
Breeding
Management

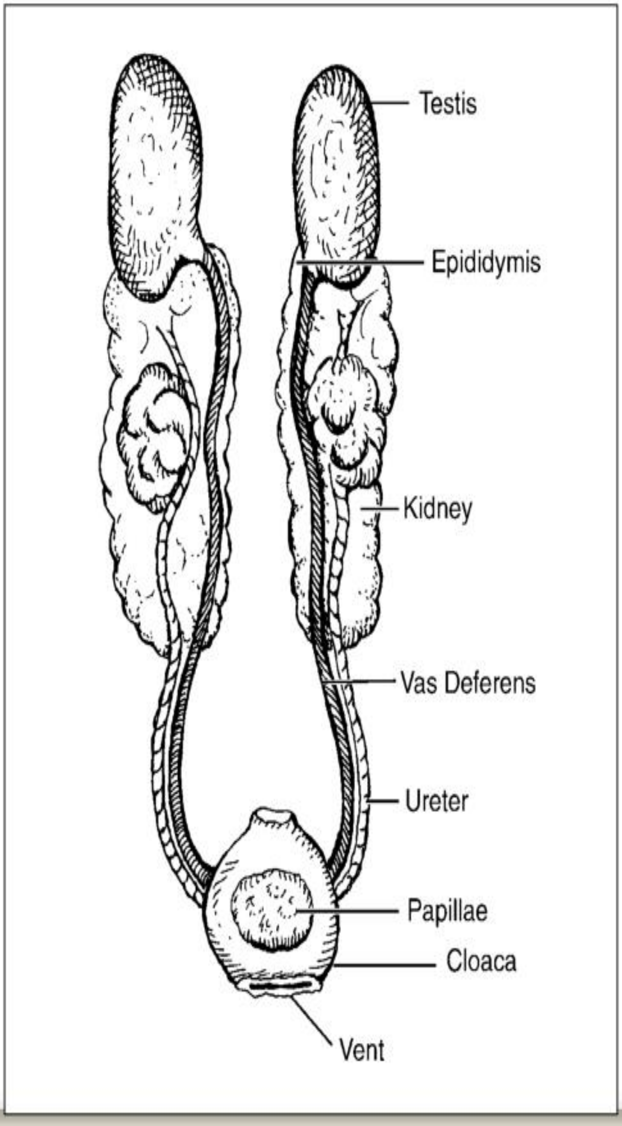
The Reproductive System

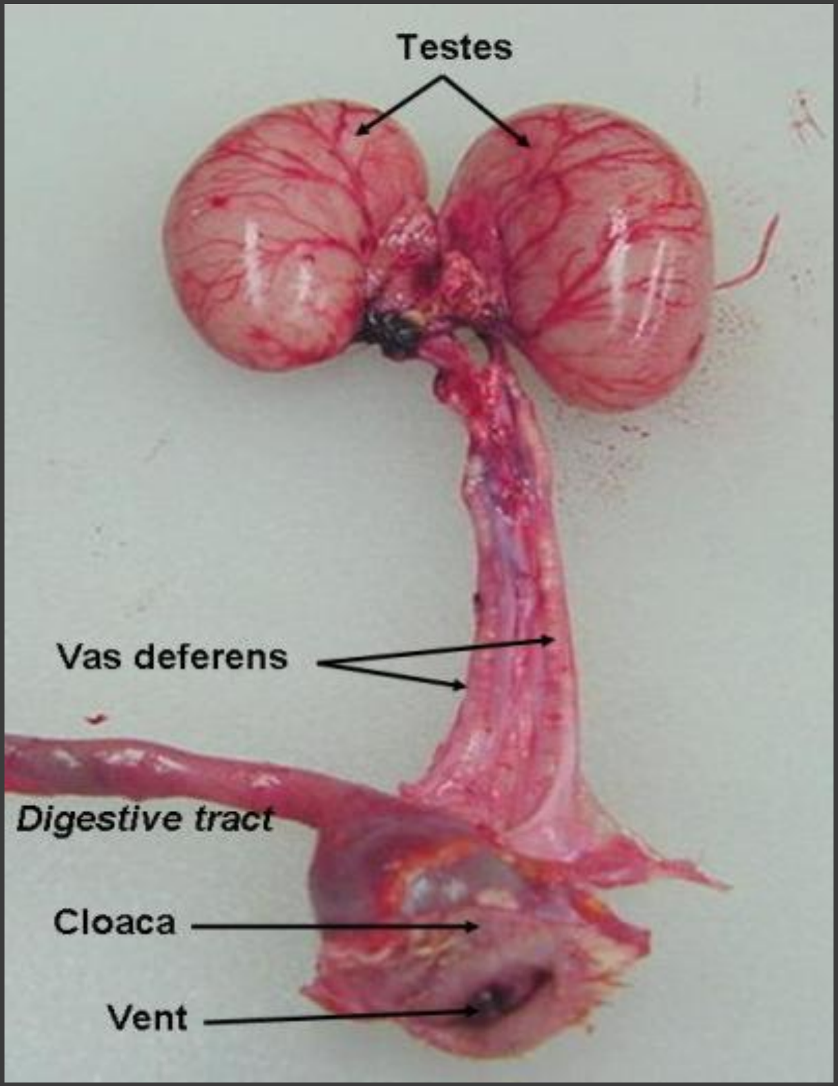
- The avian **reproductive system** is heterosexual and requires both a male and a female, each to contribute half of the genetic constitution of the offspring.
- The male contributes his half by way of the sperm produced by the testes and carried in the semen.
- The female contributes hers in the ovum carried by the egg yolk produced by the ovary.
- The ovum is often referred to as the **blastodisc**, **blastoderm** or **germ disc**.
- After release from the follicle on the ovary, the yolk moves into the oviduct where it is fertilized and has added to it the albumen, shell membranes and shell.

