

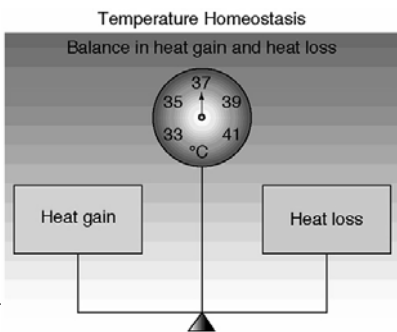
Exercise and the Environment

High Temperature/Humidity
Low Temperature/Wind

Outline

1. Types of heat loss
2. Combined effect of temperature and humidity
3. List guidelines for exercising in the heat
4. Heat injuries
5. Heat acclimatization
6. Effects of cold and wind
7. Exercise in cold environments

Temperature Homeostasis



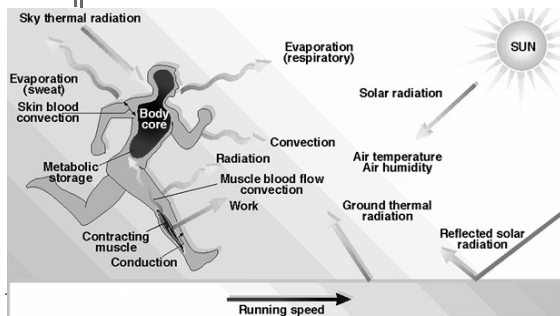
Heat Production

- Basal metabolism or basal metabolic rate
- Additional heat production:
 - Voluntary = Exercise – 70-80% of energy released as heat
 - Involuntary
 - Digestion (“thermic effect of food”)
 - Shivering
 - Uncoupling proteins (non shivering thermogenesis) e.g., brown fat
 - Action of hormones such as T3/T4 and catecholamines on cellular metabolism

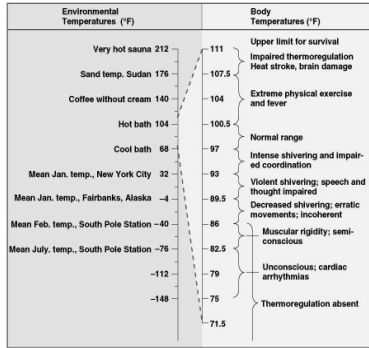
Exercise in the Heat

- Maximizing heat loss is essential
 - Evaporation
- Guidelines for exercising
- Optimizing clothing when exercising in the heat
- Heat acclimatization
- Heat injury

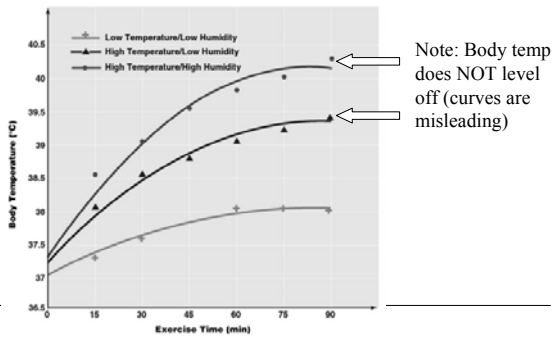
Heat Exchange During Exercise



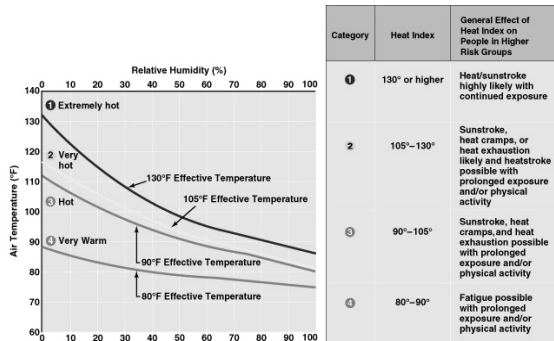
Environmental temperature extremes (examples) Effects of alteration in body temperature



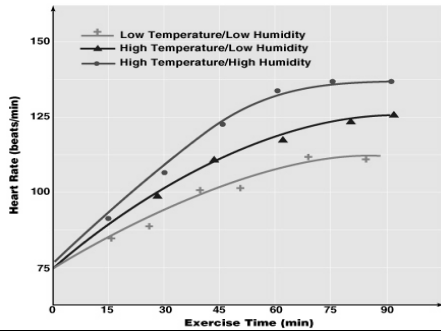
Body temperature during prolonged exercise in various temperature/humidity environments.



