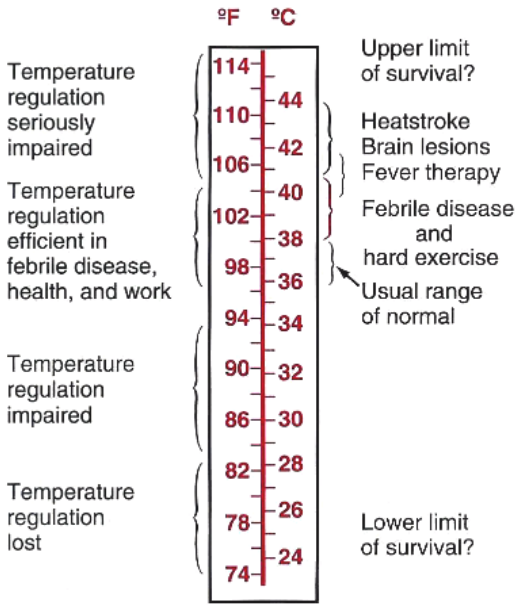
Unit I – Problem 6,7 – Physiology: Body Temperature Regulation and Fever

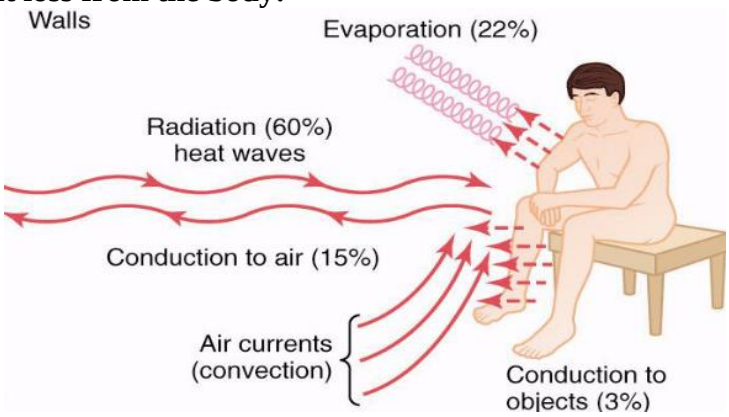
- **Core temperature vs skin temperature:**
  - **Core temperature**: temperature of deep tissues which is relatively constant (± 1 F under normal conditions).
  - **Skin temperature**: it differs widely because it depends on the temperature of the environment.
- **Normal body temperature:**
  - Normally = 37 C. Notice that extremities are generally cooler than the rest of the body.
  - Rectal temperature represents the core temperature of the body and it is not affected by changes in environment temperature.
  - Morning oral temperature = 36.7 C (± 0.2 C). Oral temperature is (0.5 C) less than rectal temperature and it is affected by many factors:
    - ✓ Ingestion of hot or cold fluids.
    - ✓ Gum chewing.
    - ✓ Smoking.
    - ✓ Mouth breathing.
  - The temperature of the scrotum = 32 C (less than normal body temperature because this is more suitable for spermatogenesis: production of sperms).
  - In females, basal temperature rises at time of ovulation (usually day 14 of he menstrual cycle).
  - **Normal body temperature range:**



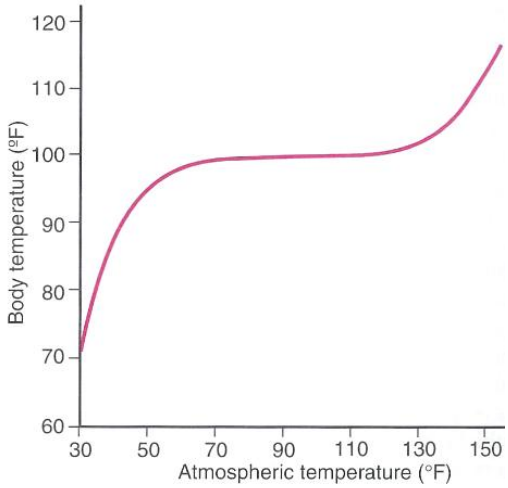
  - Rate of heat production by a normal 70 kg person can vary from 75-80 kcal/hour when sitting to more than 1400 kcal/hour at maximum rates of exercise.
- **Thermoregulation:**
  - The body has well developed mechanisms for balancing heat production with heat loss.

