

Avian Female Reproductive System

Jacquie Jacob and Tony Pescatore, Animal Sciences

Anyone raising poultry for eggs, whether for eating or for incubation, should have an understanding of the reproductive system. This will help them understand any problems that may occur and how to correct them. The avian reproductive system is different from that of mammals. Nature has designed it to better suit the risks associated with being a bird. Unless you are a bird of prey (a hawk, eagle or falcon), you are faced with the fact that everyone is trying to eat you. Being close to the bottom of the food chain requires the development of unique strategies for feeding and reproducing—all while retaining the ability to fly (Figure 1)

The reproductive strategy of most mammals, especially primates (such as chimpanzees, apes and gorillas), is to produce only a few offspring and devote a considerable amount of time to caring for them. Once they are full grown and ready to take care of themselves, the parent's job is complete.

Birds (with some exceptions, of course) have developed a strategy where they produce multiple offspring and tend to their needs for only a short period of time before tossing them into the wind, sometimes literally. The amount of time they devote to caring for their offspring depends on whether they are precocial (well developed at hatch) or altricial (under-developed when hatched), with the latter requiring more post-hatch parental care.

While mammals typically give birth to their offspring, the offspring of birds develop outside the body of the parents—in eggs. When carried in the womb, mammalian embryos receive their daily requirement for nutrients directly from their mother via the placenta. For birds, however, all the nutrients that will be needed for the embryo to fully develop must be provided in the egg before it is laid.

The female reproductive system of the chicken is shown in Figure 2. It is divided into two separate parts: the **ovary** and the **oviduct**. In almost all species of birds, including chickens, only the left ovary and oviduct are functional.

Although the embryo has two ovaries and oviducts, only the left pair (i.e., ovary and oviduct) develops. The right typically regresses during development and is non-functional in the adult bird. There have been cases, however, where the left ovary and oviduct have been damaged and the right one has developed to replace it.

The **ovary** is a cluster of developing yolks or **ova** and is located midway between the neck and the tail of the bird, attached to the back. The ovary is fully formed when pullet chicks hatch, but it is very small until the chicks reach sexual maturity. At hatch, pullet chicks have tens of thousands of potential eggs (i.e., ova) which theoretically could be laid. Most of these, however, never develop

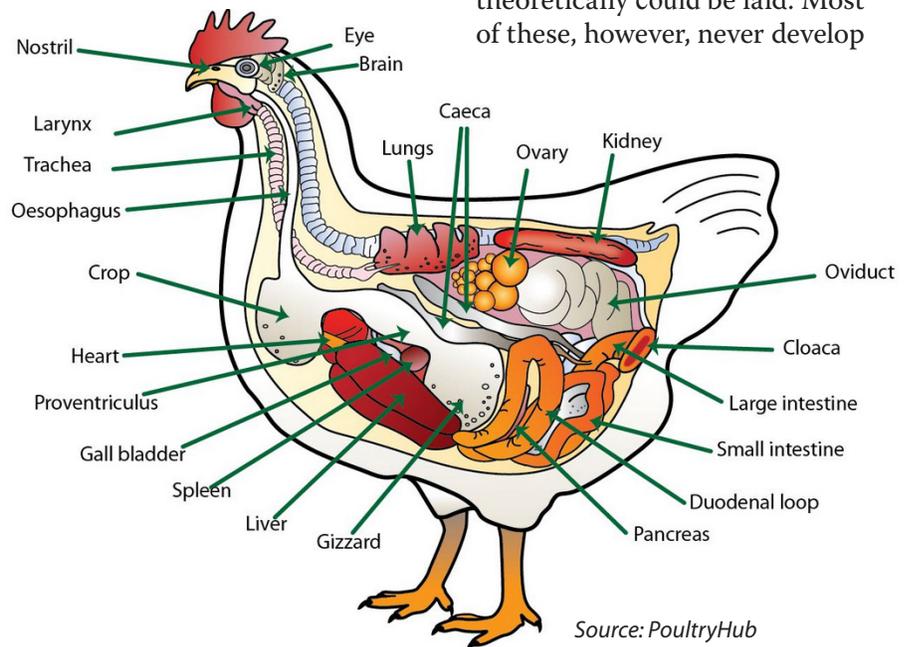


Figure 1. The internal organs of the female chicken.

to the point of ovulation. So the maximum number of eggs a hen can lay is determined when she hatches since no new ova are added once the chick has hatched.

Each ovum (singular form of ova) starts out as a single cell surrounded by a **vitelline membrane**. As the ovum develops, yolk is added. The color of the yolk comes from fat soluble pigments called **xanthophylls** contained in the hen's diet. Hens fed diets with yellow maize, or allowed to range on grass, typically have dark yellow yolks. Hens fed diets with white maize, sorghum, millet or wheat typically have pale yolks. The color of the yolks from these hens can be improved by the addition of marigold petals to provide the desired level of xanthophylls in the yolk.

