Taxonomy

Gallus gallus, chicken

Brief facts

**Distribution**

- *Gallus gallus* is native to Southern Asia, particularly the jungles of India. Molecular studies suggest that the domestication of chicken has occurred independently about 8,000 years ago in different locations of Asia including India. Data about true domestic chicken's wild progenitor are controversial. Closest wild relatives are *Gallus gallus spadiceus* or *Gallus gallus gallus* (Burmese Red Jungle Fowl), *Gallus gallus murghi* (Indian Red Jungle Fowl), and *Gallus gallus sonneratii* (Gray Jungle Fowl). Currently, domesticated chickens are found throughout the world. They are bred primarily for meat and egg production.

- Artificial incubation and hatching of chicken eggs date to the time of the 18th dynasty in Egypt (ca. ~400 BC) and possibly even earlier in ancient China. This practice, abandoned and lost throughout the Middle Ages, re-appeared only during 18th century.

**Traits for selection of broilers (meat producing chicken)**

- Uniform body weight.
- Growth rate.
- Feed conversion.
- Meat quality.
- Amount of fat.

In last decades, it is recognized that this intense selection has been accompanied by reduced reproductive efficiency, to the point that male fertility may potentially become a limiting factor for growth of the broiler industry in the near future (each 1% reduction in fertility costs industry millions of dollars annually). Continuing decrease in fertility might force producers to switch to artificial insemination. The precise causes of this fertility reduction have not been yet determined and can be quite complex, but recent studies isolated at least one of the components: large males may have more difficulties to achieve complete mating with successful sperm transfer into the female's oviduct.

**Traits for selection of egg-laying chickens**

- Uniform body weight.
- Increased weight production.
Feed conversion.

Egg quality including shell.

Egg weight and size.

Disease resistance (e.g., lymphoid leucosis).

Currently, egg-producing industry pays increased attention to earlier underappreciated behavioral traits such as cannibalism (severe pecking accompanied with consumption of the opponent's blood and tissues), feather pulling, and other aggressive tendencies; fearfulness.

Molting (feather dropping) is induced to cause ovarian arrest leading to a second cycle of egg laying. After a molt, livability and egg quality and quantity are improves compared with a nonmolt control group. Feed deprivation for about 14 days has been adopted to induce molt because it is easiest method, which produces the best results. Typically chicken loose 25-30% of their body weight during the forced fasting. Many studies have been done to find alternative, less stressful methods to induce molt in egg-laying chickens.

**Genome**

- Compared to mammals, avian genomes are small but contain a larger number of chromosomes. The chicken genome (Gallus gallus), which is characteristic of other bird genomes, contains 39 chromosome pairs (Burt 2002) but a total genome size of only 1.1 Gb (International Chicken Genome Sequencing Consortium (ICGSC) 2004).

- Avian chromosomes are also highly variable in size, leading to their classification into micro- and macrochromosomes. Chicken Genome Sequencing Consortium (ICGSC 2004) classifies chicken chromosomes into three classes: five macrochromosomes (GGA 1–5), measuring from ~50 to 200 Mb in size, five intermediate chromosomes (GGA 6–10) ranging from 20 to 40 Mb, and 28 microchromosomes (GGA 11–38), on average ~12 Mb long.

- Chicken microchromosomes are estimated to account for only 18% of the total female genome. Despite this they harbor ~31% of all chicken genes (ICGSC 2004), giving them a gene dense structure with three to four times shorter intergenic sequences than on macrochromosomes.

**Developmental stages (life cycle)**

Hamburger and Hamilton (1951) provided a detailed staging account for the chick embryo
after laying. For stages between fertilization and gastrulation, Eyal-Giladi and Kochav (1975) provide a further staging regime. In the following chart Hamilton & Hamburger stages designated with Arabic numbers preceded with "HH" and Eyal-Giladi and Kochav stages are distinguished by Roman letters.

- **oocyte** MeSH

  Oocyte, the giant single cell consisting mostly of yolk, is generated during the first reduction division (meiosis). The oocyte's nucleus and associated cytoplasm are located peripherally in a region called **germinal vesicle**, which lies on the uppermost surface of the egg. The oocyte is surrounded by follicle cells that supply the yolk. The follicle ruptures to release the mature oocyte (the process is called **ovulation**) but its acellular inner membrane remains attached to the oocyte and forms the inner layer of the **vitelline** (yolk) membrane of the egg while the egg's plasma membrane disintegrates.

