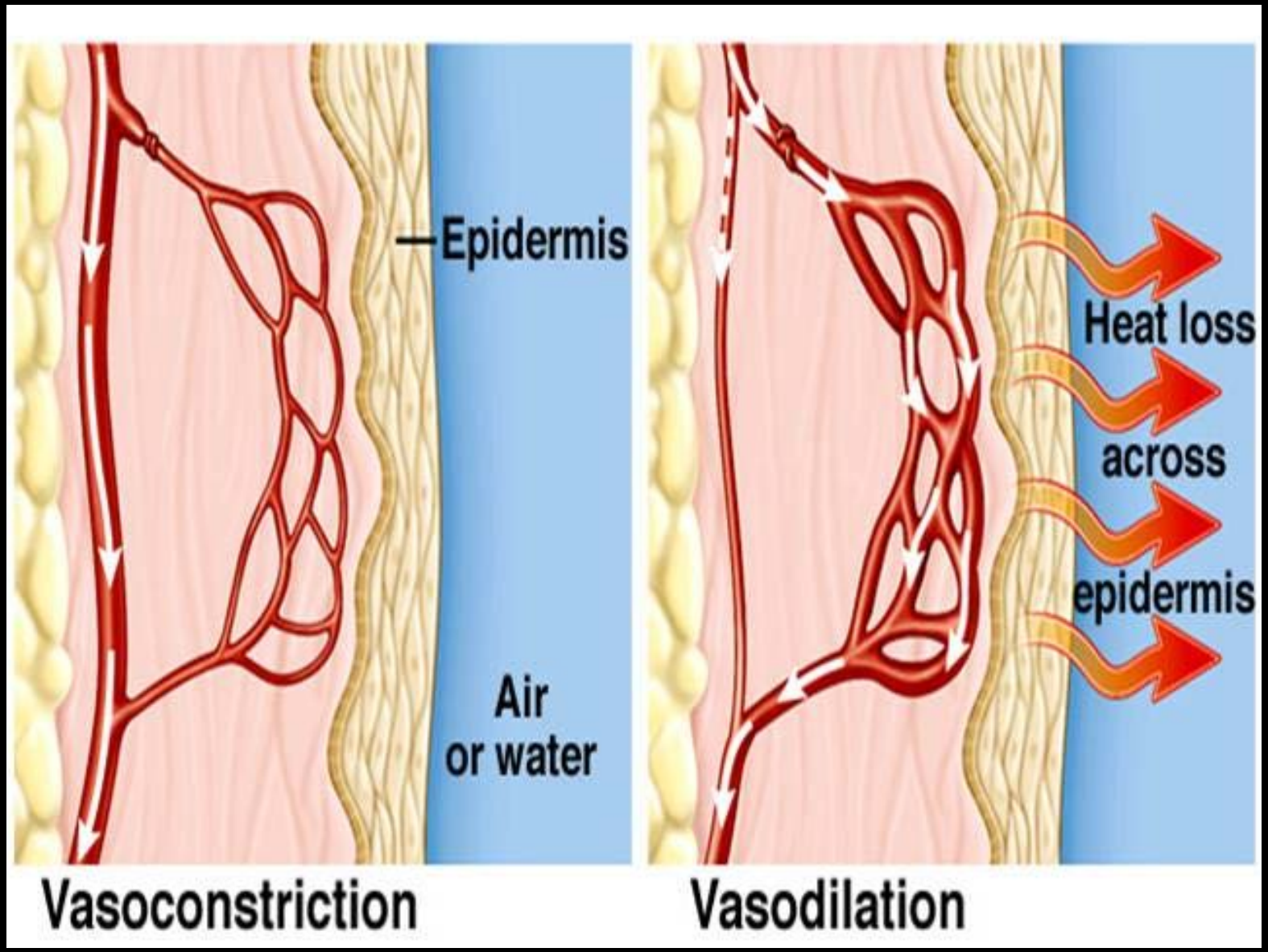
Examples of ectotherms include the "cold-blooded" animals such as most fish, amphibians, and reptiles. Endotherms have specific physiological adaptations for regulating their body temperatures; body temperatures of endotherms do not fluctuate as much as those of ectotherms. All endotherms maintain high body temperatures in the range of 36 to 42°C and include the "warm-blooded" animals, such as birds and mammals.