Male reproductive system

- The male reproductive organs in the domestic fowl consist of two testes, each with a deferent duct that leads from the testes to the cloaca.
- Fowls do not have a penis such as is found in other animals.
- The testes are bean shaped bodies located against the backbone at the front of the kidney.
- Their size is not constant and they become larger when the birds are actively mating.
- The left testes is often larger than the right. On the inside of each is a small, flattened area that is believed to correspond to the epididymis of mammals.
- The deferent duct starts at this flattened area.

Male Poultry Reproductive Tract




Testes
Vas deferens
Digestive tract
Cloaca
Vent

Deferent Duct

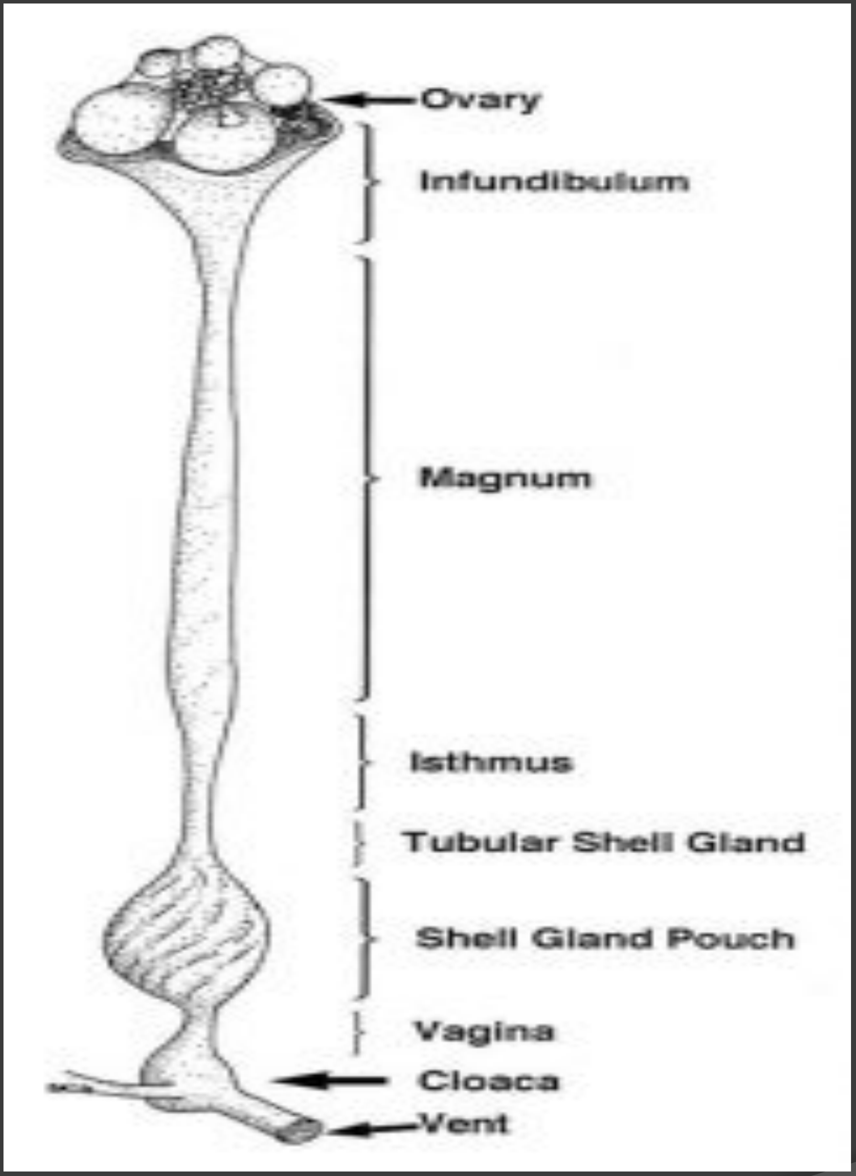
- The deferent duct transports the sperm from the testes where they are formed to the cloaca from which they enter the oviduct of the female when mating. The deferent duct enters a small pimple-like structure in the cloaca. This structure equates to the mammalian penis and is much larger in ducks to form a penis like organ. The deferent duct is quite narrow at first but widens as it approaches the cloaca.

