



Issue No.7 / July 2006

EMBRYONIC DEVELOPMENT

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INTRODUCTION

The purpose of this article is to teach the reader how to recognize good incubating eggs from poor incubating eggs on the one hand and, when opening an egg, to determine its development stage and the date of a potential problem, on the other hand.

Thorough knowledge of embryonic development is an aid in understanding the requirements for the good development of the future chick and the reasons why some incubation phases are crucial.

Such knowledge is also the basis for embryo-diagnosis, which helps to determine the age and cause of death of the embryo with the aim to remedy this phenomenon and improve hatcheries' performances.

THE DIFFERENT STAGES OF EMBRYONIC DEVELOPMENT

Total embryonic development times are 21 days for chickens, 27-28 days for common ducks, turkeys and guinea fowls, 29-30 days for geese, 31-32 days for mulard ducks and 34-35 days for muscovy ducks.

The following data applies to the hen species.

Once the embryo has been fertilized (1st day), embryogenesis begins and will last for 5 days, after which the embryo essentially grows until hatching. During the last 3 days, organs develop and the chick enters its maturation phase.

A. Embryo Differentiation (1-6 days)

As seen earlier, the encounter between the ovum and sperms takes place in the portion of the oviduct called the magnum approximately three hours after ovulation.

The egg cools down when in contact with the outer environment and embryonic development stops as long as the egg's temperature is below 25°C (the physiological zero of incubation). Development will only resume in optimal conditions after raising temperature to 37.8°C.

1. From fertilization to oviposition

The first cell division occurs when the egg is in the isthmus (it starts approximately 3 hours after ovulation) and continues throughout its descent toward the reproductive tract.

Six to eight hours prior to oviposition, two distinct zones on the yolk surface can be seen with the naked eye: the area pellucida (translucent) in the center and the surrounding area opaca (early blastula stage). At this stage, the symmetry axis of the future embryo is determined by the coiling of chalazae during egg shell formation.

The late blastula stage (50,000 cells delimiting two superimposed cavities) is reached shortly before oviposition.

Embryonic development then remains at this stage as long as temperature is kept under 21°C-22°C.

2. Embryo formation

After 5-6 hours of incubation, thickening of the rear portion of the area pellucida occurs.

After 16 hours, thickening extends along the entire length of the blastoderm and forms the primitive streak.

At 18 hours, the cephalic extension can be seen, gastrulation is completed and neurulation begins.

After 20 hours, the primitive streak shrinks while differentiation begins: cephalic folding, individualization of somites.

After 40 hours, the brain and heart are formed, and the anterior intestine takes shape. The embryo lifts up over the yolk and lies on its left side. The first heart beats occur (40/min.) and permit blood circulation between the embryo and the egg yolk.

Stage	Weight evolution in 24hrs	Embryo description
	Weight 0.2 mg	Resuming of cell multiplication and intensive embryo development
D2	X 15 3 mg	Appearance of the amniotic sheet, heart beating and onset of blood circulation
D3	X 7 21 mg	The amnion completely surrounds the embryo which turns on its left side
D4	X 2.5 52 mg	Egg pigmentation with embryonic limb buds (legs>wings)
D5	X 2.5 130 mg	Appearance of elbows and knees
D6	X 2 260 mg	Appearance of beak, fingers and toes; movement begins

B. Organ Development (7-17 days)

Stage	Weight evolution in 24hrs	Embryo description
D7	X 2 0.5 g	Onset of comb growth
D8	X 2 1 g	Onset of feathers, appearance of upper and lower mandibles of the beak
D9	X 1.5 1.6 g	Onset of bird shape, opening of mouth
D10	X 1.5 2.4 g	Fingers are separated, nails appear
D11	X 1.5 3.5 g	Comb differentiation, appearance of feathers and tail, shape of the eye
D12	X 1.4 5 g	Eyes are still closed and elliptic in shape
D13	X 1.4 7 g	Embryo starts to be covered with down, eyes open
D14	X 1.3 9 g	Embryo is aligned
D15	X 1.3 12 g	Appearance of intestine in the abdomen
D16	X 1.3 15 g	Body covered with feathers

C. Maturation and Preparation for Hatching (18-21 days)

Stage	Weight evolution in 24hrs	Embryo description
D17	X 1.2 18 g	Head between legs
D18	X 1.2 22 g	Head under right wing
D19	X 1.2 26 g	Amniotic fluid disappears (swallowed by embryo), half the yolk sac has disappeared
D20	X 1.2 32 g	Yolk sac fully included into embryo; beak starts to pip
D21		Pips egg shell; normal hatching

D. Critical development phases

The embryo is particularly fragile at the following phases of incubation:

- First 2 days:** risk of early mortality due to blastoderm fragility when embryonic development resumes, and structuring of vascular network. The transformation of the blastoderm into a basic embryo occurs during the first 2 days of incubation and during this time the embryo is at its most vulnerable to disturbances. Many of the abnormalities seen in late embryos or hatchling have their origins in mishaps at these early stages.
- Around 5-6 days:** the yolk vesicle completes its development, the vitelline membrane disappears and the allantois starts to function as a respiratory organ -> particular susceptibility to shocks.

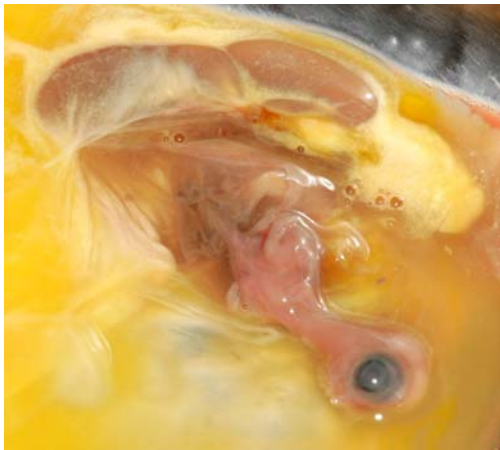
- ☑ **At the end of incubation (18-19 days):** coming into service of the definitive kidney, organization of aerial respiration.
- ☑ **At hatching:** pipping difficulties resulting in mortality due to exhaustion—at hatching or shortly thereafter—respiratory failure, inadequate resorption of the yolk vesicle (due to excessive temperature causing an increase in organ volume, thereby hampering yolk retraction).

Risks of malformation are high, especially during the first 6 days of incubation, when organs differentiate. Afterwards, organs grow in volume: any abnormality during this phase results rather in a change (extension or shortening) in embryonic development duration.

In the chicken, the association of embryonic mortality with embryo age is approximately as follows:

- ☑ 0-4 days: 25%
- ☑ 4-16 days: 10%
- ☑ 16-21 days: 65%

Example: embryo mortality at day 9.



CONCLUSION

Better understanding critical embryo development phases and recognize them is of paramount importance to diagnose at which period mortality occurs. Embryodiagnostic should be a common daily examination. The two more sensitive incubation phases are the onset of blood circulation (first week) and onset of lung breathing (last five days). This leads to investigate which parameter is incorrect (atmosphere composition, temperature, humidity, egg turn over...) and try to find a solution.