Digestive System

University of Jordan

Faculty of Medicine

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Medical Committee
The University of Jordan

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Sheet #: 2-lab

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Metabolic Rate (MR)

The measurement of metabolic rate is done by direct methods and indirect methods (closed methods & opened methods). So to measure the metabolic rate we have to measure the amount of the heat radiated by a body within time. The direct method is done by placing the person into a closed chamber or room (insulated) and we have a flow of water in and flow of water out, if we know the temperature of water going inside, to say it was 22 degrees and we have certain rate of flow and the temperature of water out is 23 degrees (higher temperature).

#if we know the difference in temperature (here it's 1) and the rate of flow, to say it's 50 cm/min for example then we can calculate:

- The amount of heat that has been accepted by the water which is the same as the amount of heat that has been radiated by the body ..... per unit time

*** The unit of metabolic rate is:**

Calories/Hour/m^2, which sometimes written as: Calories . H^-1 . m^-2

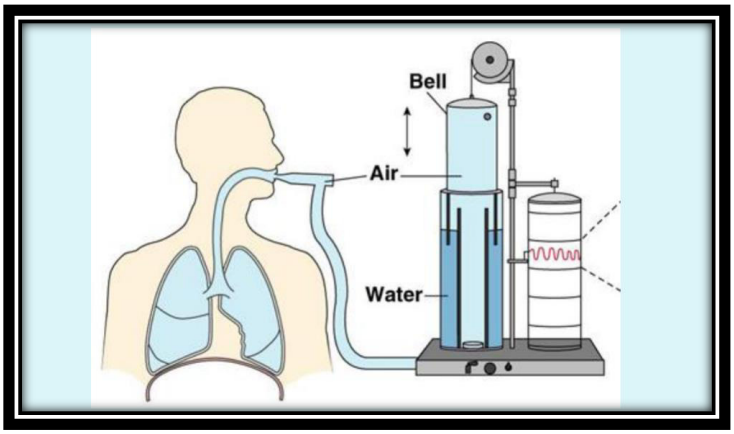
(Don't forget that Calories with capital C which refers to kilocalorie).

That was the direct method, but we don't use it for calculation, we use the indirect method. In indirect method, we can measure the amount of O_2 consumed and according to it we can calculate the heat produced. **W**e can use the **energy equivalent of oxygen** as a term to calculate the MR of that body.

- For each liter of oxygen consumption, the body can radiate 4.8 Calories, so if we know the amount of oxygen consumed by a body per unit time we can calculate the MR in that body.

❖ The first way of calculating (closed method):

We are using the Spirometer device to measure the lung volumes, its principle that we have an inverted drum filled with water inside and over that we have a degraded drum and we are doing a close system with the body, in this case any inspiration is taking place is from that volume, so what happens to that volume, which we are having? It's reduced. Once you are expiring the air, volume is increased. That movement of the upper drum up and down during respiration can be measured. As an example if we have 1 liter replacement in that drum and by getting that change in the stylus we can measure the volumes (during inspiration, expiration).



In this case we can use it to measure the MR by tracing pure oxygen in that drum and the person is inspiring pure oxygen and giving CO_2, but in the way here, all expired air is returning back to the drum. But we are tracing a substance which is called **soda lime** to adsorb the CO_2. So what return back is just the O_2 that haven't been used.

With time we are getting lower volume (which we can know it by the graded cylinder), to say we've started with 6L and after 5 min we end with 5L … So how much O_2 we have consumed in that 5 min? We consumed 1L in 5 min.

- ✓ Per one Hour? 12 L/h (How? we have twelve 5's in one hour, and in each 5minutes we consume 1 L, so it's 12 L in one hour).

- So the MR for that body is 12 * 4.8 = 57.6 Calories/Hour. ⇨ * Remember that the energy equivalent of O2 consumption = 4.8 Cal/L

- But we have to standardize that according to the surface area … for example if it was 1.7 m^2 ,,, so we divide 57.6/1.7 = 33.9 Calories/Hours/m^2

We still didn't finish the calculation. Actually, we have to look to the ideal MR for that person, assuming that we have measured under **basal conditions** so we have calculated in this case **the basal MR**. To say we have found that his ideal basal MR (according to his age for eg.) was 30 C/H/m^2 … Our result (33.9) was higher than the ideal, we have to figure out what is the percentage of the increase in the MR… In this case the difference is 33.9 – 30 = about 4 and the percentage is (4/30)*100% = almost 13% (increase in the BASAL MR by 13%).