Testes And Sperm

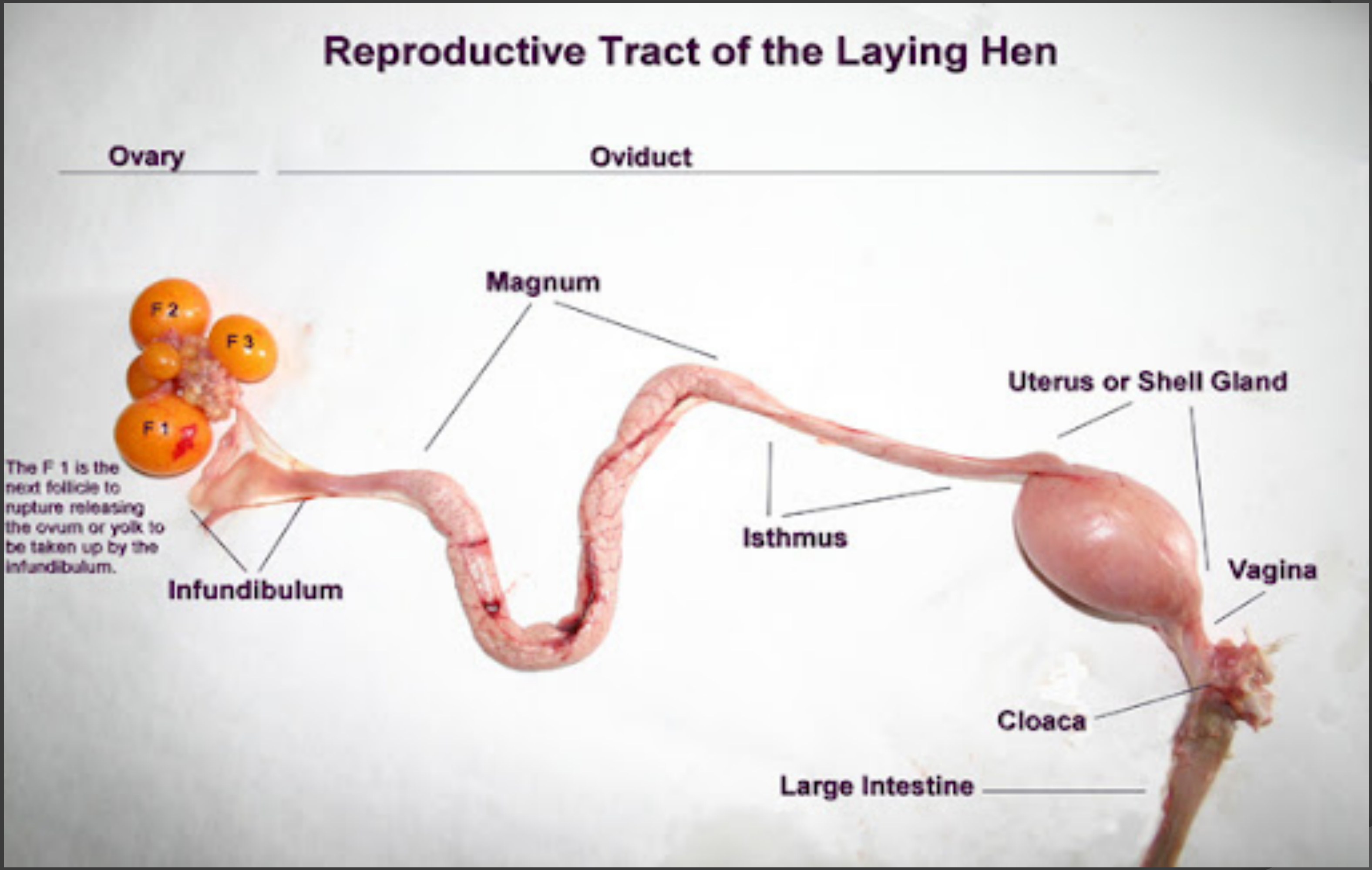
- In the testes very twisted tubes called seminiferous tubules are found.
- It is in these tubules that a special process of cell division called meiosis and transformation produces the sperm.
- The sperm carry half of the total chromosomes required to produce an embryo.
- The mother provides the other half. One cubic millimetre of the fluid called semen produced by the male contains on average 3-5 million sperm.
- Under a microscope the sperm of the fowl will be seen to have a long pointed head with a long tail.
- The testes also produce hormones called **androgens** that influence the development of what are called secondary sex characteristics such as comb growth and condition, male behaviour and mating.

Female reproductive system

- The female reproductive system in the domestic fowl consists of the ovary and the accompanying oviduct. While the female embryo in chicken has two sets of reproductive organs, only one of these, the left survives and reaches maturity to produce eggs. The single surviving ovary is located in the laying hen just in front of the kidneys in the abdominal cavity and is firmly attached to the wall of the cavity. The ovary is well endowed with blood vessels to ensure there is no hindrance to the transport of nutrients to the developing yolk.



Ovary
Infundibulum
Magnum
Isthmus
Tubular Shell Gland
Shell Gland Pouch
Vagina
Cloaca
Vent


Reproductive Tract of the Laying Hen
Ovary
Oviduct
Magnum
F 2
F 3
F 1
Uterus or Shell Gland
The F 1 is the next follicle to rupture releasing the ovum or yolk to be taken up by the infundibulum.
Isthmus
Vagina
Infundibulum
Cloaca
Large Intestine

Ovary

- The ovary consists of a mass of yellowish, rounded objects called follicles, each containing an ovum or yolk. There are many such follicles but only a small number in comparison, will ever reach maturity to produce an egg. When the hen is in lay the ovary will be active. The size of the follicles will vary from very small to those approaching the normal yolk size in the egg which can be up to 40 millimetres in diameter, and will contain a fully matured yolk ready for release into the oviduct.
- It is possible to find five stages of development in the active ovary:
- Primary follicles – follicles that have not yet commenced to grow
- Growing follicles
- Mature follicles – follicles ready or nearly so for release
- Discharged follicles – where the yolk has just been released
- Atretic follicles – those from which the yolk has been released some time ago

Yolk

- It takes approximately 10 days for a yolk to develop from the very small to the normal size found in eggs and during this time it is contained in the follicle.
- The follicle acts as a sack during this period of development supplying it with the nutrients required for its growth.
- When a mature follicle is examined an elongated area virtually free of blood vessels will be found on the distal surface of it.
- This area, called the **stigma**, is where the follicle normally splits to release the yolk into the oviduct.
- If, for some reason, the follicle splits at other than the stigma, the numerous blood vessels that rupture will result in free blood being found in the egg i.e. a blood spot will form.

