Energy
Measurements of energy expenditure

• Direct calorimetry

• Indirect calorimetry

• Factorial estimation

• The double labelled water technique (DLW)

• Heart rate monitoring (HRM)
Direct calorimetry

- Measurement of the heat produced by a reaction, as distinguished from indirect methods, which involve measurement of something other than heat production itself.
Indirect calorimetry

• Indirect calorimetry is a technique that provides accurate estimates of energy expenditure from measures of carbon dioxide production and oxygen consumption during rest and steady-state exercise.
Factorial estimation

• The wide variation observed in the physical activity patterns of adults from different geographic, social and economic groups combined with the variation observed in body size and composition of adults, do not allow the universal application of TEE measured by DLW technique.
Heart rate monitoring (HRM)

- Several investigations on total energy expenditure (TEE) of healthy wellnourished individuals have been done in a broader spectrum of countries using minute-by-minute heart rate monitor (HRM) and individual calibration of the relationship between the heart rate and oxygen consumption.
• This has become possible with an electronic device that can accurately record minute-to-minute heart rate under free living conditions, for a whole day or more.

• The mean TEE measured with this technique is comparable to mean value obtained using DLW or whole body calorimeter.
The doubly labelled water technique (DLW)

- The use of the Doubly Labelled Water technique (DLW) i.e. labelled hydrogen ($^2$H deuterium) and oxygen ($^{18}$O) to calculate total production of carbon dioxide (CO2) over several days and, from this, measurement of the mean respiratory quotient (or food quotient under steady state conditions) and total energy expenditure, was originally developed for use in small animals.
• Its application was later validated in humans. Although questions have been raised about the appropriateness of the assumptions used in the calculation of TEE, the DLW method is considered the most accurate technique for measuring TEE in free-living individuals. Can be safely used on infants also but very expensive.
Energy balance

• “Energy balance” is the relationship between “energy in” (food calories taken into the body through food and drink) and “energy out” (calories being used in the body for our daily energy requirements).

• Adults who tend to maintain energy balance keep their body weight constant.

• Those who lose weight spend more energy than intake – negative energy balance.

• If the intake of energy is consistently higher than the expenditure over an extended period of time, it results in weight gain.
• According to these laws, energy is never really created and it’s never really destroyed. Rather, energy is transferred between entities.

• We convert potential energy that’s stored within our food (measured in Calories or kcals) into three major “destinations”: work, heat and storage.
Health concern related to energy balance

• When it comes to “energy out,” the body’s energy needs include the amount of energy required for maintenance at rest, physical activity and movement, and for food digestion, absorption, and transport.

• We can estimate our energy needs by measuring the amount of oxygen we consume.
• We eat, digest, absorb, circulate, store, transfer energy, burn the energy, and then repeat.

• Energy balance also has to do with what’s going on in our cells.

• When the body is in a positive energy balance (more in than out) and when the body is in a negative energy balance (more out than in), everything from the metabolism, to our hormonal balance, to our mood is impacted.
Negative energy balance

- A severe negative energy balance can lead to a decline in metabolism, decrease in bone mass, reduction in thyroid hormones, reduction in testosterone levels, an inability to concentrate, and a reduction in physical performance.
• Yet a negative energy balance does lead to weight loss. The body detects an energy “deficit” and fat reserves are called upon to make up the difference.

• The body just knows it isn’t getting enough energy, so it will begin to slow down (or shut down) all “non-survival” functions.
Positive energy balance

• Overfeeding (and/or under exercising) has its own ramifications not only in terms of weight gain but in terms of health and cellular fitness.

• With too much overfeeding, plaques can build up in arteries, the blood pressure and cholesterol in our body can increase, we can become insulin resistant and suffer from diabetes, we can increase our risk for certain cancers, and so on.
• The relationship between the amount of calories we eat in
the diet and the amount of energy we use in the body
determines our body weight and overall health.

• The body is highly adaptable to a variety of energy
intakes/outputs. It must be adaptable in order to survive.
Therefore, mechanisms are in place to ensure stable energy
transfer regardless of whether energy imbalances exist or
not.