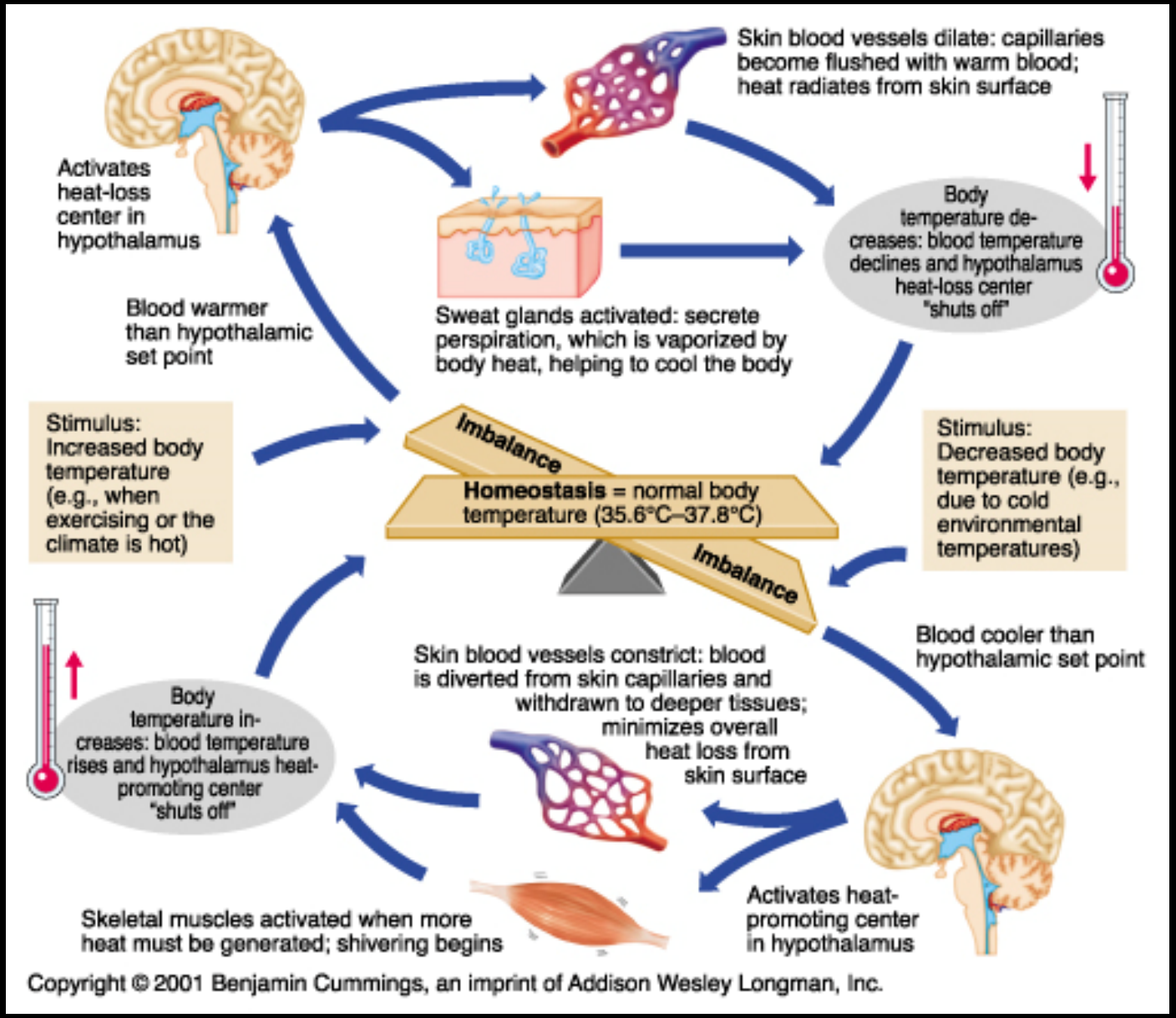


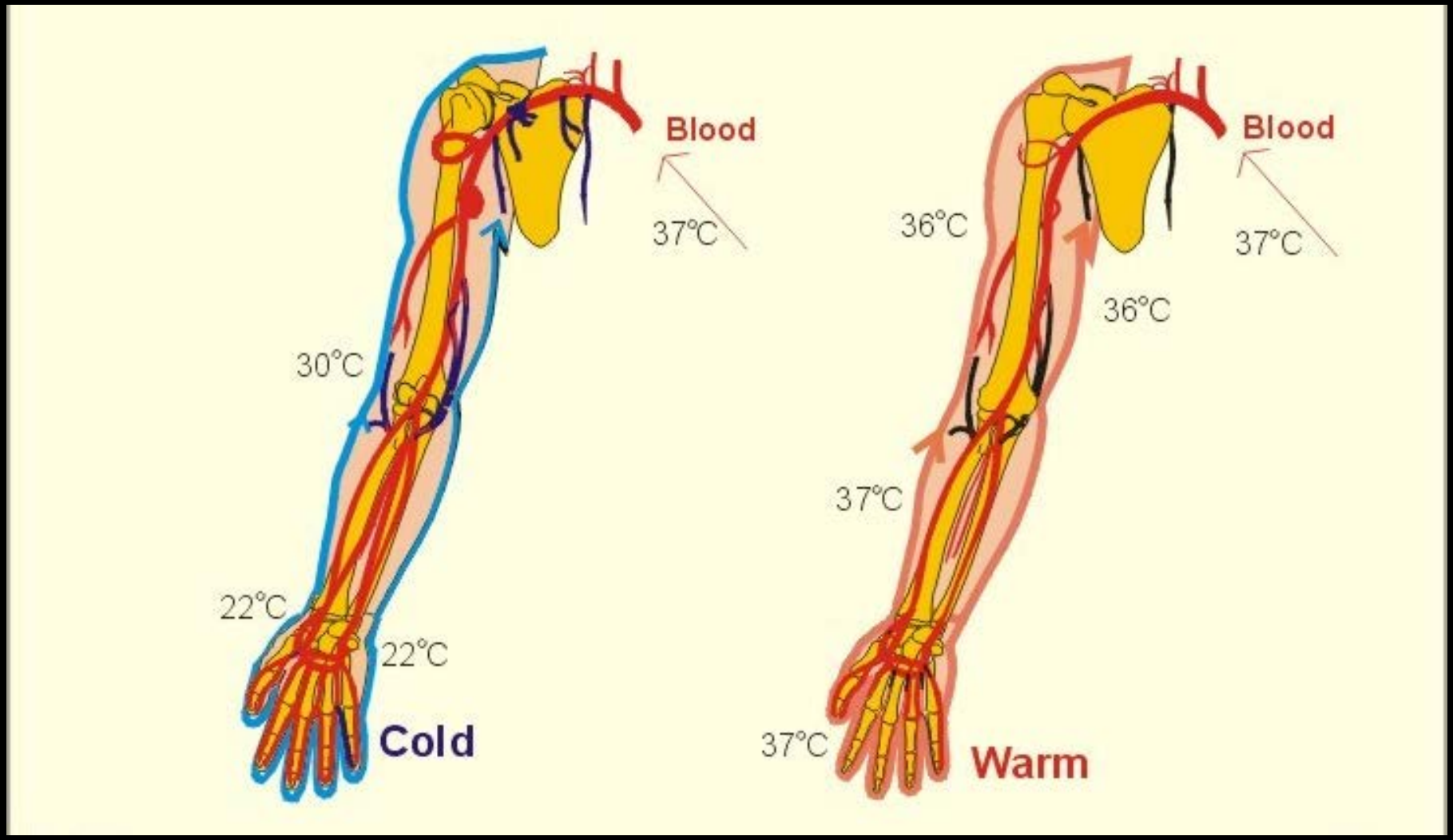

Hypothermia

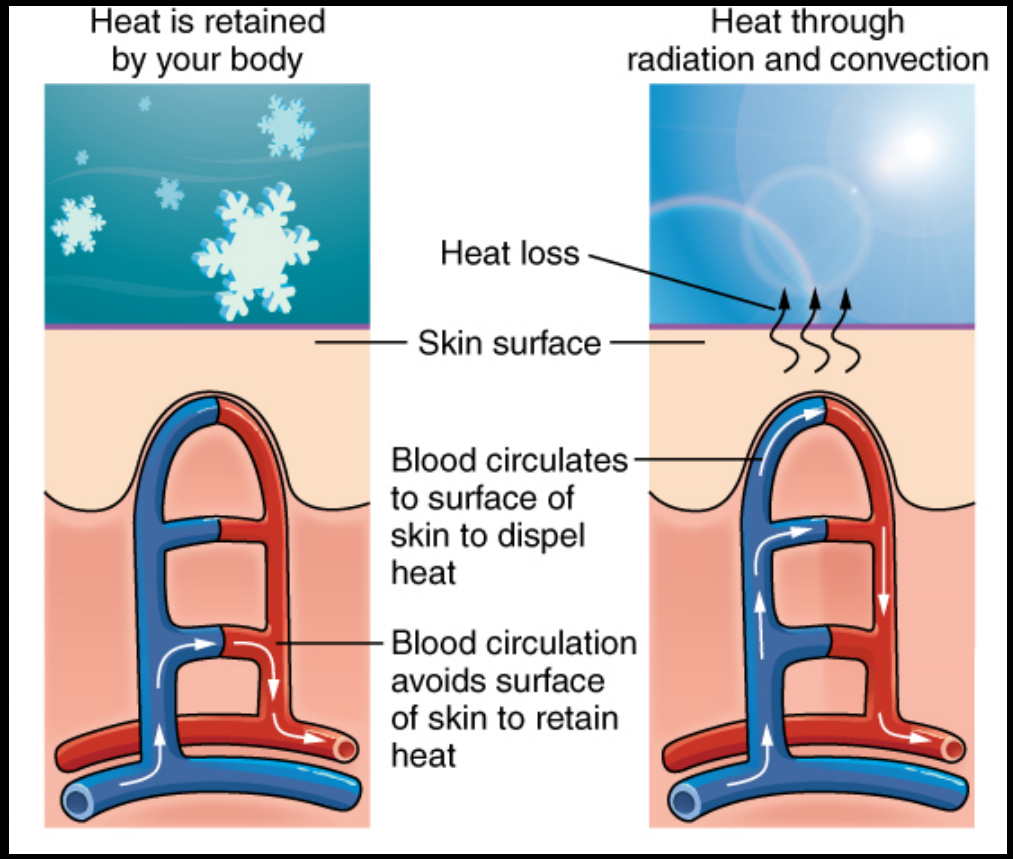
Thermoregulation of the Human Body




Epidermis
Air
or water
Heat loss
across
epidermis
Vasoconstriction
Vasodilation




Blood
37°C
30°C
22°C
22°C
Cold
Blood
36°C
37°C
36°C
37°C
37°C
Warm



