

**PHYSIOLOGY OF EMBRYOS IN THE LAST
INCUBATION PERIOD AND IN THE NUTRITION OF
EGGS**

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Received: March 22, 2024; Accepted: Apr 29, 2024; Published: May 10, 2024;

Abstract: One of the main physiological processes occurring during the pre-election period is the maintenance of glucose homeostasis. Glycogen stores are depleted as embryos hatch. The lack of glycogen causes the embryo to mobilize more muscle protein for gluconeogenesis, thereby slowing down early growth and development until glycogen stores begin to replenish when the newly hatched chick does not get full access to feed..

Keywords: chicken embryo, physiology, incubation, nutrition.

This is an open-access article under the [CC-BY 4.0](https://creativecommons.org/licenses/by/4.0/) license**Introduction**

The decreasing age at which commercial poultry enters the market has increased the importance of the incubation period. Information on the development, physiology and metabolism of poultry embryos before hatching is still very limited. The last days of the incubation period are characterized by the physiological processes of emergence from the shell, pipping and hatching and are marked by many changes and shifts in metabolism that are crucial for the survival of the embryo and its further productivity. Knowledge of the characteristics and physiological events in liver, muscle and intestinal tissues can help elucidate metabolism during late stages of embryonic development. In addition, studying the nutritional status of the embryo, including the nutrient content of the yolk and the rate of absorption during the incubation period, is also important for understanding the events that influence hatchability, hatchling quality and chick performance. To overcome the physiological limitations of existing breeds and existing poultry production systems, and to improve the gut functionality and nutritional status of hatchlings, embryo feeding methodology can be used.

Improvements in broiler growth rates over the past two decades have resulted in the incubation period becoming a larger proportion of the total growth period of commercial poultry. Thus, incubation and the final days before hatching have become more important for the successful production of meat birds. Anything that supports or limits growth and development during the incubation period is expected to have a noticeable effect on the overall performance and health of the bird. Because of this, many poultry researchers now realize that future advances in poultry production will be linked to advances made during the incubation period and embryogenesis.

The last period of incubation is characterized by oral consumption of the amnion by the embryo, intensive absorption of the yolk, accumulation of glycogen reserves in the muscle and liver tissues and their use during pipping and hatching, the onset of pulmonary respiration, abdominal internalization of the remaining yolk and shell.

Physiological and metabolic changes occur during this period of time, and any disturbances that occur during these days (eg delayed access to feed, incubation temperature) will affect the quality and subsequent productivity of the chicks hatched.

Physiological changes that occur before and after hatching.

One of the main physiological processes occurring during the pre-hatch period is the maintenance of glucose homeostasis. Glycogen stores are depleted as embryos hatch. Lack of glycogen causes the embryo to mobilize more muscle protein for gluconeogenesis, thereby slowing early growth and development until glycogen stores begin to be replenished when the newly hatched chick has full access to feed.

In birds, the pectoral muscle is a major source of protein, mobilized to supply amino acids for gluconeogenesis if energy reserves are depleted after hatching. In a low-energy state or during periods of fasting, the pectoral muscle serves as a source of amino acids and energy, which leads to atrophy. Therefore, the liver and muscles are most affected by changes in metabolic pathways that exist in the last days of the incubation period. In cases of late access to the first feed after hatching, skeletal muscle development and growth show irreversible delay until market age.

Many studies have examined COH metabolism in the liver of chick embryos and have shown that the liver is responsible for blood glucose homeostasis. It also performs important processes related to COH metabolism and glucose supply to tissues during chick embryonic development, such as glucose synthesis from non-COH precursors (gluconeogenesis), glycogen synthesis (glycogenesis), and glycogen breakdown (glycogenolysis). Based on these data, one of the criteria for assessing the energy status of embryos was measuring the level of glycogen in the liver. Low liver glycogen levels are associated with increased hatching time and decreased body weight at hatch.

Another important physiological process occurs in the yolk, where during the last week of incubation, β -oxidation of yolk-derived fatty acids provides the embryo with a major source of fuel. However, during the last 2–3 days of incubation, due to the high energy requirements of the hatching process and the relatively low oxygen availability, fatty acids are unable to provide all the energy required. The embryo then undergoes anaerobic glucose catabolism, which depends on the amount of glucose held in the glycogen stores of the liver, kidney, and muscle, and the extent of glucose production by gluconeogenesis from amino acids, glycerol, and lactate.

The physiological process of intestinal development is of great importance. Intestinal functions (digestion and absorption) and the intestinal barrier as the first line of defense against aggressions arising from luminal contents play an important role in poultry performance and performance. In broilers, the critical period for the development of an intact mature gut is the period before and after hatching, when the transition from late embryo to viable chick occurs.

During incubation, avian embryos make little contribution to gut development, but at the end of the incubation period rapid visceral growth and maturation occurs. During this period, intensive intestinal development occurs. Over the last 6 days of incubation in the small intestine, the absorption surface area increased 5 times, and the number of enterocytes increased. Goblet cells appear, producing acidic mucin, and the tissue quickly develops the ability to digest and absorb. Changes in incubation

conditions (temperature, oxygen and ventilation) affect these physiological processes and likely lead to changes in gut development and the quality of the hatchlings.

