Factors causes heat loss from the body

- The actual amount of heat lost by **radiation, convection**, **evaporation of sweat** and **respiration** depends on several factors, which are
- (1) the temperature of the surroundings
- (2) the temperature of the body
- (3) humidity and motion of the air;
- (4) the physical activity of the body
- (5) the amount of the body exposed
- (6) the amount of insulation on the body (clothes and fats).

The mechanisms of heat loss from the body

- 1-Radiation
- 2- Convection
- 3- Evaporation (or perspiration).
- 4- Respiration
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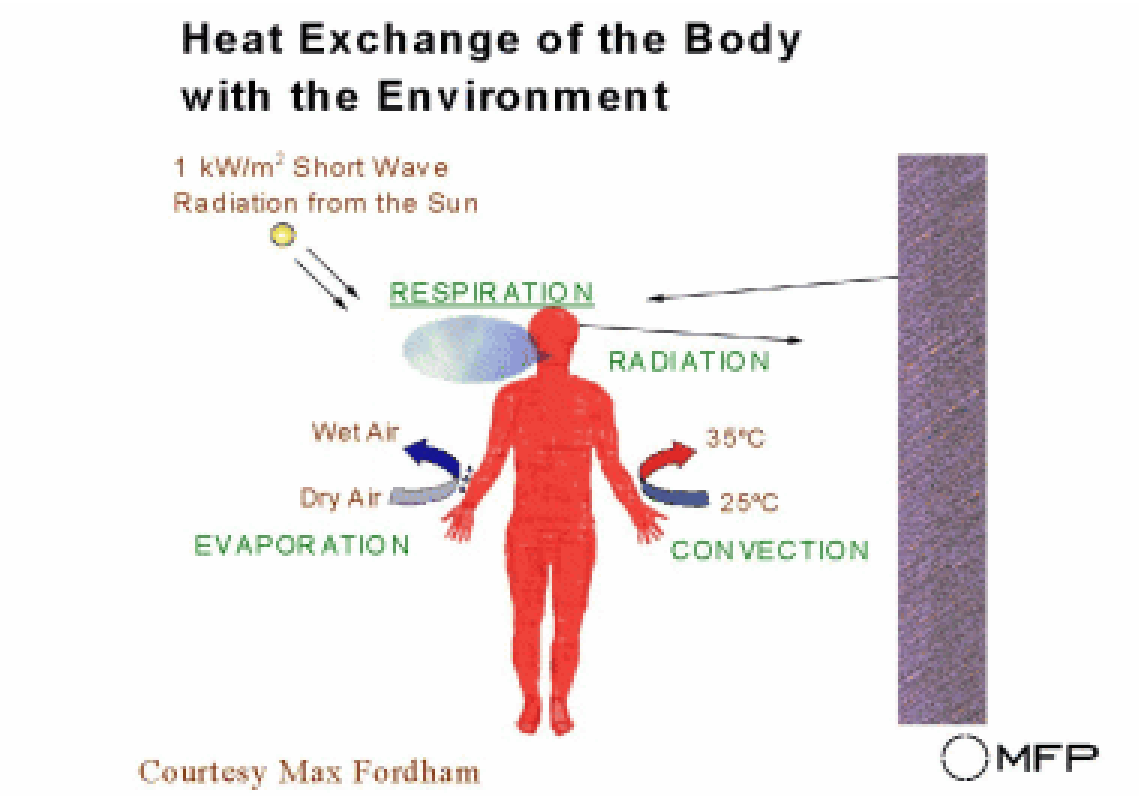

