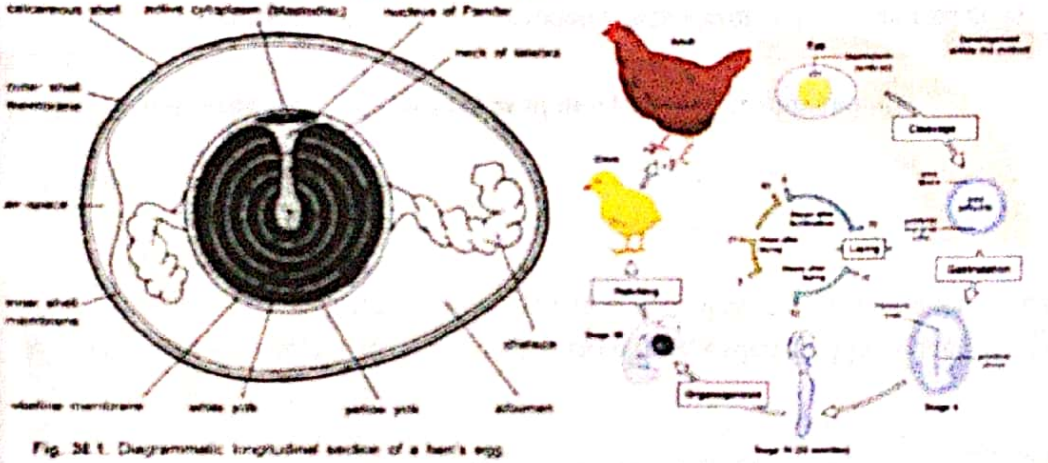
Chick Embryology

The embryology of chick has been worked out more extensively only because of the following reasons:

1. Eggs of fowl are large or of suitable size, easily available throughout the year and can be incubated artificially.
2. The various developmental stages can be easily available in laboratory conditions for experimental purposes.
3. Moreover, the process of development has been most thoroughly worked out in fowl.
4. The embryology of chick bears many resemblances with those of reptiles and mammals.
5. The embryology of chick is important due to **phylogenetic** significance. In chick, development is direct **without a larval stage.**



1- -Structure of Hen's Egg-

- The egg is about 3.0 cm in diameter and is **polylecithal.**
- It is entirely filled up by the yolk and over it, lies a small cytoplasmic disc with a nucleus at animal pole. This disc is called **blastodisc.**
- The yolk has a central mass of white yolk around which are alternate concentric layers of yellow and white yolk.
- The central flask-shaped white yolk called **latebra** runs from the centre to the lower side of the blastodisc and there it spreads to form the **nucleus of Pander.**

- The yolk and blastodise are bounded by a **plasma membrane and outer vitelline membrane**, which is a **converted form of zona radiata.**

- The yolk contains 48.7% **water**, 32.6% **phospholipids and fats**, 16% **proteins**, 1% **carbohydrates** and 1.1% other **chemical molecules**.

- Its proteins are in the form of **phosvitin and lipovitelline or livetin**. The fat is predominantly neutral fat (50%), rest is phosphatids, cerebrosides and cholesterol.

- The fertilized egg or zygote is covered by a layer of dense viscous albumen which forms a thin **chalaziferous layer** around the vitelline membrane. This **dense albumen** forms two twisted cords or **chalazae, one at each end of the zygote. They are formed by rotation of the egg during its movement through the oviduct.**

- Around the chalaziferous layer is a thick layer of watery albumen. **All albumen is secreted by the upper glandular walls or magnum of the oviduct.**

- The functions of albumen are to **provide nutrition to the embryo**, serves as a water store and also acts as protective envelope for protecting the embryo from mechanical and chemical injuries.

- The albumen and yolk also contains a variety of enzymes, vitamins, pigments and phosphorus.

- The isthmus part of the **oviduct secretes** two shell membranes made of **tough keratin fibres** matted together.

