

Marathon chick

By Ron Meijerhof

A very important process in incubation is the supply of energy for the developing embryo. To fully understand what is happening during incubation and the importance of the incubation conditions for the final result, we have to take a look at some of these energy budgets. The problem is that these processes are very complex and the biological consequences difficult to understand. However, if we compare it with a sport like long distance running, for instance running a marathon, it is much easier to picture what is actually happening. The comparison is not 100% accurate, but accurate enough to be helpful in understanding what happens during incubation.

In principle, there are two main resources of energy, both in an athlete and in a developing chick. These two sources are carbohydrates and fat. For the embryo, the fat is stored in the yolk, where the carbohydrates are stored both in the yolk and in the albumen.

For the marathon runner, the carbohydrates are stored mainly in the liver and in the blood. The fat is stored in our fat tissues, as many of us experience every day when looking in the mirror...

Start of the incubation marathon

During the first part of the marathon, the athlete uses the carbohydrates as fuel. These carbohydrates are easily accessible and supply a quick energy source. The use of these carbohydrates requires oxygen and produces three waste products, namely carbon dioxide, metabolic water and heat. This heat will force the runner to sweat to increase its heat loss, and it will increase its body temperature with several degrees. This increased body temperature will increase the rate of the burning of carbohydrates.

During the start of incubation, the embryo also uses carbohydrates to burn with oxygen as energy source. It also produces carbon dioxide, metabolic water and metabolic heat, which forces the embryo temperature to rise above air temperature in the second half of incubation. We don't know for sure if an increased embryo temperature results in an increased use of carbohydrates, but we do have some indications for it.

Halfway

After a certain period or distance, the carbohydrate resources are used and one would expect that the body would change to fat as an energy source. However, the body can only utilize the fat if there are still carbohydrates available. This is why you shouldn't start too fast in the race, as you will run out of energy because you burn carbohydrates too fast. The best chance on finishing the marathon as a "pleasure runner" is to run at low speed with a moderate heart rate and a moderate increase in body temperature. Under this conditions, carbohydrates are not used up that fast and fat can still be utilized as energy source.

Also an embryo has to utilize its fat sources in the second half of the race. Normally the use of fat starts around day 14 (chicken embryo), but also the embryo needs to have carbohydrates to be able to access that fat. The results of research in this area also indicate that the embryo has used the carbohydrates fast at increased temperature, and then also is facing problems with utilizing the fat.

The man with the hammer, the hit of the wall...

When the athlete runs too fast, has all carbohydrates used and fat is not available, there is basically no energy source available anymore and he or she will meet the famous "man with

the hammer” or “hit the wall”. Within a few kilometres all the energy is gone, everything hurts and it is almost impossible to continue running. It is good to realize that at that moment the body still has plenty of body fat as reserve, but it is simply not available anymore. If the athlete is extremely motivated and finds the mental power to continue running, the body will look for alternative energy sources. That energy source will be the protein, which means that muscle tissue will be burned. As also for instance the heart muscle is used for that, this can lead to serious and long term damage of the body.

When the embryo temperature during incubation is too high, the embryo has a problem with accessing yolk, which results in a large yolk residue. The problem for the embryo is that its body temperature and with it its “speed of running” is determined by the heat transfer. It will try to slow down its development but at the end will also use its muscle tissues as an energy source. This is probably why increased embryo temperatures result in a decreased development, increased yolk residue and poor performance.

An extra complicating factor during incubation is that the embryo stores glycogen in the liver, as energy source for the hatching process. When the embryo temperature during incubation is too high, it is not unlikely that the embryo uses this glycogen to survive, and lacks the energy for hatching. We know that restoring that glycogen by injecting in the amnion will help the embryo, but it can be questioned if this is not solving the problem from the wrong end.

For embryos, the incubation process is a form of top sport. As we can’t train our embryos and prepare them for the marathon, we have to incubate them in conditions that allow them to finish their race in the best possible way. The key to that race is the control of the embryo temperature.