- Someone asked about calculating the surface area of the body; it can be found by charts depending on height, weight and BMI… (Here it's given to us).

❖ The second way of calculating (open method):

If we want to measure the MR for **certain activity** (running for eg.) for a person, we can't give the person that big device to run with! So we can measure the MR by other way by having this person respiring from atmospheric air … I think you know the concentration of oxygen at atmospheric air which is 20% (there are special devices to measure it), now actually we are giving this person a bag to collect the expired air, so he's inspiring from the atmospheric air "which have 20% O_2" and expiring into the bag , to say that you've collected 80 L of expired air (which contains O_2 and CO_2) in that bag for 5 min of that activity,, but we want just the oxygen from that expired air, How to calculate?

Let's say that we found that just 16% is O_2 ....so we can know how much oxygen was consumed during 5 min for that activity by subtracting 20% - 16% = 4%... 4% out of 80L (0.04*80) = 3.2 L so this person has consumed 3.2 L of pure O_2 per 5 minutes.

Then we can calculate the liters per hour ... then we have to consider the surface area of that body and will get the whole calculation as we previously did → thus we can calculate the MR for this activity.

- Pay attention to the calculation please; you may have question to calculate either if we are using the atmospheric air (opened method) or using the (closed method) which contains the Spirometer.

Someone asked why we calculate with regard to the surface area, not the volume? This is **for standardization**, but they have found that the calculation of MR of the oxygen consumption is more related to surface area rather than the volume, as we know some of that volume is fat, and the increase of fat is not changing in the same way of increasing the surface area. Also you can notice that the fat is not participating very much in the process of generation of ATP or generation of heat for example..... SO it's more related to the surface area of the body.

We finished the CALCULATIONS! ☺

➢ The last thing to know is; **The Factors that can change the MR:**

1- **Exercise:** *increases* the MR.
2- **Daily activities**: *increase* the MR with increasing the daily activities.
3- **Age:** getting older *decreases* MR, so children have much higher MR than older people.
4- **Sleep :** *decreases* the MR.
5- **Climate:** person in *cold climates have higher MR* than the people who live in hot or tropical climates.

6- **Fever:** once the body have infection or inflammation it radiates heat, so we get *increase* in the MR.

7- **Malnutrition**: *decrease*, because the body starts to conserve energy so there's a decrease in metabolic activities thus decrease in MR.

8- **Specific dynamic function**: if we have a person placed on a diet of proteins and other person placed on a diet of carbohydrates with the same energetic value. They have found that the person, who is on a diet of protein, is having higher MR than the person on carbohydrate diet. So actually some are saying that having a protein diet increases the MR, which will let you lose weight from your body. Why is that? It's due to what is called **"specific dynamic action"**, which means that some amino acids in that diet are increasing the metabolic activities in the body.

9- **Hormones:**
   a) Thyroid hormone: *increases* the MR. The main activity of thyroid hormone is to increase the metabolic activities in the body.
   b) Sex hormones: *increase* MR, but the increase by the male sex hormones is higher than the increase by the female sex hormones.
   c) Growth hormones: *increases* MR, because of the building of body component.

10- **Effect of sympathetic stimulation**: *increases*, so in stress conditions during exams for eg., the MR will be much higher.

* Notice that these are the factors affecting the MR; NOT the basal…. Because once we are talking about a *SLEEPING* person, we are not talking about basal!

The basal metabolic rate is if we are measuring only under "basal conditions", so the person must be awake not asleep (so again sleeping is not considered as basal MR) …… IMPORTANT

< The End of the sheet >

صبراً؛ لعل الأيام تأتي بالأحلام راكضة ولعل الأحلام تسبق الأيام آتية.. :)

Dedication to all our Lajneh members for their amazing efforts, also the correction team especially Shatha Tailakh for correcting this sheet.

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