- The two shell membranes are closely applied except at the **blunt end** of the egg where they are separated by an **airspace** formed after the egg is laid. The **nidamental glands** of the oviduct secrete a **porous, calcareous shell which soon hardens.**

- It is pierced by a large number (about 7,000) of **fine pores** filled with a protein related to collagen. These pores allow exchange of gases (oxygen and carbon dioxide) during respiration of the developing embryo.

- The egg is laid **24 hours after fertilization**, and its further development takes place, when the egg is incubated by the female. Incubation must continue steadily for 21 days at a temperature of **103°F.**

2-Fertilization:

- In fowl,the ova are released from the ovary in the form of primary oocytes.
- The second maturation division occurs **after ovulation in the oviduct.**
- The released primary oocyte in the body coelom is grasped and swallowed by the ostium(Oviducal funnel) of the oviduct.
- The secondary oocyte or ovum after second maturation division is surrounded by several (5 or 6) sperms, but only one sperm succeeds in the fertilization process. The nucleus of one sperm fuses with the egg nucleus (amphimixis)
- As the fertilized egg passes downward inside the oviduct, it rotates, **undergoes cleavage** and various accessory egg membranes are laid down over the developing egg. **Thus, fertilization is internal**.
- The various egg membranes secreted around egg are **albumen, shell membranes and shell.**

3-Cleavage and Blastulation:

- Cleavage is **meroblastic or discoidal** and is restricted only up to **blastodisc**.
- It does not **segment the yolk** of the polylecithal egg and it is later eventually surrounded by the growing tissues of the embryo.
- First two cleavages are at right angles to each other in the **centre of blastodisc**.These cleavage furrows separate the **daughter central blastomeres from each other**, but not **from the yolk.** The central blastomeres are continuous with the underlying yolk at their lower ends.
- The marginal blastomeres are continuous with the uncleaved cytoplasm at their outer edges. Further cleavages are **irregular.** The **central cells divide more rapidly.**

- The marginal cells also divide by the appearance of new **horizontal and radial furrows**. The newly formed inner cells of marginal blastomeres are added to the central cells, resulting in the increase of volume of this area.

