

the air chamber. The chick begins to breathe slowly the contained air, and it may be heard to peep within the shell.

On the twenty-first day the escape of the chick from its prison begins. The first break in the shell is made by a sharp horny structure, the egg-tooth, located near the tip of the beak. The chick begins to breathe normally. The allantois dries up and the circulation in it rapidly ceases.

The further act of hatching is accomplished by the chick while slowly revolving in the shell and chipping it in a circular path. Then by a vigorous twist of the neck of the chick, the walls of the shell begin to shake, and the foundation falls apart; freedom is gained. But the chick is wet, and for a while seems exhausted and helpless.

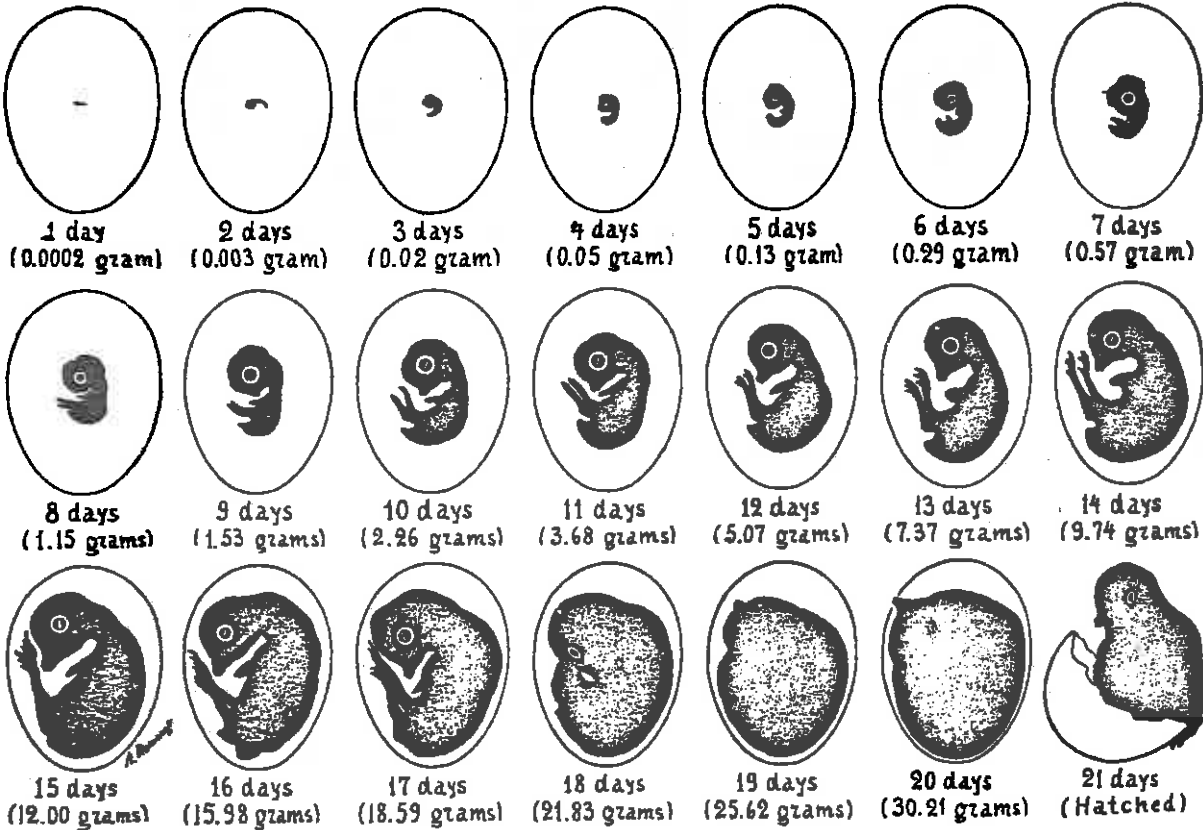
A few hours later the full advantage of freedom is

taken as the chick, dry and fluffy, wanders about the new and mysterious world.