Chick embryos have the ability to digest and absorb nutrients before hatching, as evidenced by relatively low levels of sucrase-isomaltase (SI) and L -aminopeptidase and ATPase and sodium glucose transporter (SGT-1) mRNA levels in the small intestinal mucosa. Activities of the brush border enzymes leucine aminopeptidase (LAP) and sucrase-isomaltase (SI) were detected in turkey embryos at 25E, and the activities of the glucose transporter (SGLT-1) and alanine transporter (B o+) were measured as early as 23E. This absorptive capacity increases closer to hatching and continues to increase during the first few days after hatching. It has been noted that the villus height of the poultry embryo increases by 200-300% during the 17 days of incubation until hatching, and the weight of the small intestine increases faster than body weight. Rapid growth of the intestine is due to a significant increase in the number and size of cells due to accelerated proliferation and differentiation of enterocytes, as well as the formation of intestinal crypts. Therefore, the growth, maturation and metabolism of intestinal tissue become of great importance in the last period of embryonic development of the bird.

The sooner the gut reaches functional capacity, the faster puffy babies will be able to utilize food nutrients, absorb minerals and vitamins, and support the development of critical organs (skeleton, immune system, pectoral muscles).

Use of egg nutrients by the embryo during incubation.

The main factor that has a great influence on the development of the broiler embryo and the hatched chicken is the level of deposition of macro- and microelements in the fertilized egg. Although the fertilized egg has a specific nutrient composition that varies depending on the age and nutrition of the breeding herd, the rate and mechanism of absorption of these nutrients by the embryo is not fully understood.

During incubation, the chick embryo obtains all its nutritional needs from the egg's resources (yolk, white and pulp). Protein makes up 65 to 75% of the total egg content and consists of approximately 88% water and 12% protein, both of which are completely consumed by the embryo during incubation. The yolk is approximately 50% water, 15% protein, 33% fat, and less than 1% carbohydrates; however, this composition largely depends on the egg weight, genetic line and age of the hen.

During incubation, nutrients are transferred from the yolk contents to the embryo through the yolk sac membrane and the surrounding vascular system. On the 19th day of incubation, when the yolk sac is retracted into the body cavity, it is still a rather voluminous organ.

Together with the residual yolk, it makes up approximately 1/6 of the weight of the embryo and about 1/3 of the original weight of the yolk. The process of retraction of the yolk sac is carried out, according to Lilly, due to the contraction of the internal layers of the allantois and amnion. Kuo believes that the retraction of the yolk sac is carried out by movements of the abdominal muscles, and the movements of the paws help stretch the abdominal cavity and, therefore, accelerate the retraction of the yolk sac. This is also facilitated by breathing movements. And the allantois, according to the

author, not only does not help the retraction of the yolk sac, but even delays it. According to Ragozina, by the time of hatching there are 2-3 lobes in the yolk sac, which are formed due to the uneven growth rate of the yolk sac tissue and its large blood vessels, which grow more slowly. This structure of the yolk sac facilitates its retraction through the relatively narrow umbilical opening. Retraction of the yolk sac occurs, according to the author's observations, due to contraction of the muscle layer surrounding the yolk sac, which is a direct continuation of the ventral part of the muscles of the abdominal wall of the embryo's body.

After the yolk sac is retracted, the so-called umbilical cord remains in the place where it retracted. It consists of a part of the yolk stalk adjacent to the body of the embryo, remnants of the allantois and a connective tissue ring, which first thickens and then narrows. The yolk stalk, after retraction and resorption of the yolk sac, remains in the form of a process of the duodenum. Poor yolk sac retraction is an unfavorable sign when assessing chick quality. It can be caused either by insufficient yolk intake during incubation (usually due to increased incubation temperature or humidity) or by weakening of the muscle fibers, indicating general weakness of the chick.

The yolk sac, which is retracted upon hatching, contains about half the dry matter of the egg yolk before incubation, but the concentration of proteins in them is greater and less fat than in the yolk. Mineral salts from the yolk are consumed during incubation from 1/4 to 1/2, and iron is almost completely consumed (for the formation of hemoglobin), up to 3/4 of phosphorus salts (for the formation of the brain, liver, muscles), a lot of sulfur is consumed (for the formation fluff, beak, claws) and about 2/3 of calcium for building bones.

The nutrients contained in the retracted yolk sac are used by the chick in the first days of postembryonic development, and the enzymes contained in them are also involved in the digestion of food eaten by the chick at this time. In addition, in the first three weeks of postembryonic development, the yolk sac is an organ with apocrine secretion, and then turns into a lymphoid organ with the function of lymphopoiesis.

Regardless of the age of the breeding flock, the overall picture obtained from the analysis of yolk content during the incubation period shows a variable uptake of yolk macronutrients over the 21 days of incubation. By E17, almost 50% of the protein was absorbed by the embryo from the yolk. 65% of the fat was absorbed in a linear manner from the yolk between E11 and E17. Then, at E17-E20, only a small amount of fat was absorbed, whereas on hatch day, 15% of the fat in the yolk was absorbed vigorously in just 24 hours. Interestingly and unexpectedly, the amount of carbohydrate in the yolk increased significantly during incubation (E15 to E20), reaching a peak at 19E. In this regard, the question arises about the role of the yolk and the membrane of the yolk sac in carbohydrate metabolism.

In terms of micronutrients, yolk mineral analysis showed that at E19 the levels of Zn, Cu, Mn and P in the yolk (the major mineral reserve) were significantly reduced to approximately 3, 6, 10 and 13% of their levels. on the day of recruitment (Yair and Uni 2011). This leaves the embryo with low mineral reserves for the final period of incubation and likely results in mineral deficiency in the embryo.

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