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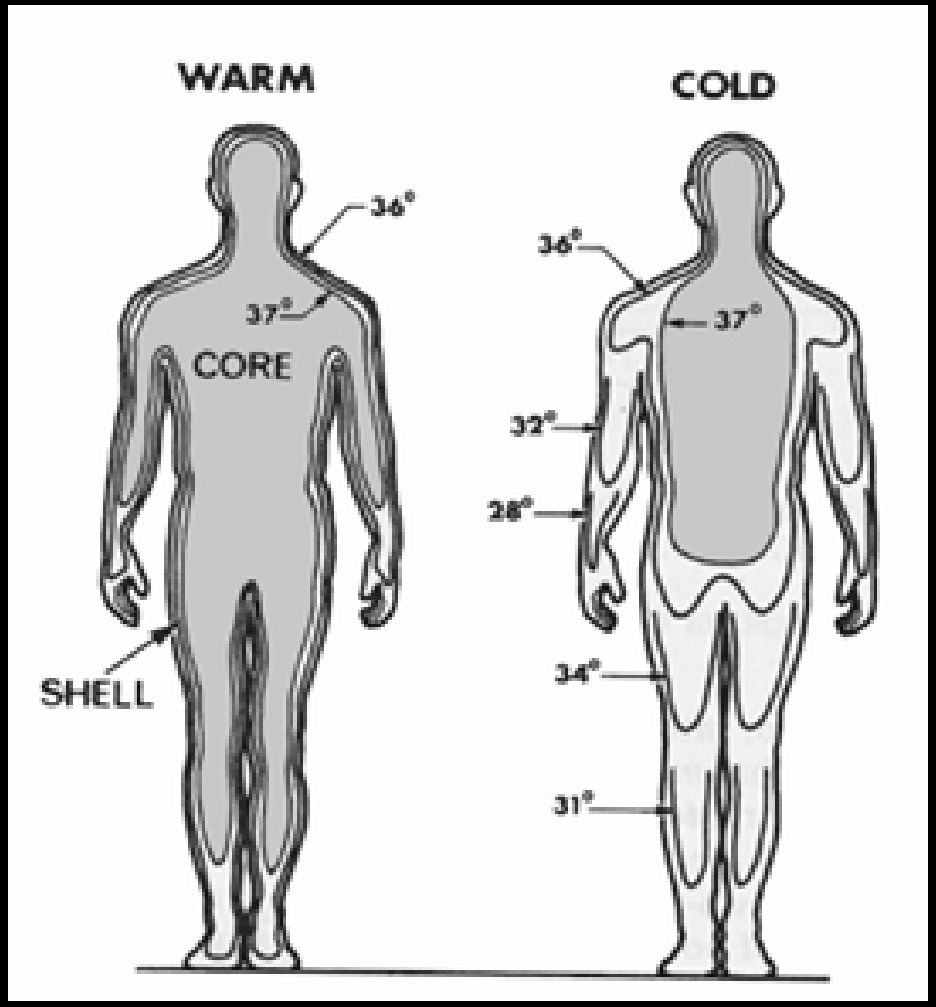
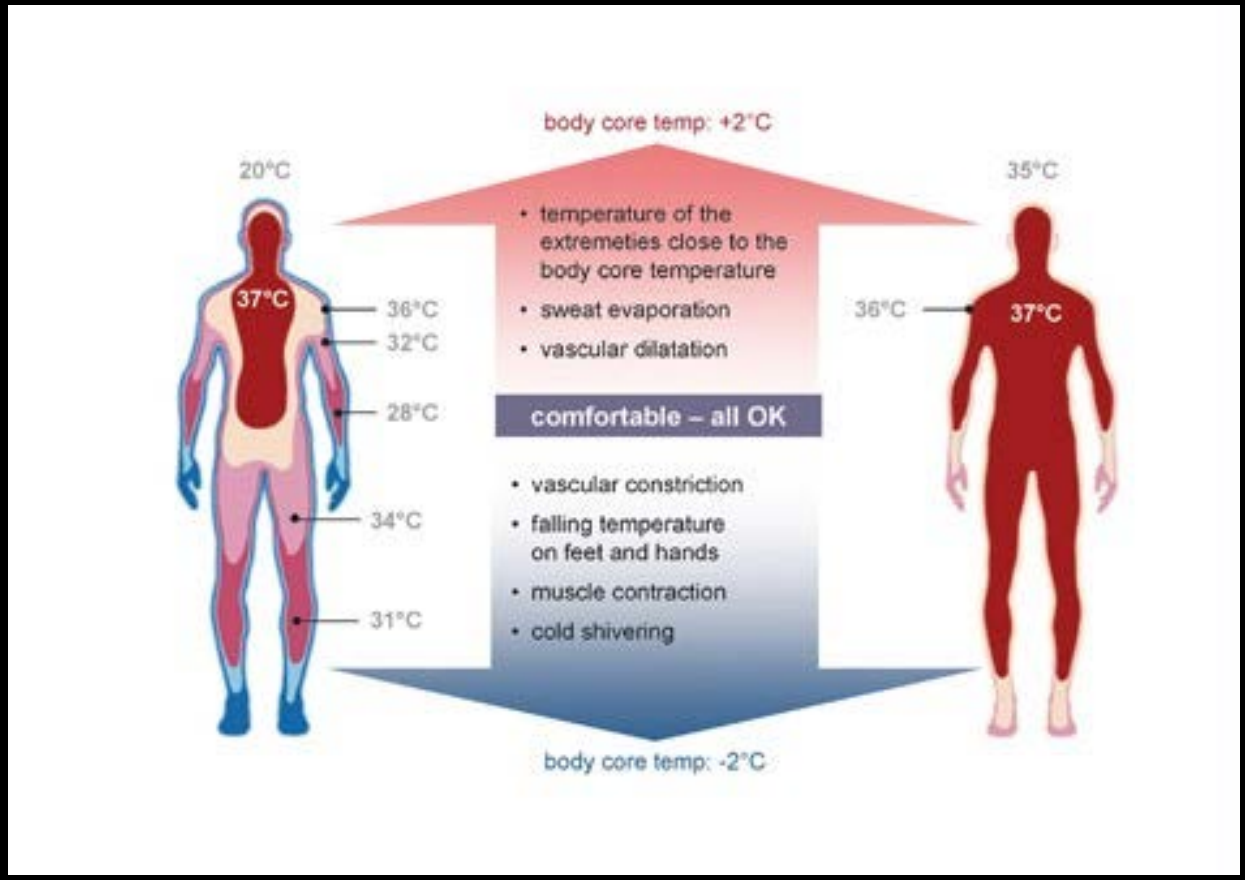

WARM
COLD
34°
37°
CORE
SHELL
36°
37°
32°
28°
34°
31°

HOT	COLD
Vasodilation Arterioles dilate (enlarge so more blood enters skin capillaries and heat is lost	**Vasoconstriction** Arterioles get smaller to reduce blood going to skin; keeping core warm
Sweating Sudorific glands secrete sweat which removes heat when water changes state.	**Shivering** Rapid contraction and relaxing of skeletal muscles; heat produced by respiration.
Pilorelaxation The hairs on skin flatten.	**Piloerection** The hairs on skin stand up.
Stretching Out By opening up, the body is a larger surface area.	**Curling Up** Making yourself smaller so there is a smaller surface area.


body core temp: +2°C
20°C
35°C
37°C
36°C
32°C
28°C
34°C
31°C
36°C
37°C
• temperature of the extremeties close to the body core temperature
• sweat evaporation
• vascular dilatation
comfortable – all OK
• vascular constriction
• falling temperature on feet and hands
• muscle contraction
• cold shivering
body core temp: -2°C

