

Development of the Chick

Tony Pescatore and Jacquie Jacob, Animal and Food Science

Poultry eggs are part of a unique reproductive system. The egg serves to protect and provide nutrients to the developing embryo. Since the embryo receives no additional nutrients from the hen, the egg must contain all the nutrients essential for life. Nutrients are found in the yolk, the albumen, and the shell of the egg. The egg is a convenient, self-contained package for studying embryology.

An egg consists of a yolk, albumen, shell membranes, shell, and a single reproductive cell called the germinal disc or ovum. The ovum appears as a small white dot on the surface of the yolk. The ovum contains half the genes of a new chick. The other genes come from the rooster and are found in the sperm cell. The union of the ovum with a sperm cell is called **fertilization** and is the beginning of a new individual. After fertilization, the embryo begins to grow by cell division. By the time the egg is laid, the initial single cell has developed into 4,000 to 6,000 cells.

Once the chicken egg is laid, temperatures below 68°F (20°C) will stop embryo development. The embryo will remain at rest until the egg is re-warmed by either a brood hen or an incubator. This temperature (68°F/20°C) is referred to as “physiological zero.” The ideal incubation temperature of the chicken is 99°F-100°F (37°C-38°C). If the temperature of the egg goes above physiological zero, embryonic development can occur. Above physiological zero but below optimal incubation temperatures will result in weaker embryos and higher mortality.

Once rewarmed to the correct incubation temperature, the chicken embryo will grow and develop over a 21-day period and then emerge from the egg as a fully developed chicken. Other types of birds have different incubation periods, as shown in Table 1.

Table 1. Incubation Periods of Different Poultry Species.

Species	Incubation period (days)
Chicken	21
Chukar partridge	24
Duck (except Muscovy)	28
Muscovy duck	35
Goose (except Canada and Egyptian)	28-32
Canada and Egyptian geese	35
Grouse	25
Guinea fowl	28
Peafowl	28
Pheasant (ringneck)	24
Pigeon	17
Quail-Bobwhite	24
Quail-Japanese (Cortunix)	16-18
Turkey	28

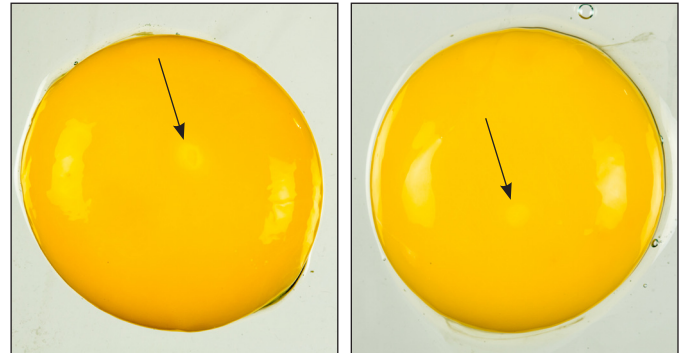


Figure 1. Yolk from a fertile egg (left) versus yolk from an infertile egg.

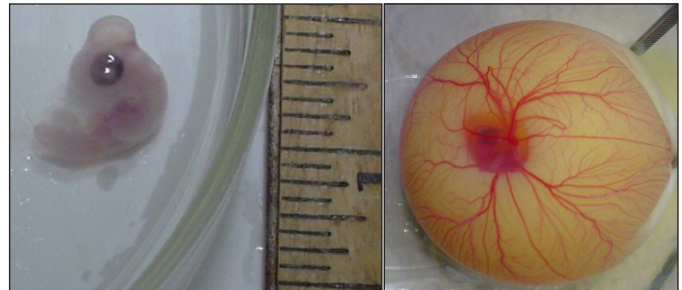


Figure 2. Day 6 embryo.



Figure 3. Day 4 embryo.

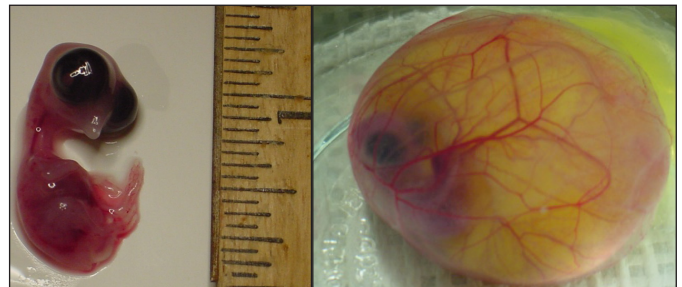


Figure 4. Day 9 embryo.