Ovulation is the term used for the release of the mature ovum from the ovary into the second part of the female reproductive system, the oviduct. During ovulation the ovum, which is enclosed in a sack, ruptures along the suture line or **stigma** (see Figure 3). Occasionally the vitelline membrane is damaged and pale spots or blotches develop on the yolk. This is referred to as **mottling**. Although the appearance of the yolk is changed, there is no effect on the

egg's nutritional value or flavor. A slight degree of yolk mottling is normal and is not typically noticed by consumers. A high incidence of yolk mottling, however, adversely affects consumer acceptance. The use of cottonseed meal (which contains gossypol) and sorghum (which contains tannin) in the diet can also increase the incidence of mottling. A calcium deficient diet will also have the same effect.

The female reproductive system is sensitive to light exposure, especially the number of hours of light in a day. The release of the next ova typically occurs 30-75 minutes after the previous egg has been laid. If the egg was laid too late in the day the next ovulation will wait till the next day and the hen will have a day when she does not lay an egg.

The second major part of the female chicken's reproductive system is the **oviduct**. The oviduct is a long convoluted tube (25-27 inches long when fully developed) which is divided into five major sections. They are the infundibulum or funnel, magnum, isthmus, shell gland, and vagina.

The first part of the oviduct, the **infundibulum** or funnel, is 3-4 inches long, and engulfs the ovum released from the ovary. "Funnel" is an inaccurate choice of name for

this part since it gives the vision of the infundibulum waiting for the ovum to fall into it, which is not the case. Instead the released ovum stays in place and the muscular infundibulum moves to surround it. The ovum or yolk remains in the infundibulum for 15-18 minutes.

Fertilization, if it is going to occur, takes place in the infundibulum.

The next section of the oviduct is the **magnum** which is 13 inches long and is the largest section of the oviduct as its name implies (from the Latin word for "large"). The ovum or yolk remains here 3 hours during which time the thick white or **albumen** is added and the **chalaza** is formed.

The third section of the oviduct is the **isthmus** which is 4 inches long. The developing egg remains here for 75 minutes. The isthmus, as its name implies, is slightly constricted (The term "isthmus" refers to a narrow band of tissue connecting two larger parts of an anatomical structure). The isthmus is where the inner and outer **shell membranes** are added.

The next section of the oviduct is the **shell gland** or uterus. The shell gland is 4-5 inches long, and the egg remains here for 20 plus hours. As its name implies, the **shell** is placed on the egg here. The

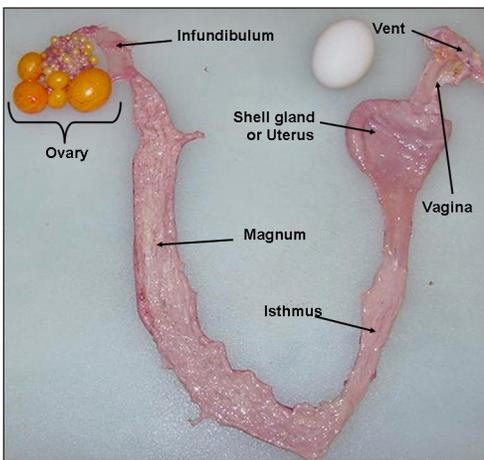


Figure 2. Parts of the reproductive tract of a female chicken. *Jacque Jacob.*

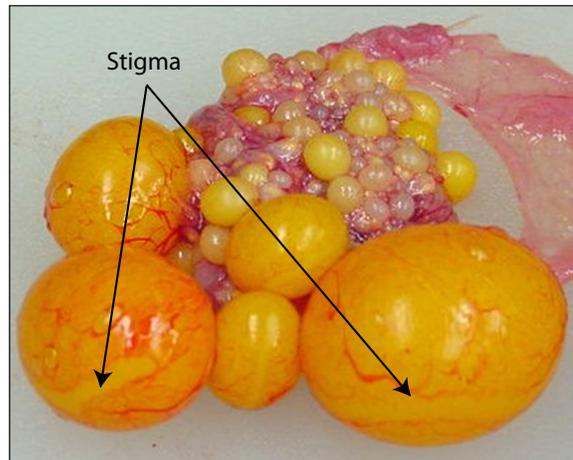


Figure 3. Ovary of a female chicken. *Jacque Jacob.*

shell is largely made up of calcium carbonate. The hen mobilizes calcium from her bones to provide 47% of the calcium for the shell. The remainder of the required calcium is supplied by the feed.

Pigment deposition, if there is any, is also done in the shell gland.

The last part of the oviduct is the **vagina** which is about 4-5 inches long and does not really play a part in egg formation. The vagina is made of muscle which helps push the egg out of the hen's body. The **bloom** or cuticle is also added to the egg in the vagina prior to **oviposition** (the laying of the fully formed egg).

Near the junction of the vagina and the shell gland, there are deep glands known as **sperm host glands**. They get their name from the fact that they can store sperm for long periods of time (10 days to 2 weeks). When an egg is laid, some of these sperm can be squeezed out of the glands into the oviduct so that they can migrate farther up the oviduct to fertilize an ovum. This is one of the really remarkable things about birds; the sperm remain viable at body temperature. This allows the hen to have fertile eggs for a period of time after a mating.