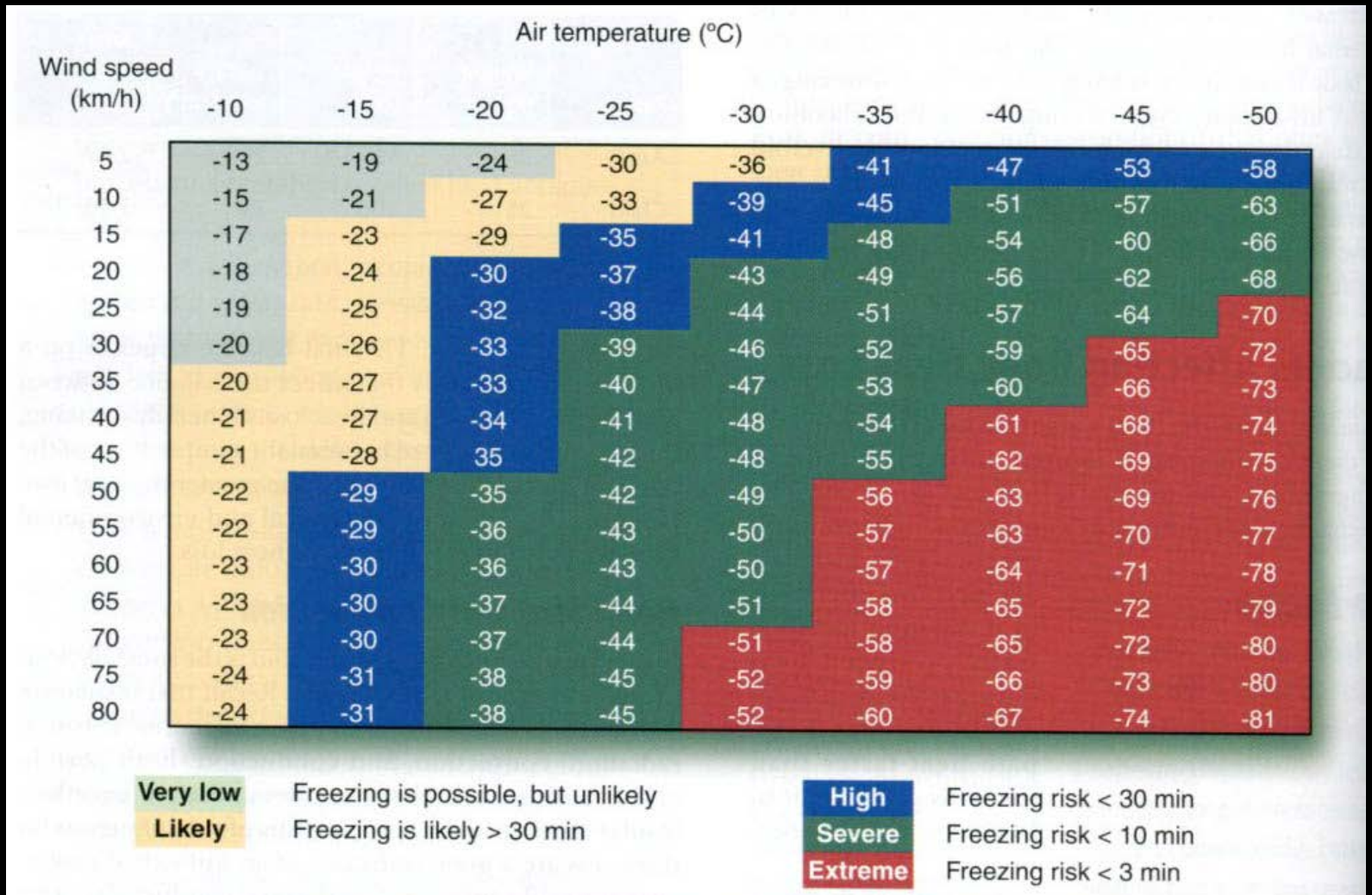


Figure 11.14 Windchill equivalent temperature chart showing various combinations of temperature and wind speed that result in the same cooling power as that seen with no wind. For example, a wind speed of 20 km/h at –10 °C would result in the same heat loss as –30 °C with no wind. Also shown in the figure is the risk of tissues freezing as windchill—the cooling power of the environment—increases.