Oviduct

- The function of the oviduct is to produce the albumen, shell membranes and the shell around the yolk to complete
- the egg. It is a long tube well supplied with blood via numerous blood vessels. There are many glands found in its walls that produce the albumen, the shell membranes and the shell. In the non-layer, the oviduct is quite short and small in diameter. However, once the reproductive system becomes active, it grows to a length of 70-80 centimetres with a variable diameter depending on the function of the section being examined.
- The oviduct consists of five distinct parts or sections, each having different functions:

- **Infundibulum (or funnel):** located adjacent to the ovary and with long segments enclosing the ovary, the infundibulum collects the yolk after its release from the follicle as a funnel and directs it into the oviduct.
- This section has very thin walls and is 6-9 centimetres long.
- Fertilisation of the ovum by the male sperm occurs here.
- **Ampulla or magnum:** at approximately 40 centimetres long it secretes more than 40% of the albumen.
- **Isthmus:** at about 12 centimetres in length, it secretes some albumen and the shell membranes.
- **Uterus or shell gland:** at approximately 12 centimetres in length it secretes about 40% of the albumen and the egg's shell.
- **Vagina:** at approximately 12 centimetres in length, it secretes the egg's outer cuticle and possibly the shell pigment.

Androgen, Oestrogen And Progesterone

- In addition to the production of eggs, the female reproductive system also produces hormones that aid in the control of body functions. These include androgen, oestrogen and progesterone. Androgen causes comb growth and condition and has a function in the formation of albumen. Oestrogen causes the growth of the female plumage, mating and nesting behaviour, oviduct development together with the nutrient supply to the ovary/oviduct for egg formation. Progesterone, with androgen, is involved in the production of albumen and the carriage of the message to the pituitary gland to release luteinising hormone.
- The female reproductive system remains dormant in the young chicken and growing pullet until she reaches the age when these organs start to prepare for the normal production of eggs. One of the first signs of her developing maturity is the change in the comb development. This organ starts to grow and to take on a vivid red hue as the hormones produced by the now awakening ovary start to have an effect.

The Ovary And Yolk Formation

- The ovary is attached to the abdominal cavity wall by the meso-ovarian ligament. It carries anything from 2,000 to 12,000 small ova in miniature follicles on its surface, plus hormone producing cells in its body. Not all of the ova found on the immature ovary develop and only approximately 200 to 350 reach maturity under normal modern commercial practice. Each yolk or ova takes about 10 days to grow and reach maturity when it is approximately 31% of the weight of the egg.
- The yolk is laid down in concentric rings of darker and lighter coloured material, the colour being produced by xanthophylls that are yellow/orange/red pigments occurring in many plants, plant products and other naturally occurring materials. The bulk of the yolk material provides a source of food for the developing embryo that originates by the fertilising of the germ disc or blastoderm usually located on the upper surface of the yolk of the broken out egg. It lies in the surface segment of the latebra which is a vase-shaped segment of different yolk with its base in the centre of the yolk, the lips on the surface and the stem joining the base to the lips.

- Yolk development in the **maturing pullet** is initiated by follicle stimulating hormone **(FSH)** produced by the anterior lobe of the pituitary gland.
- The compounds in the yolk material are formed in the liver and, on the appropriate signal, are transported by the blood stream to the target follicle and into the yolk.
- The appropriate signal for this development comes from the hormones oestrogen, progesterone and testosterone which are produced by the ovary after receiving the signal of the FSH.
- These ovarian hormones also provide the stimulus for the formation of the development of the oviduct.
- The yolk is contained in a very thin, transparent membrane called the vitelline membrane.
- As an egg becomes stale, the vitelline membrane becomes significantly weakened and often breaks to release the yolk contents when the stale egg is broken out.
- On ovulation the yolk is released and enters the oviduct where, as it passes along that organ, fertilisation occurs and the remaining parts of the egg are added around it.
- The yolk is located in a sack called the follicle, held on the ovary. The follicle, which although quite thin-walled, is extremely well supplied with blood vessels. These are necessary to carry the yolk constituting materials that have been formed in the liver.

Ovulation

- The release of the yolk (the process of ovulation), is the major controlling factor influencing the subsequent steps in the formation and laying of the egg.
- As a consequence, factors that influence ovulation are of critical importance to the various aspects associated with egg production.
- The presence of a mature yolk in a follicle causes hormones from the ovary to stimulate the release of **luteinising** hormone (LH) by the pituitary gland.
- The presence of LH in the blood stream causes the follicle that contains the mature yolk to split along the stigma thus releasing it into the oviduct abdominal cavity adjacent to the oviduct.

- **Sexual Maturity**
- Sexual maturity is reached when the hen lays the first egg in her life. Generally sexual maturity is genetically controlled, however, environmental factors play a very significant role. It will be in the age range of 18-24 weeks depending on fowl genotype, but it can be manipulated by controlled feeding practices, light intensity and day length management and other management practices.
- **Initiation Of Ovulation**
- The controlling mechanism setting the time of the day for the first ovulation is not fully understood. However, nervous and hormonal factors are important. Subsequent ovulations are, however, controlled largely by the time of the previous egg passing through the vent (being laid). Subsequent yolk release, if at all, occurs approximately 40-60 minutes after the previous egg has been laid.