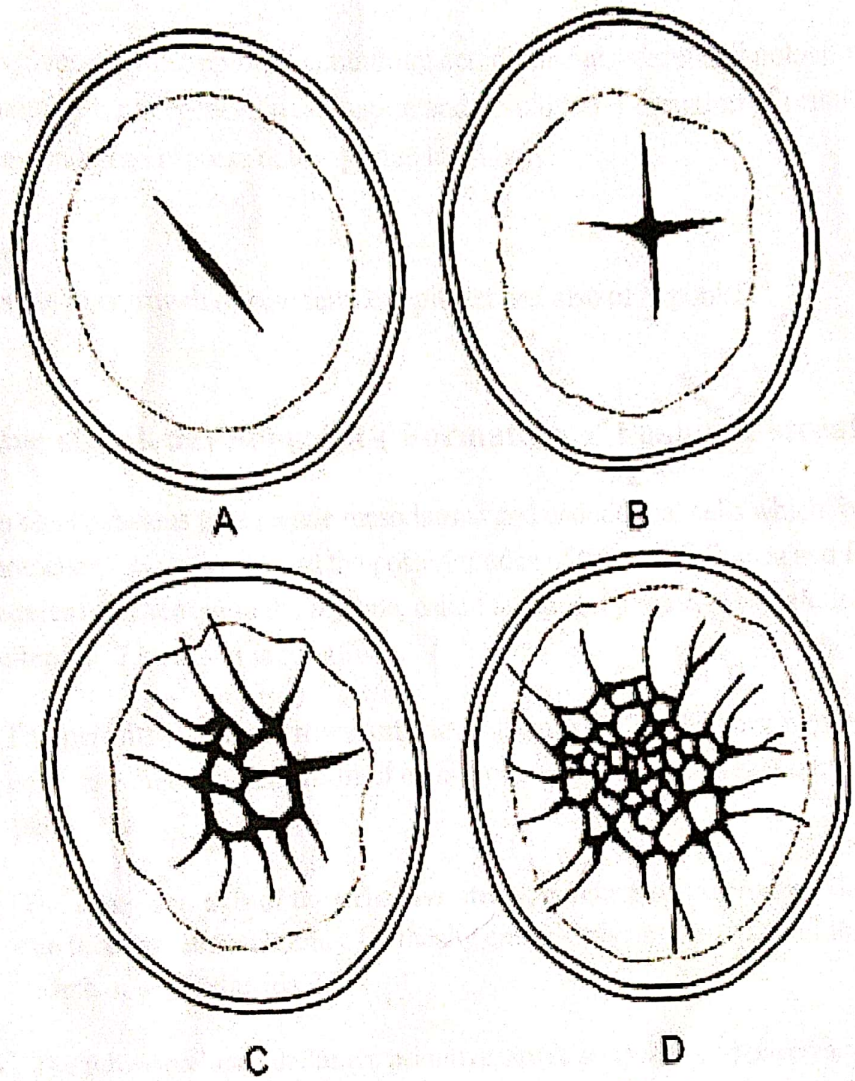


Fig. 38.2. Surface view of germinal disc of hen's egg showing early cleavage. A–Two-cell stage; B–Four-cell stage; C–Twenty-cell stage; D–A late cleavage stage.

- Due to further cleavage, the blastodisc becomes cellular, called the **blastoderm**- a round disc, The embryo is now called the blastula stage.The egg is laid by the female about the time the blastula is formed or even a little later.

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4-Gastrulation:

Gastrulation includes the following two types of morphogenetic movements:

a. Emboly:

- It involves only the epiblast containing ectoderm, mesoderm and notochordal cells.
- It includes convergence, invagination and involution. Formation of primitive streak and head process develops due to emboly.

b. Epiboly:

It includes the overgrowth of ectoderm or epiblast and also of hypoblast.

Primitive streak development-(Formation of Primitive streak)

- In chick, various prospective mesodermal and endodermal cells which forms the notochord converge toward the posterior edge of the area pellucida and form a **conical thickening** in the midline, called the **initial primitive streak.** It appears after **6 to 7 hours of incubation.**
- The primitive streak grows anteriorly because of proliferation of its own cells as well as the addition of cells from anterior and lateral parts of area pellucida.
- The **elongated axis of the primitive streak marks the antero-posterior axis of the future embryo.** It, thus, eventually extends about **three fifths** of the entire length of area pellucida.
- The fully developed definitive primitive streak is usually completed after **18 to 19 hours** of incubation.
- Along the middle of the fully developed primitive streak, there runs a narrow furrow, called the primitive groove.
- At the anterior end of the primitive streak, there is a thickening called the primitive knot or Hensen's node. The centre of Hensen's node is excavated to form a funnel-shaped depression.