Birds lay eggs in clutches. A **clutch** consists of one or more eggs laid each day for several days, followed by a rest period of about a day or more. Then another egg or set of eggs is laid. Clutch size is species- and breed-specific. For commercial egg layers clutch size is typically quite large. Clutch size, as well as the numbers of clutches laid in a laying cycle, will vary with species, but the principle is the same.

In chicken hens, ovulation usually occurs in the morning and under normal daylight conditions, almost never after 3:00 PM. The total time to form a new egg is

about 25-26 hours. This includes about 3½ hours to make the albumen, 1½ hours for the shell membranes, and about 20 hours for the shell itself.

Ovulation of a yolk for the next egg in a clutch occurs 30-75 minutes after the hen lays the previous egg, and so that each day the hen gets later and later in her timing. As an analogy, she runs behind, like a clock that is improperly adjusted. Eventually she gets so far behind schedule that she would have to lay eggs after dusk. Since hens do not typically ovulate late in the day, the next ovulation is delayed until at least the next day and egg laying is interrupted. This delay results in the break between clutches and the cycle repeats itself a day or so later.

Occasionally, a hen will produce **double-yolked eggs**. This phenomenon can be related to hen age but genetic factors are also involved. Young hens sometimes release two yolks from the ovary in quick succession. Double-yolked eggs are typically larger in size than single yolk eggs. Double-yolked eggs are not suitable for hatching. There is typically not enough nutrients and space available for two chicks to develop to hatch. It has happened, but it is rare.

Occasionally a young hen will produce an egg with no yolk at all. **Yolkless eggs** are usually formed when a bit of tissue is sloughed off the ovary or oviduct. This tissue stimulates the secreting glands of the different parts of the oviduct and a yolkless egg results.

Although it is rare, hens have laid an egg with a whole egg inside. This occurs when an egg that is nearly ready to be laid reverses direction and moves up the oviduct and encounters another egg in process of being put together. The results is that the first egg gets a new layer

of albumen added and two eggs are encased together within a new shell. Such eggs are so rare that no one knows exactly why they happen.

Another egg problem that is commonly noted if you raise your own chickens is blood and meat spots. **Blood spots** are normally found on or around the yolk (Figure 4). The main cause is a small break in one of the tiny blood vessels around the yolk when it is ovulated. High levels of activity during the time of ovulation can increase the incidence of blood spots. **Meat spots** are usually brown in color and are more often associated with the egg white. They are formed when small pieces of the wall of the oviduct are sloughed off when the egg is passing through. In commercial operations, eggs with blood or meat spots are typically identified during candling and removed. It is rare, therefore, to see these eggs in stores. The incidence is higher in brown shelled eggs, and it is harder to identify them when candling the darker colored shells.

Occasionally an egg will be laid without a shell. It feels like a water balloon. The shell membranes were placed on the yolk and egg white, but it somehow slipped past the shell mechanism and the shell wasn't deposited. The occurrence

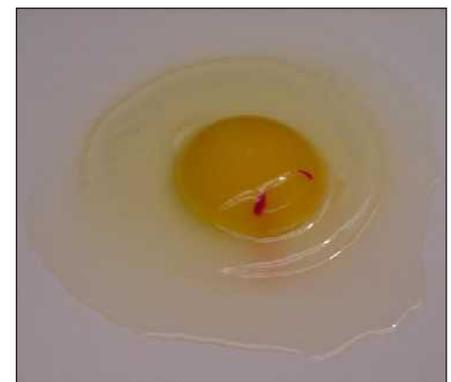


Figure 4. An egg with a blood spot on the yolk. Steve Patton, UK.

Precocial and Altricial Birds



Precocial birds are well developed when hatched and are able to get up and walk around on their own very quickly. This type includes most of the domestic poultry species—chickens, ducks, turkeys, etc.

Altricial birds are underdeveloped when they hatch



and require a considerable amount of parental care before they are able to survive on their own. This type includes pigeons and passerine birds (i.e., perching/song birds) and hummingbirds. *Photos by Jacquie Jacob.*

of the occasional shell-less egg is not necessarily an indication of any health problem. If the incidence increases, however, there may be a deficiency of calcium, phosphorus and/or vitamin D. If the condition persists a veterinarian should be consulted. Infectious Bronchitis and Egg Drop Syndrome have been known to cause an increase in shell-less eggs.

Other things occasionally go wrong when an egg shell is being developed. The most obvious relates to shell texture. Occasionally the shell becomes damaged while still in the shell gland and is repaired prior to being laid. This results in what is known as a **body check**. Occasionally there will be **thin spots** in the shell or **ridges** will form. The shells of such eggs, though not cracked, are weaker

than 'normal' eggs and should not be used as hatching eggs or sold as table eggs. Such hatching eggs will typically not produce a chick while table eggs are easily broken on the trip from the farm to the consumer.

A second category of problems is **abnormal shape**. Such eggs do not fit well into a typical egg carton or are more likely to break during transport, so they are removed during egg inspection and do not normally appear in eggs sold in the store.

To be considered a hatching egg, the egg should be a typical egg shape. Abnormally shaped eggs should not be used as hatching eggs. In many cases it is not clear which is the large end (and eggs should be incubated large end up) or they may not properly fit in the egg trays.