- **Clutches**
- Eggs laid on successive days are called a clutch. Clutches are separated by days when no eggs are laid. Clutch size is an individual characteristic and may vary in a flock from 2 up to 100 eggs. However, the normal clutch size is significantly less than that and ranges from 3-8 eggs. The larger the clutch size the better will be the total production. Small clutch size indicates an inferior laying performance and is usually associated with long breaks in between.
- **Egg Formation Time**
- The time taken from ovulation until when the egg passes through the vent varies with individuals within the range of 23 to 26 hours. If the time is longer than 24 hours then the time of laying will be progressively later in the day for each successive egg in the clutch. When eggs are laid at a late hour, an ovulation is missed and the start of a new clutch will be earlier in the next laying day.
- **Ovulation Time**
- Hens that produce long clutches release the yolk very shortly after first light (whether natural or artificial light). Successive ovulations occur very shortly after the laying of the previous egg. Those that produce short clutches usually release the yolk later in the day and often have longer periods between laying time and the next ovulation.

- **Oviduct**
- The other components of the egg are the albumen, the shell membranes and the shell, and are produced by different segments of the oviduct. These segments are:
- Infundibulum
- Magnum or ampulla
- Isthmus
- Uterus or shell gland
- Vagina
- Cloaca
- In the egg laying hen the oviduct is a tube like organ that consists of the previously named segments with one end lying adjacent to the ovary and the other entering the vent. It is approximately 70 centimetres long and is very glandular. The glands of the different segments produce the remaining different parts of the egg. Because of its function the oviduct is very well supplied with blood vessels.
- **Infundibulum**
- This segment is funnel-shaped and lies adjacent to the ovary. It is up to 9 centimetres long in the laying hen and has the function of searching for and engulfing the yolk that has just been released from the follicle into the adjacent ovarian pocket or body cavity. The yolk remains in the infundibulum for about 15 minutes and it is here that fertilisation takes place.
- If the infundibulum malfunction and does not engulf the yolk, the yolk will remain in the ovarian pocket from where normally they will be absorbed within three days. If the number of such occurrences reaches a high level, the yolks will accumulate in the ovarian pocket faster than they can be absorbed. Such birds' are called internal layers as the abdomen becomes distended and the hens adopt a very upright stance.

- **Magnum Or Ampulla**
- The magnum is the longest segment at up to 40 centimetres long. Its function is to add approximately 40% of the albumen to the developing egg that takes about three hours to move through. These percentages vary considerably depending on quite a few factors including the genetics of the hen, age of the bird, the egg's age and/or storage conditions. However, in a good quality, freshly laid egg the above relationship mostly applies.
- The **chalazae** are two twisted chords of albumen extending from the opposite sides of the yolk into the remaining albumen in the broken out egg. These two cords extend into the ends of the egg along the longitudinal axis and are parts of a very thin envelope of special albumen that surrounds the yolk and holds it in its position. The yolk has to remain centrally located for the survival of the embryo. The yolk turning or rotating as it passes along the oviduct causes the twisted effect of the chalazae.
- While the bird produces only dense albumen, as the egg moves along the oviduct, water is added thus making **liquid albumen**. The rotation of the developing egg causes the albumen to separate into the inner liquid and the **dense layers**. The outer liquid layer is caused by the addition of more water when in the uterus. The dense layer contains significant amounts of mucin that binds it together in a jelly like form. As an egg stales, the amount of dense albumen decreases as it changes to the liquid form. The liquid form increases in volume and becomes even more fluid.

- **Isthmus**
- The isthmus is approximately 12 centimetres long and has the functions of adding approximately 20% of the albumen and the shell membranes to the egg. There are two shell membranes:
- The inner shell membrane – laid down first
- The outer shell membrane – laid down last and about three times the thickness of the inner membrane
- The isthmus takes approximately 75 minutes to carry out its tasks. While the egg is still in the oviduct the shell membranes appear as one over the total surface of the egg, so close, they are associated with each other. However, as the egg cools after it has been laid, the membranes separate, usually at the larger end to form the air cell. The air cell in the new laid egg is approximately 1.5 centimetres in diameter and approximately 0.5 centimetres deep.
- As the egg ages, the interior contents lose water and the air cell increases in size. This change in size is an indicator of egg quality as related to the age of the egg and the holding conditions. The shell membranes consist of a fibrous protein material and act as a barrier to bacteria and fungi penetration into the egg. They also help reduce the rate of evaporation of water from the egg thus slowing the rate of deterioration of the egg. The isthmus also lays down the foundation for the shell by forming the first **crystals of calcium** carbonate on the outer shell membrane.