Figure 5. Newly hatched chick.

During incubation, the embryo develops in a predictable manner with specific events occurring at specific times. A list of events for the chicken embryo, and the approximate times of their occurrence are presented in Table 2. The information in this table can be used to determine the stage of development of the embryo.

In order to develop, the embryo must have a way to receive nutrients from the egg. The embryo develops extra-embryonic membranes for this function. The extra-embryonic membranes are the yolk sac, the amnion, and the chorio-allantoic membrane. The **yolk sac** is a membrane that spreads over the yolk and transports food from the yolk to the embryo. The **amnion** is a fluid-filled sac that covers the embryo and protects it from physical shocks and injury. The **chorio-allantoic** membrane has four functions:

1. It is a respiratory organ that provides oxygen to the embryo.
2. It is a storage area for the waste products the embryo produces.
3. It provides food from the albumen to the embryo.
4. It brings calcium from the egg shell to the embryo.

Once these extra-embryonic membranes have made contact with the food supplies and shell, the embryo proceeds to grow at a rapid rate.

The development of an embryo is a fragile process that is easily disturbed. A list of common incubation problems and their causes is presented in Table 3. Many of these problems can be prevented by maintaining proper temperature, humidity, ventilation, and by turning the egg regularly.

Table 2. Events in the Development of the Chicken Embryo.

Before the egg is laid	Union of ovum and sperm (fertilization) Division and growth of cells
From lay to incubation	Embryo is at rest
Day 1 of incubation	Head begins to form Eyes begin to form Vertebral column (spine) begins to form
Day 2	Blood vessels form Heart begins to beat Ears form
Day 3	Limb buds visible Extra-embryonic membranes begin to form
Day 4	Eye pigmentation begins Tongue begins to form
Day 5	Formation of the reproductive organs
Day 6	Beak begins to form
Day 7	Egg tooth is distinct Segments of wing and legs distinct Feather tracts on back
Day 8	Feather tracts are more distinct
Day 9	Toes are formed
Day 10	Beak begins to harden
Day 12	Down present on body Eyes nearly closed Scales on shanks
Day 14	Eyes closed Embryo turns to point head to air cell
Day 17	Head of embryo under right wing
Day 19	Yolk sac enter body
Day 20	Yolk sac completely in body Chick pips shell
Day 21	Chick hatches

Table 3. Common Incubation Problems.

Symptoms	Causes
Many eggs with no embryo	Problems with parents Eggs stored too long Eggs stored above 55°F (12.8°C)
Blood rings	Improper temperature in the incubator Improper care of eggs
Dead embryos	Temperature too high or too low Improper turning of eggs Poor ventilation
Pipped eggs not hatching	Low humidity
Chicks hatching too early	Temperature too high
Late pipping of eggs	Low temperatures
Eggs pipped by chick take a long time to hatch	Temperature too high
Short down on chicks	High temperature Low humidity
Rough navels	High temperature Low humidity
Shell sticking to chicks	Low humidity during hatch
Mushy, bad-smelling chicks	Bacteria in the incubator
Crippled and deformed chicks	Heredity Possible nutrient deficiency in the breeder flock

The temperature in a still-air incubator should be 100°F to 101°F (37.8°C to 38.3°C). In a forced-air incubator (one that is equipped with a fan), the temperature should be 99°F to 100°F (37.2°C to 37.8°C). Overheating the eggs will reduce the number of chicks that will hatch.

The relative humidity in the incubator should be 70 percent. Use a wet-bulb thermometer and the chart in Table 4 to measure humidity.

Each incubator is equipped with ventilation holes. These holes should be opened to allow fresh air to enter the incubator.

Chicken eggs should be turned at least three times per day from Day 2 to Day 18 of incubation. Do not turn the eggs after 18 days of incubation.

The study of the development of the chick is a fun and interesting project that can be done by all ages.

Table 4. Wet-bulb Reading for Different Incubation Temperatures.

Incubator Temperature	Relative Humidity					
	45%	50%	55%	60%	65%	70%
	Wet-bulb Reading (°F)					
99.5°F (37.5°C)	80.8	82.8	85.1	86.9	88.7	90.1
100°F (37.8°C)	81.3	83.3	85.3	87.3	89.0	90.7
101°F (38.3°C)	82.2	84.2	86.2	88.2	90.0	91.7
102°F (38.9°C)	83.0	85.0	87.0	89.0	91.0	92.7