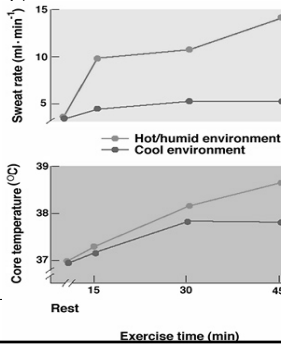
The concept of “heat index” or “effective” temperature.



Heart rate during prolonged exercise in various temperature/humidity environments.




Core Temperature and Sweat Rate During Exercise in Heat/Humidity




Consequences of Hyperthermia

- High heart rate
- Redistribution of blood flow to skin, respiratory system
- Higher lactate production
- Impaired performance
- Possibly heat exhaustion or heat stroke



Heat Acclimatization

- Doesn't happen overnight – requires a few days
 - Increased plasma volume
 - Earlier onset of sweating (threshold)
 - Higher sweat rate (gain or slope)
 - Reduced sodium chloride loss in sweat
 - Reduced skin blood flow
 - Increased synthesis of heat shock proteins
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Hydration is the key to exercise in heat

- Dehydration leads to shorter endurance time in the heat
 - Hyperhydration leads to improved endurance time in the heat
 - Eu- or hyperhydration will help prevent reduction in stroke volume
 - If severe, dehydration can lead to cessation of sweating and heat shock
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Dehydration

- 0.5% weight loss – Thirst
 - 2% weight loss – More thirst, discomfort, appetite loss
 - 5% weight loss – Difficulty concentrating
 - 8% weight loss – Dizziness, labored breathing in exercise, confusion
 - 10% weight loss – Decreased blood volume, possible kidney failure
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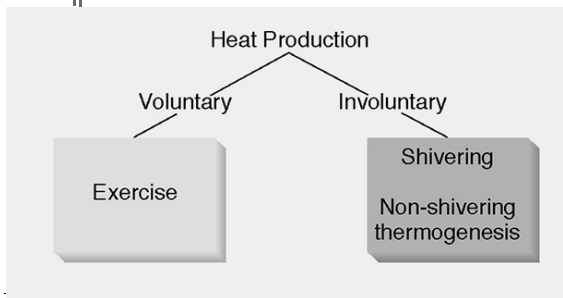
Exercise in the Cold

- Maintaining body temperature is essential
- Proper clothing is critical
- Wind decreases the “effective” temperature (wind chill effect)



(c) Dimitri Barton


Heat Production



The “wind-chill” index.

		Ambient Temperature, °F*														
		40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30
		Effective Temperature, °F*														
Wind Speed, mph	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30
	5	37	33	27	21	16	12	6	1	-6	-11	-15	-20	-26	-31	-35
	10	28	21	16	9	4	-2	-9	-15	-21	-27	-33	-38	-46	-52	-58
	15	22	16	11	1	-5	-11	-18	-25	-36	-40	-45	-51	-58	-65	-70
	20	18	12	3	-4	-10	-17	-25	-32	-39	-46	-53	-60	-67	-76	-81
	25	16	7	0	-7	-15	-22	-29	-37	-44	-52	-59	-67	-74	-83	-89
	30	13	5	-2	-11	-18	-26	-33	-41	-48	-56	-63	-70	-79	-87	-94
	35	11	3	-4	-13	-20	-27	-35	-43	-49	-60	-67	-72	-82	-90	-98
	40	10	1	-6	-15	-21	-29	-37	-45	-53	-62	-69	-76	-85	-94	-101

*C = 0.556 (°F - 32)
Convective heat loss at wind speeds above 40 mph have little additional effect on body cooling.



Summary

- Evaporation is the primary means of heat loss during exercise.
 - Guidelines for exercise in the heat should be heeded.
 - Heat acclimatization reduces the chance of heat injury.
 - Short-term exercise in the cold doesn't pose a serious threat to heat balance.
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