- **Uterus (Shell Gland)And Eggshell Quality**
- The uterus is a relatively short, bulbous gland up to 12 centimetres in length. The developing egg remains in the uterus for 18-20 hours while approximately 40% of the albumen and all of the shell is added. It is for this reason that the organ is often called the shell gland. Shell formation really begins by the deposition of small clusters of calcium carbonate crystals onto the outer shell membrane while in the isthmus. These are the initiation grains for the subsequent calcium carbonate deposition in the uterus. The number of these grains is genetically controlled and is related to the subsequent shell thickness as the more grains deposited in the isthmus, the thicker will be the final shell.
- The shell of an egg is formed in two layers:
- Mammillary layer – a sponge like layer composed of soft calcite crystals ($CaCO_3$). This layer is the inner layer.
- Palisade layer – formed of columns of hard calcite crystals; the longer the columns the stronger the shell. This layer is the outer layer of the egg.
- The calcium for the eggshell comes from the diet, a special bone called medullary bone (found in the cavity of long bones)and the skeleton. The hen uses approximately 2.5 grams of calcium in the formation of one normal egg. She cannot absorb sufficient calcium from her diet each day (approximately 2.0 grams per day) to supply this need and hence, it becomes necessary for her to utilise skeletal calcium to make up the shortfall. This is particularly so at night when most of the shell is being formed but the hen in unlikely to be eating. In addition to the calcite, the shell also contains small quantities of **sodium**, **potassium** and **magnesium**.
- The carbonate ions which go with the calcium to form the calcium carbonate of the egg's shell, come from the blood and the shell gland. If anything should interrupt the supply of carbonate, thin-shelled eggs will result. This occurs in hot weather when hens pant to remove excess heat energy. The increased respiratory rate removes carbon dioxide from the blood thus reducing the carbonate ions available for eggshell formation.
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- **Increased environmental temperature:** This results in reduced food consumption (and calcium) and the reduction of carbonate ions because of panting.
- **Egg laying time:** Eggs laid early in the morning are more likely to have thinner shells than those laid by the same bird later in the day. This is because in the case of those eggs laid early the shells have been deposited during the hours of darkness when the bird does not eat, and therefore no dietary calcium for the shell formation.
- **Stress:** Stressed birds lay thinner shelled eggs.
- **Body checked and misshapen eggs:** Most of these defects are caused by the birds being startled shortly after the egg has entered the uterus and the first layers of calcium carbonate have been deposited. At this stage the shell is very fragile and weak and when startled the hen’s muscles contract (including those in the wall of the uterus) and thus crack the newly forming shell. These are covered by subsequent depositions of shell but the damage remains in the form of body checks and/or misshapen eggs.
- **Disease:** Certain diseases can cause weak shell and misshapen eggs.
- **Drugs:** Certain drugs influence eggshell formation and deposition.

Breeds and strains of broilers and layers of chicken

- A **broiler** is any chicken (*Gallus gallus domesticus*) that is bred and raised specifically for meat production.
- **Classification of Poultry Breeds**
- **Americal Class**
- New Hampshire
- White Plymouth Rock
- Rhode Island Red
- Wyandote II
- **Mediterranean Class**
- They are light bodied & well developed for high egg production.
- Leghorn
- Minorca
- Ancona

- **English Class**
- They are generally utility breeds known for their excellent flushing properties.
- Australorp
- Sussex
- Orphington
- **Asiatic Class**
- They are large bodied with heavy bones feathered shanks & poor layers.
- **Indian breeds**
- Asil (For fighting purpose)
- Kadacknath (Resh is black in colour)
- **Breeds of Chicken**
- Chickens are mainly grown for eggs & meat. Similarly, they are classified as egg-type chicken & meat-types chickens. Breeds of meat type chickens mainly include broilers, roasters, fryers & other meat type chickens. Broilers are genetically selected for quicker growth and raised for meat rather than eggs.

Native breeds of egg type chicken in India

Breed	Body weight (20 weeks)	Age at sexual maturity (days)	Annual egg production (No.)	Egg weight at 40 weeks (g)	Fertility	Hatchability FES (5)
Aseel	1220	196	92	50	66	63
Frizzle	1005	185	110	53	61	71
Kadaknath	920	180	105	49	55	52
Naked neck	1005	201	99	54	66	71

(Source: Central Avian Research Institute)

General aspects of breeding for better egg production and body weight gain.

- **The laying cycle** of a chicken flock is cyclical in nature, particularly in northern latitudes with its seasonally fluctuating hours of light and dark. Egg production normally begins when young birds reach maturity, rises sharply and reaches a peak about eight weeks after it starts, then gradu ally declines over about 12 total months of lay. For most spring hatched birds, the first adult molt occurs in their second fall at the end of their first laying cycle. The total number of eggs laid in that first laying cycle is the highest single year of production the hen will ever experience, as successive years will see a decrease in eggs laid of approximately 15%-20% annually.

  Many factors can adversely affect egg production during a hen's normal laying cycle. Egg production can be affected by the age/breed of chicken, feed consumption (quality and quantity), water intake, intensity and duration of light levels, parasite infestation, disease, and numerous management and environmental factors. A few of the most common are listed here.

- **Age of Hens**
- Pullets normally start to lay between 20-24 weeks of age, depending on breed and line. Some large, slow growing breeds can take up to seven months. However, these timelines are dependent on light levels being above 14 hours of daylight.
- For those like us who are in northern latitudes, this means that pullets hatched later in spring and summer may not begin to lay before the light levels decrease dramatically in autumn.
- In order to lay successfully through their first winter, birds may either need to be hatched early in the year to obtain maturity before light levels decrease, or to be maintained on supplemental lighting beginning in fall of their hatch year.
- If allowed to mature naturally, later-in-the-season hatched chicks may not begin to lay until after the winter solstice.
- The upside to this later beginning of laying is that hens have had longer to mature and may begin their lay cycle with larger eggs and omit the "pullet" egg stage.

- Chickens can live for many years and continue to lay eggs for many of these years.
- However, after two or three years many hens significantly decline in productivity.
- This varies greatly from bird to bird, within lines of the same breed and between various breeds.
- Good heritage layers will lay consistently for 3-5 years, high production hatchery hybrids may lay almost daily for only a year or two.
- Poorer layers and older hens will lay less consistently. If consistent egg production is critical, then a yearly addition of pullets should be scheduled to occur.
- If hatched in the early spring, they will normally begin laying by fall and continue (sometimes at less than maximum levels) through winter.
- If hatched in the late summer/early fall they will be ready to begin laying by spring.