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AMERICAN COLLEGE of SPORTS MEDICINE

Prevention of Cold Injuries during Exercise

This pronouncement was written for the American College of Sports Medicine by John W. Castellani, Ph.D., FACSM (co-chair); Andrew J. Young, Ph.D., FACSM (co-chair); Michel B. Ducharme, Ph.D.; Gordon G. Giesbrecht, Ph.D.; Ellen Glickman, Ph.D., FACSM; and Robert E. Sallis, M.D., FACSM.

www.acsm-msse.org

Stages of Hypothermia

Stage	Core Temperature	Signs and Symptoms
Mild	97–95° F (36–35° C)	•Shivering begins—can be mild to severe •Unable to perform complex tasks with hands •Hands numb
Moderate	95–90° F (35–32° C)	•Shivering becomes uncontrollable and violent •Changes in mental status, mild confusion, higher reasoning becomes impaired; eventually becomes withdrawn, may show "paradoxical undressing"—person imagines they are warm and takes off clothing •Muscle incoordination becomes apparent, movements slow and labored, stumbling pace
Severe	90–85° F (32–29° C)	•Shivering stops •Skin blue or puffy •Unable to walk, confusion, muscles become rigid •Incoherent/irrational behavior, becomes semiconscious •Pulse rate decreases •Respiration rate decreases
	85–80° F (29–27° C)	•Unconscious •Heartbeat and respiration erratic •Pulse may not be palpable •Cardiac and respiratory failure

Core Temperature and associated physiological changes that occur as core temperature falls

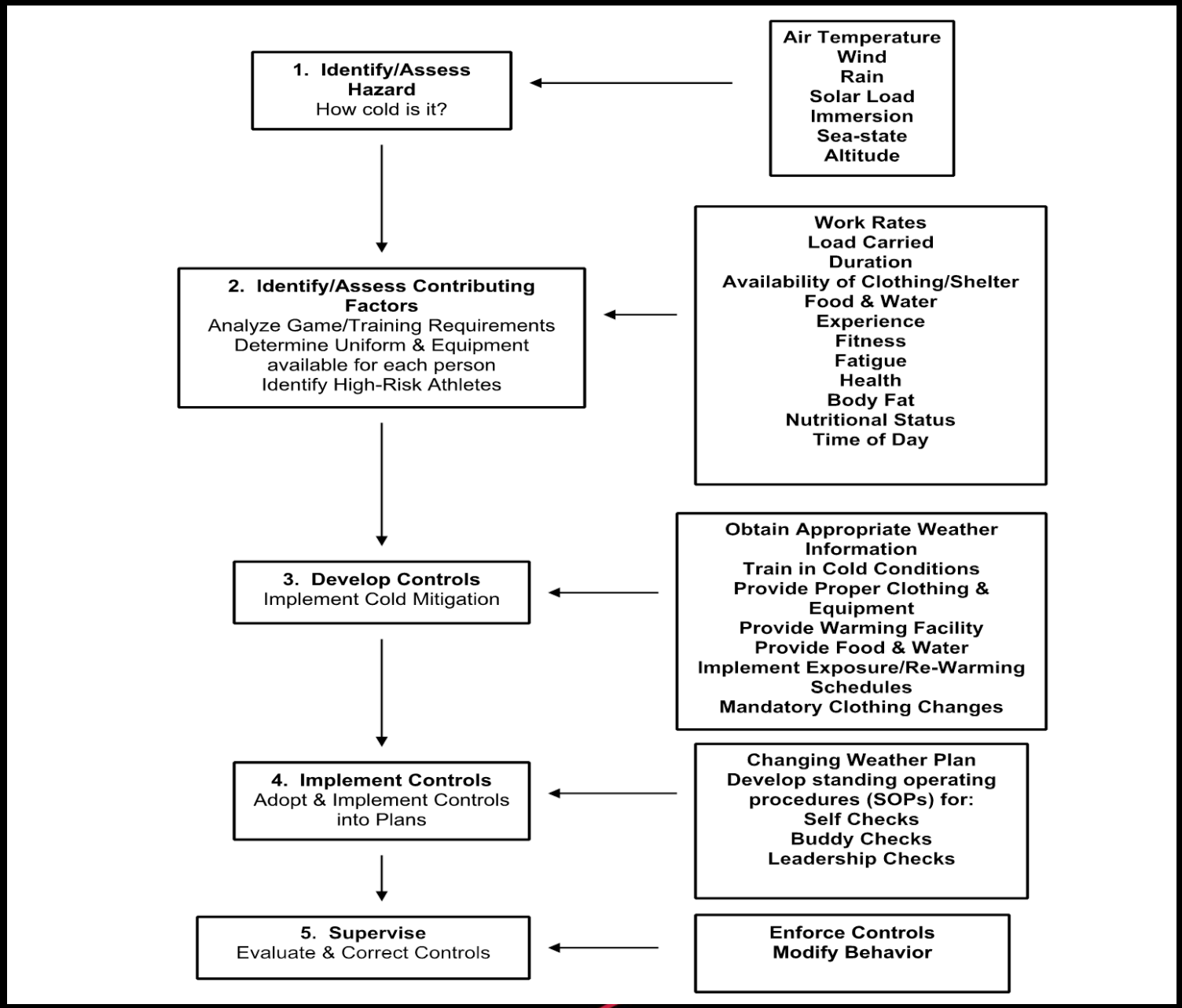
Stage	°F	°C	Physiological Changes
Normothermia	98.6	37.0	
Mild Hypothermia	95.0	35.0	Maximal shivering, increased blood pressure
	93.2	34.0	Amnesia, poor judgment, behavior change
	91.2	33.0	Ataxia, apathy

