Al-Mustaqbal university college

Pharmacy Department

Medical physics

Energy, work and power

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1rd class

Lecture -2

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Energy, work and power

The body uses food energy to operate its various organs, maintain constant body temperature, and do external work, small percentage (5%) of the body energy excreted in the feces and urine, any energy left over is stored as a body fat.

Conservation of Energy in the body

$\Delta u = \Delta Q - \Delta W$

Δu= change in stored energy

ΔQ= heat lost or gain

ΔW= work done by the body

BMR (basal metabolic rate)

It is the amount of energy needed to perform minimal body function (such as breathing, and pumping blood through arteries under resting condition). BMR depends primarily upon thyroid function. A person of an over active thyroid has a higher BMR than a person with normal thyroid function.

Since the energy used for basal metabolism becomes heat and dissipated from the skin, so BMR is related to the surface area, or the mass of the body.

The metabolic rate depends on temperature of the body, if temperature changes by 1C° there is a change about 10 % in the metabolic rate.

For example, if a patient has temperature of 40 C° or 3 above normal, the BMR is about 30% greater than normal, you can see why patients temperature sometimes lowered during heart surgery.

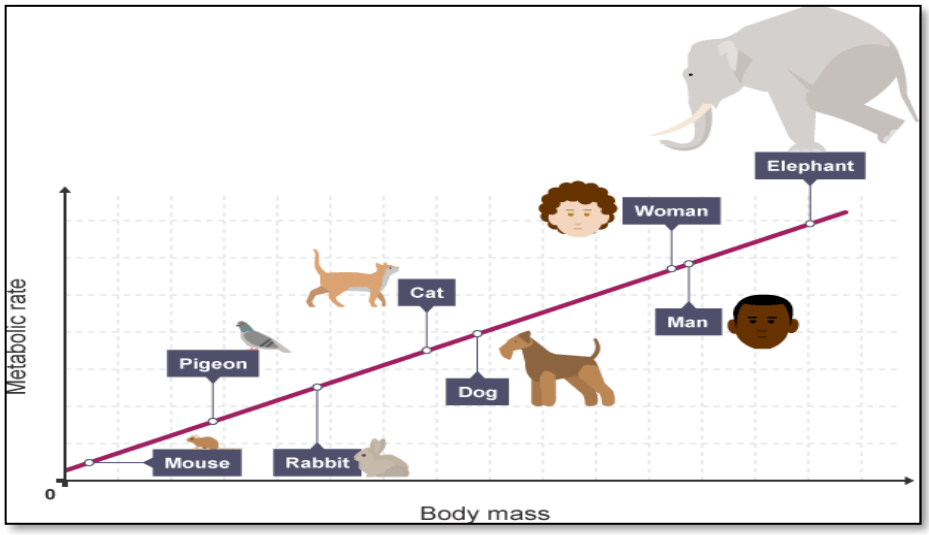

Figure 1: relationship between BMR and body mass for different animals

Work and Power

$\Delta W = F \Delta X$

F= force

Δ X= distance

$P = \Delta W / \Delta t = F \Delta X / \Delta t = F v$

P= power

ϵ = work done / energy consumed

ϵ= efficiency

The convenient unite for expressing the rate of energy consumption of the body is the met, the met is defined as 50 Kcal/m^2 of body surface area per hour

For normal person 1 met is equal to the energy consumption under resting conditions. A typical man has about 1.85 m^2 of surface area women has 1.4 m^2 and for typical man 1 met is about 92 Kcal/hr or 107 w oxidation occur in the cells of the body.

In oxidation by consumption heat is released within the body heat is released as energy of metabolism. The rate of oxidation is called metabolic rate.

The oxidation of glucose a common form of sugar used for intravenous feeding. The oxidation equation for one mole of glucose $C_6 H_{12} O_6$ is

$C_6 H_{12}O6 + 6 O_2 \rightarrow 6 H_2 O + 6 CO_2 + 686$ Kcal

That is 1 mole of glucose (180) gm combines with 6 moles of O_2 (129) gm to produce 6 moles each of H_2O (108) gm and CO_2 (264) gm releasing 686 Kcal of heat energy in the reaction.

When completely at rest, the typical person consumption of energy at rate of about 92 Kcal /hr or 107 w or about 1 met this lowest rate of energy consumption called basal metabolic rate

When a man climbing a hill or walking upstairs, we calculate the work done by multiplying person weight (gm) by vertical distance (h).

When a man walking or running at constant speed on level surface, the force act in the direction perpendicular to his motion, thus external work done by him appears to be zero, however his muscles are doing internal work which appears as heat in the muscle and causes arise in its temperature.

Heat Losses From The Body

The main heat loss mechanisms are

1-Radiation

2-Convection

3-Evaporation (perspiration)

4-Some cooling of the body in lungs.