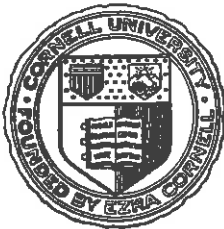
AFTER HATCHING

The egg-tooth has served its purpose very well, although only for a single critical event in the life of the chick, as a tool to crash through the shell. But now its usefulness is over. And it will be lost in a few days.

The yolk material, weighing about one-sixth of the chick weight will soon be advantageously utilized. This natural provision of food helps the chick to be contented for a day or two during a long journey from the hatchery to a new permanent home, which may be hundreds of miles away.



Daily changes in the weight and form of the developing chick embryo (white leghorn)



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FROM THE EGG TO THE CHICK

Alexis L. Romanoff

One of the greatest miracles of nature is the transformation of the egg into the chick. In a brief three weeks of incubation, a new fully-developed chick emerges from a seemingly lifeless egg.

WHERE CHICK LIFE BEGINS

The life of the chick begins from a single cell. This cell is originated from the union of two parental cells in the process known as *fertilization*. In birds, the fertilization occurs about 24 hours before the egg is laid.

DEVELOPMENT PRIOR TO EGG-LAYING

The newly-formed single cell begins to divide, first in two, then in four, eight, sixteen, thirty-two, and more

cells. At the time of egg-laying, hundreds of cells are grouped in a small, whitish spot which is easily seen on the upper surface of the egg-yolk. This spot, or blastoderm, of a fertilized freshly-laid egg is the beginning of the chick (figure 1).

When the egg is laid and cooled the development ceases. Cooling of the egg at ordinary temperature does not result in the death of the embryo. It may resume its development after several days of rest, if it is again heated by the hen or in the incubator.

DEVELOPMENT DURING INCUBATION

As soon as the egg is heated again the cluster of cells in the blastoderm begins to multiply by successive divisions. The first cells so formed are all alike. Then as the division of cells progresses some differences begin to appear. In some parts of the cluster these differences in the appearance of cells become more and more pronounced. Gradually the various parts of the cluster acquire peculi-

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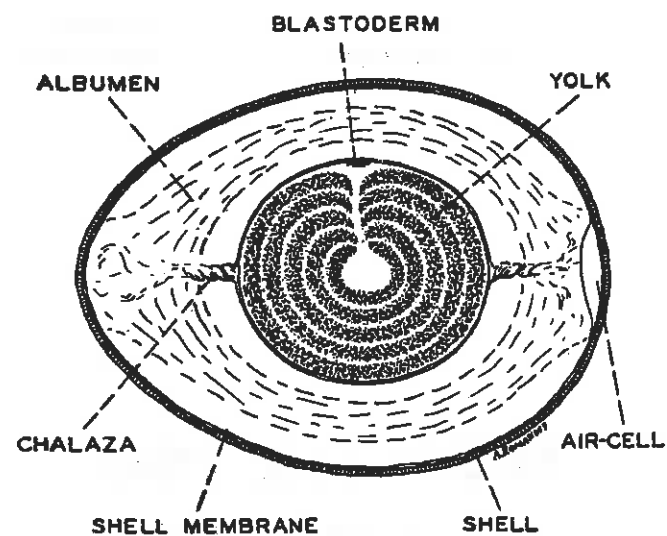


Figure 1. Cross-section of a fresh egg

arities in structure and cell grouping. These new groupings of cells start to serve the rest of the cluster in their own way. They become important organs, and the whole cluster, consisting of many millions of cells, becomes a new organism.

The development from a single cell to a pipping chick is a continuous, orderly process. This process involves many changes from apparently simple to new, complex structures. From these structures arise all organs and tissues of the living chick (table 1).