Heat production	Heat loss
Muscular activity	Radiation
Basic metabolic processes	Conduction and convection
Food intake	Evaporation of sweat
	Respiration
	With urine and feces

- **Physics of heat loss from the body:**



- **From the graph below you will notice that core temperature remains stable despite wide variations in atmospheric temperature.**

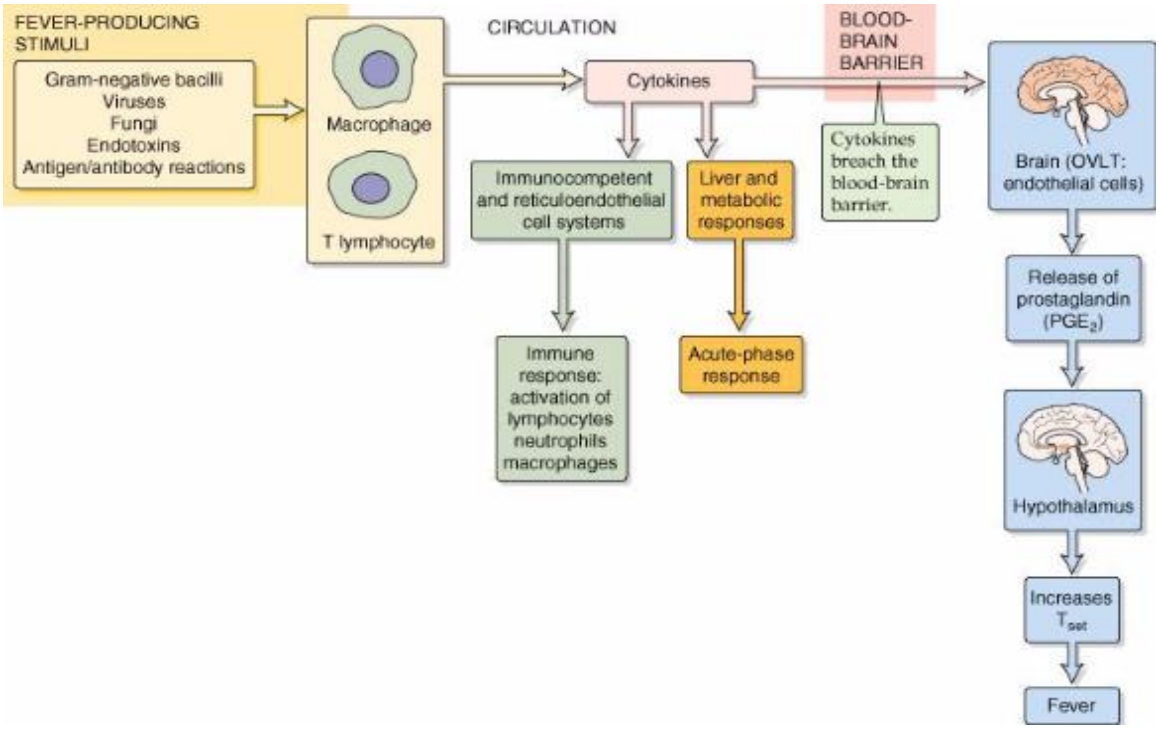


- **How is heat lost from the body when the environmental temperature is greater than the body temperature?**
  - ✓ <u>When environmental temperature rises, there will be vasodilation which will increase heat conductance through the skin.</u>
  - ✓ <u>Sweating:</u>
    - ❖ Sweat glands are innervated by acetylcholine-secreting sympathetic nerves.
    - ❖ Rate of sweat production varies from 0 to 1.5 L/h
    - ❖ Notice that 1L of water evaporated from the surface of the skin can lead to heat loss of 580 kcal.
    - ❖ *Sweat gland:*
      - ➢ Primary secretion: mainly protein-free filtrate.
      - ➢ In the ducts there will be absorption of sodium and chloride ions from the primary secretion.