- **fertilization** MeSH

  Fertilization occurs during the time between release of the oocyte and its entry into the end of the oviduct. Sperm penetrate the vitelline membrane and the second meiosis takes place. The rapid and precisely timed fertilization is possible because of hen's ability to store viable sperm for a number of weeks.

- **embryo** MeSH

  embryonic development of chicken takes 20-21 days at 99.5 °F (37.5 °C) and ~55% relative humidity

  - before laying

    The fertilized egg is located in the hen's oviduct.
Fertilized egg, 1-cell embryo, 0 day post-conception, is called **blastodisc**. Peristaltic movements start pushing the egg down the oviduct.

**cleavage** MeSH

Dividing egg, stages I-VI (~6-16 h post-ovulation).

- **early cleavage**
  Takes place in isthmus of the oviduct. Cleavage proceeds rapidly. The chick is **telolecithal** (yolk concentrated on one end of the egg) and **meroblastic** (incomplete). The first 3 divisions are radial and incomplete with the cells being opened to the yolk ventrally, forming a **cyncytial blastoderm**.

- **late cleavage**
  Takes place in uterus. Shell formation begins. The fourth cleavage division results in bi-layered **blastoderm**. Further divisions increase the thickness of the embryo, but its diameter stays roughly constant at 3 mm.

- **formation of area pellucida**
  Stages VII - X (~17-25 h post ovulation). The blastoderm begins to expand over the yolk. Marginal cells, known as the **area opaca**, become specialized to
consume yolk. The first evidence of area pellucida is noted as more transparent area in the posterior half of the blastoderm. The thinning of the posterior aspect is attributed to cell shedding. The process establishes the anterior-posterior axis of the embryo. After about 20 h post ovulation, the egg is oviposited. The hypoblast formation begins. Two regions of area pellucida are central disc and marginal zone. When area pellucida is clearly delineated from the area opaca, the egg is laid.

- after laying
  - formation of hypoblast

Stages XI - XIV. Pre-streak (HH 1). The area pellucida comprises upper layer of the embryo (epiblast), from which the embryonic tissues derive. The lower layer, hypoblast, is formed by multiple fusion of separate cell masses, and constitutes the extraembryonic endoderm. These two layers are separated by a narrow fissure, which is equivalent to the blastocoel. The hypoblast forms a triangle posteriorly, the embryonic shield or posterior marginal zone, and is generated particularly from an adjacent region of epiblast known as Koller's sickle. The posterior aspect of the hypoblast and the area opaca form a cellular bridge, an event immediately preceding primitive streak formation.
HH 2-4. A major function of hypoblast is to initiate gastriculation through formation of the primitive streak. At the onset of the primitive streak formation, the embryo is 5-6 mm in diameter. The streak forms as an accumulation of cells in the epiblast in the posterior pole of the embryo and extends subsequently in anterior direction until it covers 80% of the epiblast. Epiblast cells migrate through the streak to form prospective endoderm and mesoderm. Those cells that do not ingress are fated to form the ectoderm and neuroectoderm. At mid-streak (HH 3, ~12 h post laying), the anterior end of the streak broadens to form Hensen's node, a structure roughly equivalent to the organizer of Xenopus embryos and the shield of zebrafish. At HH 4 (18-19 h post laying), the area pellucida becomes pear-shaped with expanded end anterior, primitive groove, primitive pit, and Hensen's node are present.

- **neural induction**

HH 5-7; 20-26 hours after laying

- **head process**

HH 5; 20 hours after laying. The notochord or head process (0.2 mm) is visible as a rod of condensed mesoderm extended forward from the anterior edge of the Hensen's node.

- **head fold**

HH 6; 23-25 hours after laying. A definite fold of the blastoderm
anterior to the notochord marks the anterior end of the embryo.

- **first somites**

  HH 7. The first pair of somites condense either side of the notochord.

- **neurulation**

  HH 8-10; 26-38 hours after laying. Starting from stage 7 (1 pair of somites) until stage 14 (22 somites), subsequent somites develop, and a stage is assigned to every third pair of somites which is added. Neural tube closure (neurulation) begins at stage 8. Closure at the rostral extremity (anterior neurospore) is complete by stage 10, whereas posterior neuropore remains open until the tail bud develops. Soon after closure, neural crest emerges from the midbrain and hindbrain. Simultaneously with neurulation, the embryo also folds ventrally to enclose the gut and bring the two heart primordia together to fuse.