- **Lighting Conditions**
  Light triggers a hen's pineal gland, located behind her eye and under the bones of her skull, to initiate the process of egg laying. Regular egg laying requires 14-16 hours of light and decreased daylight hours in fall and winter can cause egg production to decline or stop completely.
- Supplemental lights can be added to the coop to encourage egg laying, while recognizing that additional factors also influence egg production.
- It will not force them to lay. Adding lights in the fall, as light levels begin to drop, is best done by adding 20-30 minutes a week in the mornings until 15 hours of light is reached.
- A sunrise/sunset chart for your latitude can be found online and is helpful. A timer is needed to keep the light consistent and the light itself only needs to be bright enough to "read a newspaper by" as the old flock masters described it.
- One caution, there is some evidence that adding supplemental lighting before pullets are fully mature in size can lead to perpetually smaller eggs and lower than expected production.
- Nature may know best when pullets are ready.

  Molting
  Molting is the natural process of feather shedding and re-growth. Hens divert protein and energy away from egg production to grow a new set of feathers every fall.
- Feathers in good condition are crucial for a bird's protection from the elements, and the shiny new feathers they sport are a sharp contrast to the dull, often bleached feathers that they shed at the end of summer.
- The molt is also a time to replenish bone stores and vitamin levels, as well as gain muscle lost during egg production.

- **Broodiness**
  During spring and summer, some hens will show a tendency to go broody.
- This is the inclination to "set" on the nest and hatch chicks. If a hen is hunched and growling in the nest box, her neck hackles flaring when you reach for her, she is feeling the hormonal urge to reproduce.
- While broody, a hen will not lay eggs. And the very presence of a broody hen will encourage the other hens of her flock to become broody too so that it can become a cascading behavior.
- Broodies should either be allowed to hatch chicks, away from the other birds, or broken of their broodiness as soon as possible so that egg production will resume.

Nutrition
In order to be productive egg layers, hens must receive adequate nutrition and have full time access to clean water, granite grit and calcium.

- Nutrition starts at hatch (actually before, with breeder rations for the parents) and chicks should receive balanced rations appropriate for each stage of growth (starter, grower, layer). Feed should always be offered in a manner that allows all birds to eat at once, or more dominant birds may keep more submissive birds from eating their ration.
- the correct level of protein for your flock, while also rationing their feed to prevent overeating, is a cornerstone for good egg production.
- Each adult bird should be provided with one ounce of complete feed per pound of body weight per day.
- Most standard bred and heritage breeds do best on feeds that contain a protein level of 18%. Any treats or other feed additives should be limited to no more than 5% of all food consumed, as higher levels will reduce the protein needed for good egg production.
- Too many treats can also add fat to the birds, and the combination of too much fat and too little protein is cause for low rates of lay in many backyard flocks.
- Additionally, too much vegetable matter can lead to the formation of runny egg whites.
- Conversely, too much protein can lead to increased egg size.
- This can be a health challenge for hens who are more likely to prolapse when trying to lay an extra large egg.

- **Water**
  Eggs contain a large amount of liquid, so hens need a constant source of clean, fresh water. They will drink twice as much water a day as they eat food. If water is allowed to become too warm in summer, they will drink less than needed for good egg production.

  Parasites and Illness
  Hens not in optimal health will show a decreased rate of lay. A drop in egg production can indicate that birds are infected with parasites such as mites, lice and worms. If a new bird has been introduced into the flock, it may have introduced an illness or parasites and all of the birds should be investigated for signs.

  Stress (predators, social, environmental)
  Hens are sensitive to change and disturbances in their environment. Introduction of new flock mates, change of living situation, new feed, predators, loud activity outside their yard, hot weather, sudden weather changes, and loud dogs are all factors that can lead to a decrease in egg production.

Process of Culling in Poultry Farming

- Culling is the name given to the process of eliminating undesirable birds or those birds which do not possess the qualities for giving enough benefit in return for their culture.
- This is a very important aspect of poultry farming because an un-culled stock may give a serious setback to the farmer. Culling is a continuous operation throughout the year. Culling is advantageous because it helps in saving the feed, in preventing the spread of diseases and in bringing uniformity of the stock.

- Culling of chickens is done at every stage of their life. One day old chick if shows the tendency of drowsiness, inactivity and remains thinner than the fellow ones of the same breed should be culled. Growing chicks with a slow rate of growth of body and feathers or having a protruded breast or thin thigh muscles or a deformed body should be culled. Laying birds can be culled before they start laying eggs and after that, at every six months. A good layer has a warm, full, bright red comb and wattles whereas in poor layers the comb is shrunken, cold and dull coloured.
- The pubic bones in good layers are placed quite apart and can accommodate two or three fingers. The space between the keel and the pubic bones in such birds is 3-4 fingers apart. The morphological differences between a good and bad layer are given in the chart on the next page. In this way a poor layer should be culled. All hens should be invariably culled after three years of egg lying. For breeding purposes, only healthy cocks should be maintained at a cock- hen ratio of 1:10.
- The egg production average of a farm can be obtained on “hen day” basis. Hen day for a particular period can be calculated by multiplying the number of hens by the number of days involved. For example, if there are 10 birds in a flock, the number of hen day during 30 days will be 10 x 30 = 300 days (provided all the birds survive during that full period). The number of hen days will decrease accordingly if some of the birds are destroyed during that period. So the average egg production can be obtained by dividing the number of eggs laid during a given period by the average number of the birds on hand during the same period.