1-Radiation

- **All objects, regardless of their temperatures, emit electromagnetic radiation.**
- **In general, the amount of energy emitted by the body is proportional to the absolute temperature raised to the fourth power.**
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- **The body also receives radiant energy from the surrounding objects.**
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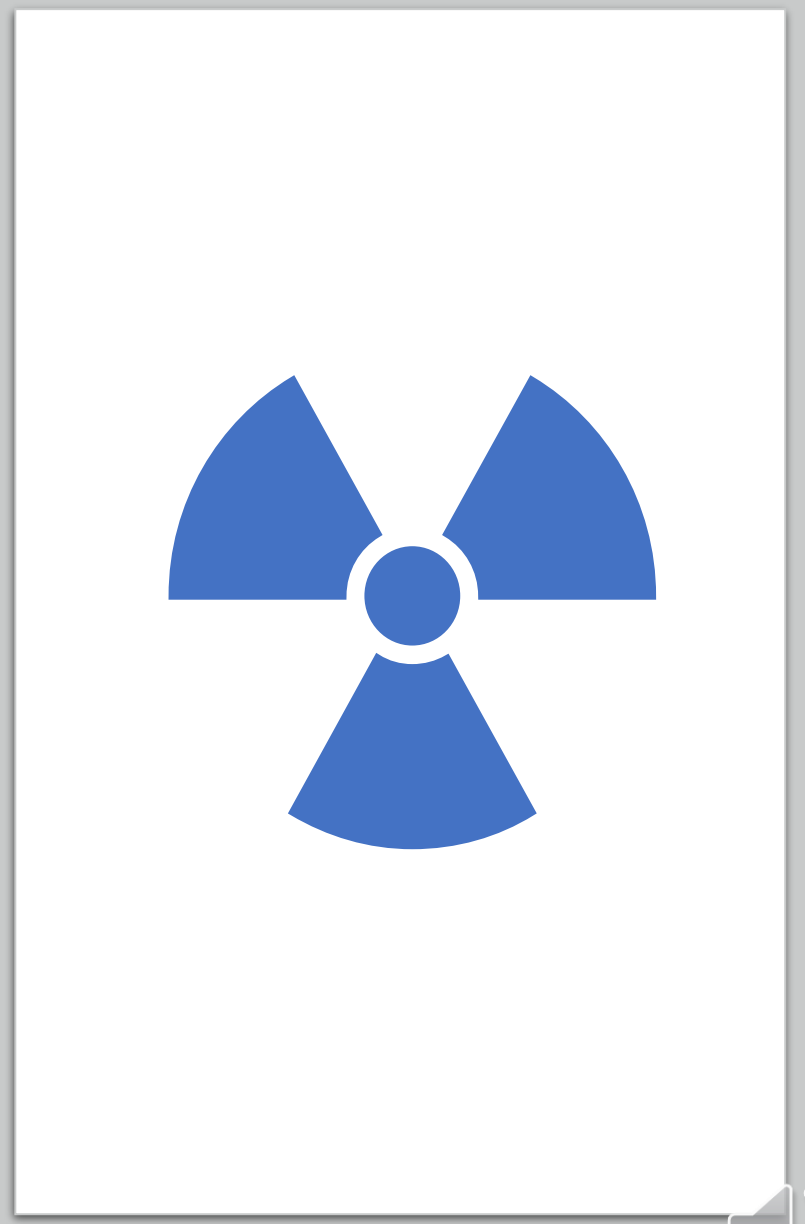
- **The difference between energy radiated by the body and the energy absorbed from the surroundings can be calculated from the equation:**

- $H_r = \sigma A_r e (T_S^4 - T_W^4)$
- **where H_r is the rate of energy loss (or gain) due to radiation,**
- **A_r is the effective body surface are emitting the radiation,**



1-Radiation

- e is the emissivity of the surface,
- T_s is the skin temperature (in Kelvin)
- T_w is the temperature of the surrounding walls (in Kelvin)
- σ is the Stefan-Boltzmann constant (= 4.9 x 10^{-8} kcal/m^2.h.K).
- The emissivity e of the skin is almost equal to 1.

- Under normal conditions a large fraction of our energy loss is due to radiation even if the temperature of the surrounding walls is not much lower than that of the temperature of the body.
- For example, if a nude body has an effective surface area of 1.2 m^2 and a skin temperature 34 ^oC, it will lose about 54 kcal/h to walls maintained at 25 ^oC. This amount to about **54%** of the body's heat loss.

2-Convection

- The heat loss due to convection (H_c) is given approximately by the relation:

- $$\mathbf{H_c = K_c A_c (T_s - T_a)}$$

- where K_c is a constant that depends upon the movement of the air,

- A_c is the effective surface area,

- T_s is the temperature of the skin and T_a is the temperature of the air.

- When the body is resting and there is no apparent wind, K_c is about 2.3 kcal/m^2.h.^{o}C.

- When the temperature of air is 25^{o}C, the temperature of the skin is 34 ^{o}C, and the effective surface area is 1.2 m^2, the nude body losses about **25 kcal/h** by convection.

- This amount to about **25%** of the body's heat loss.

- When the air is moving, the constant K_c increases.

Wind chill factor

- The equivalent temperature due do moving air is called **the wind chill** factor
- It is determined by the actual temperature and wind speed.
- For example, at an actual temperature of -20 ^{o}C and a wind speed of 10 m/s (a stiff breeze), the cooling effect on the body is the same as -40 ^{o}C on a calm day.

3- Evaporation of sweat

- **The method of heat loss that most of us are familiar with is the evaporation of sweat.**
- **Under normal temperature conditions and in the absence of hard work or exercise, this method of cooling is rather unimportant compared to radiative and convection cooling.**
- **Under extreme conditions of heat and exercise, a man may sweat more than 1 liter of liquid per hour.**
- **Since each gram of water that evaporates carries with it the heat of evaporation of 580 calories, the evaporation of 1 liter carries with it 580 kcal.**

3- Evaporation of sweat

The sweat must evaporate from the skin in order to give this cooling effect; sweat that runs off the body provides essentially no cooling.

The amount of sweat evaporated depends upon the air movement and the relative humidity.

There is some heat loss due to perspiration even when the body does not feel sweaty.

It amounts to about 7 kcal/h or **7%** of the body's heat loss.

4-Respiration

A similar loss of heat is due to the evaporation of moisture in the lungs

. When we breath in air, it becomes saturated with water in the lungs.

The additional water in the expired air carries away the same amount of heat as if it were evaporated from the skin.

Also, when we inspire cold air, we warm it to body temperature and lose heat.

Under typical conditions the total respiratory heat loss is about **14%** of the body's heat loss.