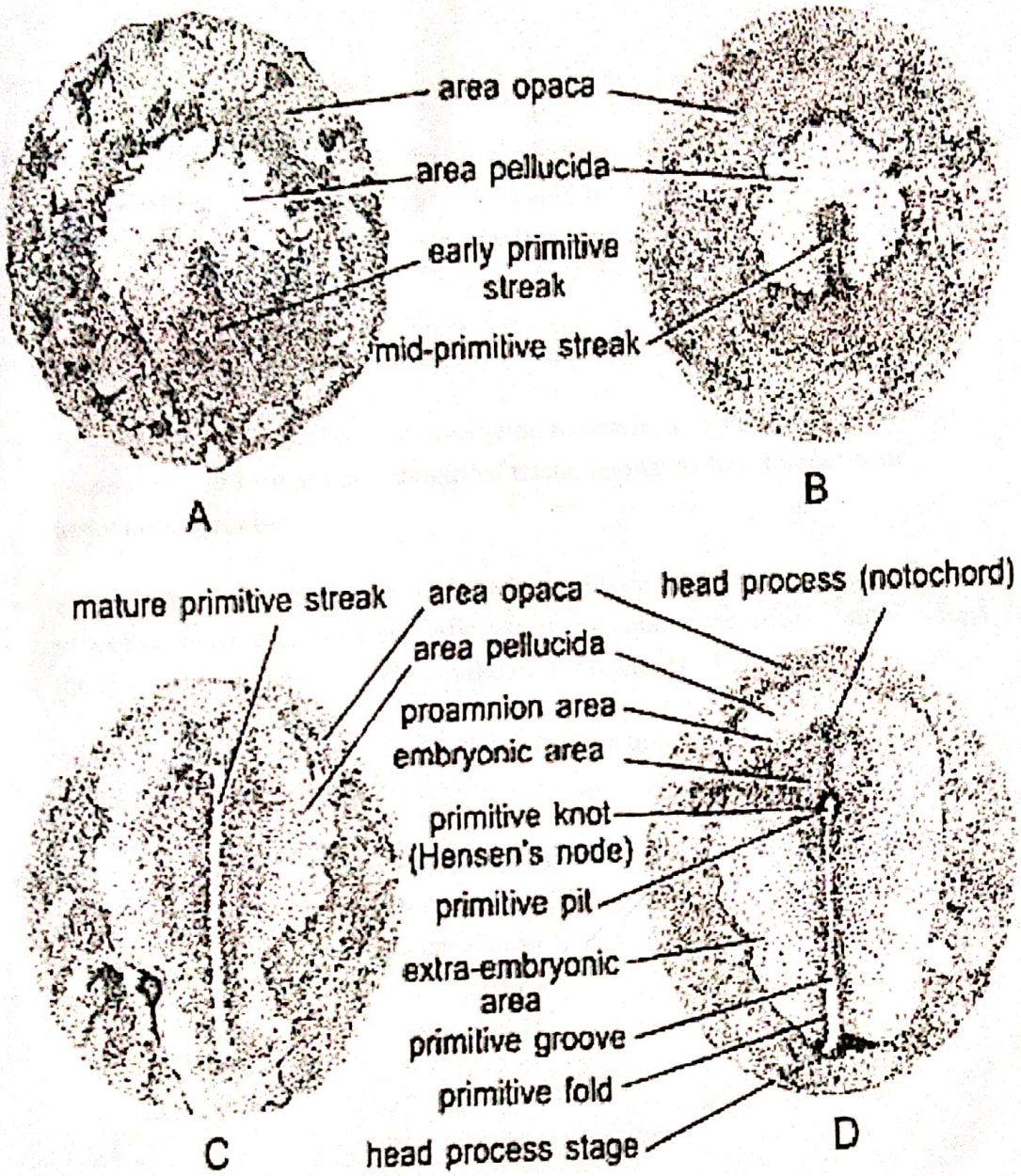

Fig. 38.5. Surface view of chick blastoderm showing development of primitive streak (gastrulation) and head process (neurulation). A–Initial streak (stage 2); B–Intermediate streak (stage 3); C–Definitive streak (stage 4); D–Head process stage (stage 5 embryo of 19 to 22 hours of incubation).

Regression of Primitive streak-

- With the gradual disappearance of endodermal, notochordal and mesodermal cells from the primitive streak, it begins to shrink from anterior to posterior side and **its remains** are partly included in the **tail bud and partly into the cloacal region of the embryo.**

Formation of Head process in chick embryo-

- Prospective notochoral cells converge on the node, sinks through it and then passes directly forward as a tongue of tissue known as **head process or notochord process**
- As the streak regresses posteriorly, the embryo develops anterior to it. The head process consists of a thick central mass of cells and more diffuse lateral wings. In the beginning it is also blended in the midline with the hypoblast.
- The thicker central portion forms the definitive notochord, whereas the lateral wings form the paraxial (somitic) mesoderm.
- With its differentiation, the notochord becomes detached from the hypoblast, except at the extreme end. Thus, the head process stage is completed at about **20 to 25 hours of incubation.** Gastrulation is also completed at this stage.