- **organogenesis**

  HH 11-29; 1.5-6 days after laying.

  - **13 somites**

    HH 11; 40-45 h after laying. Five neuromeres of hindbrain are distinct.

  - **16 somites**

    HH 12; 45-49 h after laying.
Anterior neuropore closed. Telencephalon (anterior portion of the forebrain) defined.

**19 somites**

HH 13; 48-52 h after laying. Distinct enlargement of telencephalon. Primary optic vesicles and stalks established. Atrioventricular canal indicated by constriction.

**22 somites - 34-40 somites**

HH 14-19; 48-72 h after laying. Beyond stage 14 (22 somites) the number of somites becomes difficult to determine with accuracy. The head begins rotate to the left, and the optic vesicle, otic vesicle, nasal pits, branchial arches, and pituitary gland begin to develop. The limb buds begin to form; the amnion extends over the embryo and closes.

**40-43 somites - digits-toes-beak**

HH 20-29; 70 h - 6 days after laying. Rotation completed. Eye pigment. Digestive tract develops. Somites extend to tip of tail. Limbs develop further, toes develop, and beak is a distinct in profile.

**formation of bird**

HH 30-45; 6-21 days after laying. At HH 30, *egg-tooth* distinct. Between the

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*Note: HH stands for Hamburger and Hamilton stages, which are used to describe embryonic stages in chickens.*
sixth day and hatching, much of development is concerned with growth of the existing organs, and in the case of nervous system, considerable increase in complexity.

- after hatching
  - hatchling
    Newly hatched chicken (chick) covered by fine dawn and no feathers.
  - juvenile
    Fully feathered by 4-5 week of age; adult feathers on wings are fully grown by 8-9th week. Broiler chickens are slaughtered after 6-7 weeks of hatching.
  - adult
    Sexually matured by 5-6 months (females a little later than males). Lifespan is up to 10 years.

Chicken anatomy

Animal Structures

- female genital
  A female reproductive system is usually composed of a pair of ovaries and a pair of oviducts. Chickens and
most other birds have only one ovary and one oviduct.

- **ovary** MeSH
  
  Organ in which yolk formation occurs; yolk is formed in the follicular sac **ovarian follicle** by the deposition of continuous layers of yolk material; ninety-nine percent of the yolk material is formed within the 7-9 days before the laying of the egg.

- **oviduct** MeSH
  
  The egg moves through oviduct takes about 22 hours. During this journey it undergoes a number of modifications. First, a thickened outer layer is applied to the vitelline membrane, which has two cord-like extensions, **chalazae**, which anchor the yolk in center of the egg and stabilize it.

- **infundibulum**
  
  Also called **funnel**; the first section of the oviduct that quickly engulfs the yolk with its thin, funnel-like lips.

- **magnum**
  
  After passing the infundibulum the yolk quickly enters the magnum section. The albumen is applied to the outer surface of the egg providing water, nutrients, and antibiotic agents. The shape of the egg is largely determined in this section. The magnum is separated from the isthmus by a narrow, translucent ring without glands.

- **isthmus**
Isthmus is smaller in diameter than the magnum. It is here the two shell membranes are added. The membranes touch each other throughout the egg, except at the blunt end of the egg, where the air cell is formed later because the egg content cools down and contracts after laying.

- **uterus**

Also called shell gland. In this portion of the oviduct, calcite crystals are deposited in and over the outer shell membrane layer to form the eggshell.

- **vagina**

In the vagina, a thin, protein coating called "bloom" is applied to the shell to keep harmful bacteria or dust from entering the egg shell pores. The egg is turned horizontally (the process called oviposition) just before laying so that egg will exit with blunt end first.

**Egg anatomy**
Photo gallery
Normal chicken behaviors

- Nesting.
- Dust bathing.
- Foraging.
- Perching.
- Scratching.
- Wing flapping.
- Stretching.
- Body shaking and feather ruffling.
- Walking and running.
- Preening.

References

Articles and links

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- **Animal Diversity Web: Gallus gallus**
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