Physiological Processes Within the Egg

Many elaborate physiological processes take place in the course of the transformation of the egg into the chick. These processes are: the utilization of highly nutritious food materials from the egg; the respiration of gases, or the taking in of oxygen and the removal of carbon dioxide; and the building up of living energy within the chick with the elimination of heat (figure 2).

Function of embryonic membranes

Special temporary organs or embryonic membranes are formed within the egg, both to protect the embryo and to provide for its nutrition, respiration, and excretion. These organs include the yolk sac, amnion, and allantois (figure 3). The yolk sac supplies food material to the embryo. The amnion, by enclosing the embryo, provides for its protection. The allantois serves as a respiratory organ and as a reservoir for the excreta. These organs function within the egg only until the time of hatching, and form no part of the fully developed chick.

TABLE 1. Important Events in Embryonic Development

Before egg-laying	Fertilization Division and growth of living cells Segregation of cells into groups of special function
Between laying and incubation:	No growth; stage of inactive embryonic life
During incubation:	
First day:	
16 hours	First sign of resemblance to a chick embryo
18 hours	Appearance of alimentary tract
20 hours	Appearance of vertebral column
21 hours	Beginning of formation of nervous system
22 hours	Beginning of formation of head
23 hours	Appearance of blood islands — vitelline circulation
24 hours	Beginning of formation of eye
Second day:	
25 hours	Beginning of formation of heart
35 hours	Beginning of formation of ear
42 hours	Heart begins to beat
Third day:	
50 hours	Beginning of formation of amnion
60 hours	Beginning of formation of nose
62 hours	Beginning of formation of legs
64 hours	Beginning of formation of wings
70 hours	Beginning of formation of allantois
Fourth day	Beginning of formation of tongue
Fifth day	Formation of reproductive organs and differentiation of sex
Sixth day	Beginning of formation of beak and egg-tooth
Eighth day	Beginning of formation of feathers
Tenth day	Beginning of hardening of beak
Thirteenth day	Appearance of scales and claws
Fourteenth day	Embryo turns its head toward the blunt end of egg
Sixteenth day	Scales, claws, and beak becoming firm and horny
Seventeenth day	Beak turns toward air cell
Nineteenth day	Yolk sac begins to enter body cavity
Twentieth day	Yolk sac completely drawn into body cavity
	Embryo occupies practically all the space within the egg except the air cell
Twenty-first day	Hatching of chick