Stage	°F	°C	Physiological Changes
Moderate Hypothermia	89.6	32.0	Stupor
	87.8	31.0	Shivering ceases, pupils dilate
	85.2	30.0	Cardiac arrhythmias, decreased cardiac output
	85.0	29.0	Unconsciousness

Stage	°F	°C	Physiological Changes
Severe Hypothermia	82.4	28.0	Ventricular fibrillation likely, hypoventilation
	80.6	27.0	Loss of reflexes and voluntary motion
	78.8	26.0	Acid – base disturbances, no response to pain
	77.0	25.0	Reduced cerebral blood flow
	75.2	24.0	Hypotension, bradycardia, pulmonary edema
	59.2	15.2	Lowest infant survival from accidental hypothermia
	56.7	13.7	Lowest adult survival from accidental hypothermia

Death Pronouncement

"…a person is not dead
until they are warm and dead



ACSM 2006
Risk Management Strategy

Risk Management Strategy

- Exercising in water and rain significantly increases the risk for developing hypothermia
- Individuals with high combined values of subcutaneous fat thickness, %fat, and muscle mass can maintain core temperature better than individuals with less fat and muscle

Risk Management Strategy (cont)

- Core temperature responses to cold exposure between average men and women are primarily attributed to differences in body composition.
- Older individuals (>60 yr) are at an increased risk of hypothermia due to blunted physiological and behavioral responses to cold.

Risk Management Strategy (cont)

- Children are at a greater risk of hypothermia than adults due to differences in body composition.
- Hypoglycemia impairs shivering and increases the risk for hypothermia.

Risk Management Strategy (cont)

- Physical fitness and training do not improve thermoregulatory responses to cold.
- Physical fitness does allow someone to exercise for a longer period at a higher metabolic rate, and may contribute to maintenance of normal core temperatures.

Risk Management Strategy (cont)

- Clothing insulation requirements during exercise are a function of metabolic rate and ambient temperature. Layering provides the most flexibility to adjust insulation to prevent sweating, overheating, underdressing, and remaining dry in wet conditions.

Risk Management Strategy (cont)

- Cold environments can increase energy expenditure and may cause fluid losses; dehydration does not impair vasoconstriction or shivering, thus dehydration does not increase susceptibility to cold injuries.

Risk Management Strategy (cont)

- The risk of frostbite is less than 5% when the ambient temperature is above -15°F (5°C), but increase safety surveillance of athletes is warranted when the wind chill factor (WCF) falls below -27°C (-18°F) since, in these conditions, frostbite can occur in 30 minutes or less in exposed skin.

Risk Management Strategy (cont)

- Mortality rates are higher in winter compared to the summer months for most populations, however hypothermia only accounts for a very minor percentage of these deaths. Most winter deaths are due to ischemic heart disease, stroke, and respiratory disease.
- Mortality increases in regions with relatively warm winters that have cold snaps and in people who are less active outdoors.

SUMMARY

1. The greatest occurrence of hypothermia happens when people are not prepared for it, that is, when people are not expecting it (rainy weather in spring/summer/fall; ocean/lake swimming on a hot day in spring and early summer).

2. Cold, wet, and windy weather poses the greatest risk for developing hypothermia. Heat loss is much greater in these conditions and if the exercise intensity is not high enough to match heat loss due to fatigue or if fatigue occurs before cold exposure, an individual may be more susceptible to hypothermia.

SUMMARY

3. Exercise can be safely performed in cold weather if coaches, athletes, and medical personnel, and officials follow a risk management strategy.

3. Successful implementation of this strategy includes asking the following questions:

SUMMARY

- ✓ How cold is it?
- ✓ What clothing protection is available?
- ✓ Who is at risk for a cold-weather injury?
- ✓ What is the health condition of the athlete?
- ✓ What effective strategies do I have available to mitigate the cold stress and injury risk?
- ✓ Is there a contingency plan in place to deal with changing conditions?

terima kasih

grazie

감사합니다

chnorakaloutioun

kiitos

tak

go raibh maith agaibh

Баярлалаа

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благодарам

Дзякую

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