Good Layer	Bad Layer
1. Head small, lean and well proportionate	1. Head large and thick
2. Beak strong, shining and well curved	2. Beak long, thin and dull coloured
3. Comb and wattles warm; brightly red and full	3. Comb cold, shrunken and dull coloured
4. Eyes bright, well opened and alert	4. Eyes dull and sleepy
5. Neck short and strong	5. Neck long and thin
6. Body long, deep and proportionate	6. Body short, weak and thin
7. Back broad and straight	7. Back long and curved
8. Skin thin, smooth and oily	8. Skin coarse and thick
9. Abdomen large and soft	9. Abdomen small and hard

Artificial insemination

- **Artificial insemination (AI)** is the most widely used reproductive technology in the livestock industry.
- Its adoption in poultry species has increased in popularity, especially in the western countries for research and commercial purposes.
- AI in chicken requires one to understand the basic anatomy and physiology of the hen's and the cock's reproductive tract.
- AI involves the deposition of semen into female reproductive tract manually.
- It starts with the collection of the semen from the male and its evaluation in terms of motility, viability and concentration followed by its deposition into female reproductive tract.
- One must be technically competent with the semen collection and deposition procedures in order to achieve effectiveness in producing fertilized eggs.
- Males can produce semen as early as 12 weeks of age, depending upon body size and lighting programme.
- However, sperm from such roosters is rarely viable and effective; maturity does not develop until birds are around a minimum of 18 weeks of age.
- So the cocks from 22 or 24 weeks of age are used for semen collection.

- Semen consists of spermatozoa and seminal plasma.
- Fowl semen is generally highly concentrated (3 to 8 billion spermatozoa per ml for broiler fowl).
- The natural colour of poultry semen is white or pearly white.
- Heavy breed male can produce 0.75 to 1 ml semen and light breed male can produce 0.4 to 0.6 ml of semen.
- Chicken semen begin to lose fertilizing ability when stored >1 hour.
- Liquid cold (4°C) storage of chicken semen can be used to transport semen and maintain spermatozoa viability for ~6–12 hours.
- Semen is collected 4–6 times in a week.
- Although every day semen collection will not change the fertilizing capacity but the volume of semen will be low.
- Inseminations should be carried out on two consecutive days at the first week and then once each week thereafter while fertile eggs are required.
- As poultry semen has a very limited life, insemination of hens should be complete within one hour of semen collection.
- It is a good idea to carry out the operation at the same time each day, the best time being between 2.00 and 4.00 pm.

- **Semen collection procedures.**
- Prior to semen collection, cocks need to be trained and this is achieved through abdominal and back massage for about a minute for 3 days, consecutively. The abdominal massage method is the most commonly used since it is non- invasive and has minimal stress on the cock.
- The procedure involves restraining the male, followed by gentle but rapid stroking of the abdomen and back region (testes are located in this region) towards the tail. This stimulates the copulatory organ causing it to protrude. At this point, the handler quickly pushes the tail forward with one hand and, at the same time, using the thumb and forefinger of the same hand to gently squeeze the region surrounding the sides of the cloaca to "milk" semen from the ducts of the copulatory organ.
- Semen may then be collected in a small tube or any cup-like container. This procedure is repeated twice, once a day; an additional round may cause damage to the testes and cloacal region. The volume of semen that can be collected from a single cock ranges from about 0.7 to 1.0 ml, with a spermatozoon concentration of 3 to 4 billion/ml. However, the quantity of semen depends on genetics and environmental factors such as age, body weight, season and nutrition.
- The degree to which the male will respond to the abdominal massage technique and the pressure applied on the ejaculatory ducts will also influence the quantity of semen produced. Chicken semen begins to lose fertilizing ability when stored for more than 1 hour; therefore it must be deposited in the hen within the 1 hour of collection. In the case of short-term storage and transportation of the semen, it is necessary to use liquid cold (4^0c) storage to maintain spermatozoa viability for up to 24 hours.

- Semen deposition procedure.
- Vaginal insemination is commonly used for semen deposition as there are less risks of injury the hen. Preliminary stroking and massaging of the back and abdomen is required to stimulate the hen. This is followed by applying pressure to the left side of the hen's abdomen around the vent causing evertion of the cloaca hence protrusion of the vaginal orifice.
- An inseminator containing the semen is inserted 2.5 cm deep into this opening for semen to be deposited. As the semen is expelled by the inseminator, pressure around the vent is released, so that the oviduct can return to its normal position and draw the semen inwards to the utero-vaginal junction.
- Inseminators such as straws, syringes or plastic tubes may be used. During insemination, the volume of semen required per hen is about 0.1ml which contains about 100 to 200 million sperms. Timing of the insemination should be considered. It is best to inseminate hens in the late afternoon (2:00pm and 4:00pm), since in the morning hours hens may have an egg in the oviduct, making it difficult for the sperm to swim up to the ovary.
- A significant feature of the reproductive physiology of the hen is her ability to store fertile spermatozoa for up to 14 days in the sperm storage tubules located at the utero-vaginal junction. The tubules release the semen, slowly over time, which swim to the fertilization site and therefore allows for hens to be inseminated consecutively for two days for the first time, and thereafter at regular intervals of 14 days.

- Twenty-four hours after insemination, egg-breakout analysis is carried out to determine egg fertility. Currently, the Smallholder Indigenous Chicken Improvement Program (InCIP) – research unit at Egerton University offers training to interested farmers on the artificial insemination in poultry.
- The training does not require any background on poultry science, just an individual's interest. This is because the training covers the fundamentals of the reproductive anatomy and physiology of the male and female, at a theoretical and practical level.
- Thereafter, the trainees are taken through a practical lesson on semen collection and deposition techniques, and egg fertility analysis. The training takes a period of two weeks and the expectation at the end of it is that individuals have the capacity to carry out semen collection from males (abdominal massage, semen milking and semen handling), semen deposition in females (cloacal evertion, semen deposition) and differentiate fertile eggs from infertile eggs.