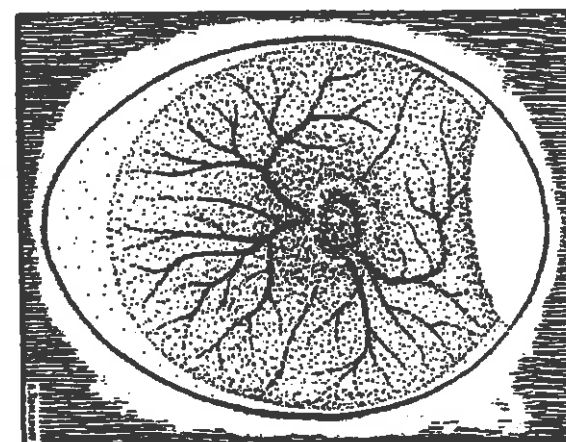


Figure 2. Four-day-old chick embryo seen through the shell

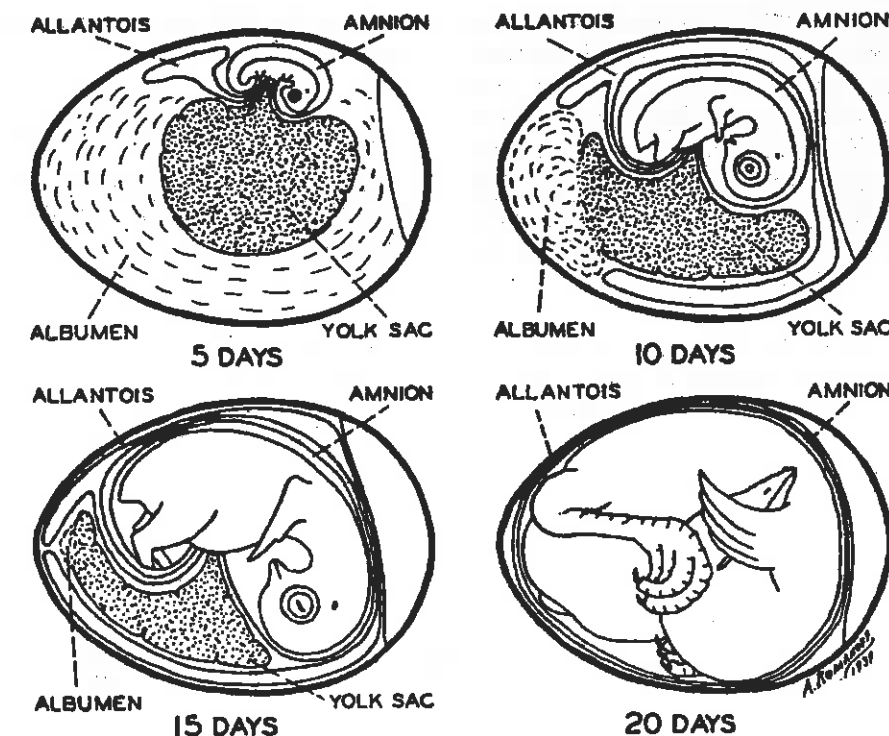


Figure 3. Successive changes in the position of the chick embryo and its membranes

Function of embryonic blood vessels

During the incubation period of the chick there are two sets of embryonic blood vessels. One set, the vitelline vessels, is concerned with carrying the yolk materials to the growing embryo. The other set, the allantoic vessels, is chiefly concerned with the respiration and with carrying waste products to the allantois (figure 4). When the chick is hatched these embryonic blood vessels cease to function.

HATCHING

The time of hatching is an important event in the life of the chick. Several changes preparatory to hatching take place on the seventeenth to the nineteenth days. Fluid decreases in the amnion. The neck acquires a double bend so that the beak is under the right wing and toward the air chamber. The remaining yolk sac is retracted into the body cavity for use as food after hatching.

On the twentieth day the chick thrusts forward its head; the beak rapidly pierces the membranes and enters

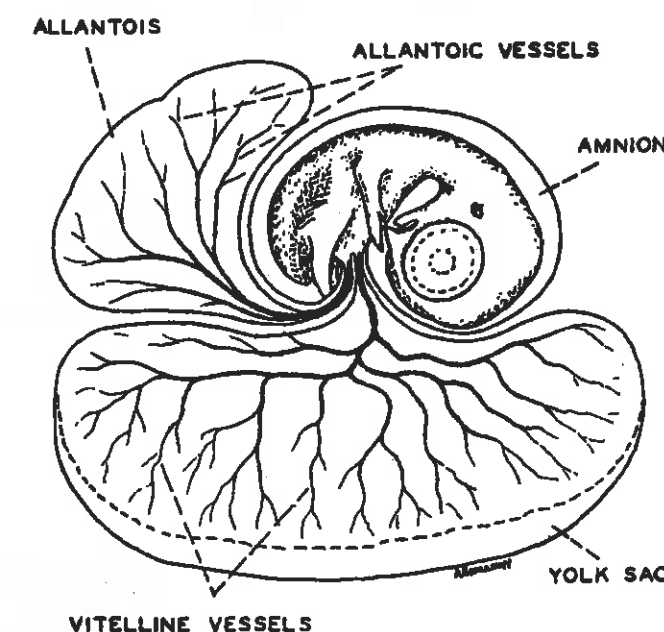


Figure 4. Seven-day-old embryo with its embryonic membranes and embryonic blood vessels (slightly modified from Duval)