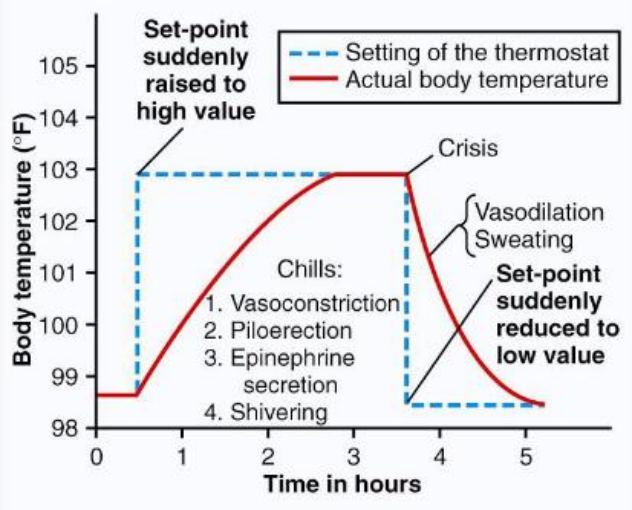
Temperature decreasing mechanisms	Temperature increasing mechanisms
Vasodilation: transfers heat to the skin	Vasoconstriction
Sweating: evaporative heat loss	Piloerection: usually not important in humans
Decreased heat production: shivering and chemical thermogenesis are inhibited	Increased heat production: shivering; sympathetic excitation of heat production; thyroxine secretion

- **How is body temperature detected?**
  - ✓ Hypothalamus temperature control center:
    - ❖ Preoptic area of anterior hypothalamus.
    - ❖ Heat sensitive and cold sensitive neurons.
  - ✓ Skin and deep body temperature receptors:
    - ❖ Mainly detecting cool temperatures.
    - ❖ Function to prevent hypothermia.
  - ✓ Role of posterior hypothalamus:
    - ❖ Receives input from anterior hypothalamus and peripheral temperature receptors to elicit mainly heat producing and heat conserving reactions.
- **Response to cold environment:**
  - ✓ Increase in sympathetic activity:
    - ❖ Stimulates chemical thermogenesis (NE and E → ↑metabolic rate).
    - ❖ Initiates piloerection.
    - ❖ Shivering thermogenesis.
  - ✓ Notice that long-term cold exposure stimulates hypothalamus to produce more Thyroid Releasing Hormone (TRH).
- **Response to hot environment:**
  - ✓ Vasodilation of cutaneous circulation.
  - ✓ Sweating: regulates sensible evaporative heat loss; critical for cooling in environment hotter than body.
  - ✓ Decreased heat production.

- **Fever: resetting the set-point T^0**
  - **Pyrogens (bacteria and degenerating tissues) can directly reset set-point.**
  - **Pyrogens can indirectly reset set-point:**
    - ✓ Interleukin-1 (IL-1) released from phagocytes following phagocytosis of blood-borne pyrogens.
    - ✓ (IL-1) raises set-point by increasing prostaglandin production (mainly E_2).
- **Pathogenesis of fever:**



- **Time course of fever:**



- **Heat stroke:**
  - **It occurs when body temperature rises above 106-108 F:**
    - ✓ Malfunction of preoptic temperature control center: sweating ceases.
    - ✓ Rising body temperature increases metabolism which generates more heat.
  - **Symptoms include:**
    - ✓ High body temperature: ≥ 40C
    - ✓ Altered mental state or behavior.
    - ✓ Alteration in sweating:
      - ❖ *Heat stroke brought on by hot weather*: dry skin.
      - ❖ *Heat stroke brought on by strenuous exercise*: moist skin.
    - ✓ Nausea and vomiting.
    - ✓ Flushed skin.
    - ✓ Rapid breathing.
    - ✓ Racing heart rate.
    - ✓ Headache.
- **Heat exhaustion:**
  - **Due to circulatory problems:**
    - ✓ Excessive loss of salt and water due to severe sweating.
    - ✓ Heat cramps.
    - ✓ Vasodilation.
    - ✓ Venous return compromised.
    - ✓ Circulatory collapse.
    - ✓ Notice that body temperature may not be very high.
  - **It is common in elderly, athletes and soldiers when doing heavy exercise in hot environment, persons taking drugs that inhibit sweating and/or vasodilation such as atropine.**
- **Acclimatization to heat:**
  - **Increased tolerance to hot and humid environment occurs in 5-10 weeks.**
  - **Physiological changes:**
    - ✓ ↑ in the maximal rate of sweating.
    - ✓ ↓ loss of salt in the sweat and urine.
    - ✓ ↑ plasma volume.