TOPIC: BLASTULATION AND GASTRULATION IN CHICK

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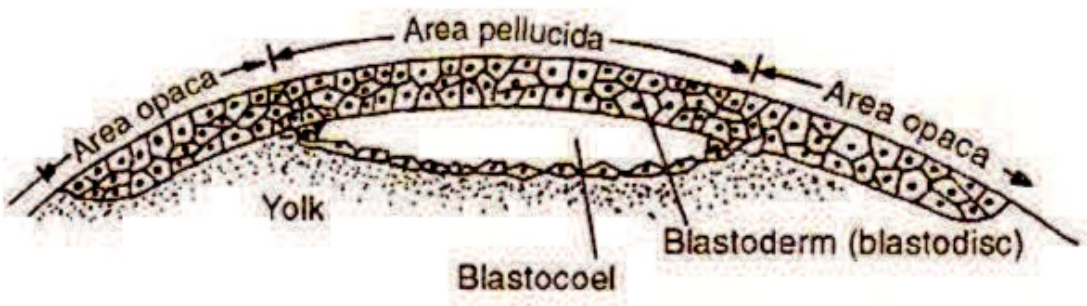
BLASTULATION IN CHICK

The morula condition is of short duration. Almost as soon as it is established there begins a rearrangement of the cells prece ding the formation of the blastula. A cavity is formed beneath the blastoderm by the detachment of its central cells from the underlying yolk while the peripheral cells remain attached. The space thus established between the blasto derm and the yolk is termed the segmentation cavity (blastocoele). The central part appears more distinct



and transparent due to the pre sence of the segmentation cavity called area pellucida the marginal area of the blastoderm in which the cells remain undetached from the yolk and closely adherent to it, is called th e zone of junction. This zone looks opaque an d white and is known as area opaca. With the establishment of the blastocoels the embryo iss said to have progressed from the morula to the blastula stage.

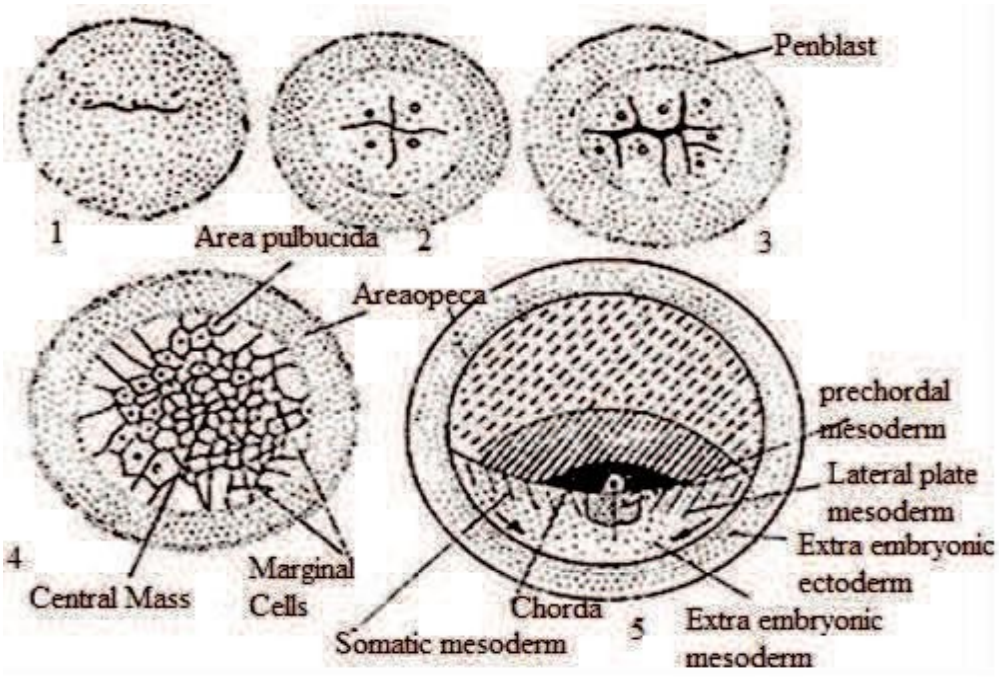


Fig. Cleavage in egg, e-4 early stages, 4-blastula; 5. Prospective map and later formative movements

At this magnification the complete yolk must be imagined as about three feet in diameter. The structure of the bird embryo in these stages may be brought in line with the

morula and blastula stages of forms having little yolk if the full significance of the great yolk mass is appreciated. Instead of being free to aggregate first into a solid sphere of cells (morula) and then into a hollow sphere of cells (blastula), as takes place in forms with little yolk, the blastomeres in the bird embryo are forced to grow on the surface of a large yolk sphere. Under such mechanical conditions the blastomeres are forced to become arranged in a disc-shaped mass on the surface of the yolk. If one imagines the yolk of the bird morula removed, and the disc of cells left free to assume the spherical shape dictated by surface tension its comparability with the morula in a form having little yolk becomes apparent.

The process of blastulation also is modified by the presence of a large amount of yolk. There can be no simple hollow sphere formation by rearrangement of the cells if the great bulk of the morula is inert yolk. But the cells of the central region of the blastoderm are nevertheless separated from the yolk to form a small blastocoele. The yolk constitutes the floor of the blastocoele and at the same time by reason of its great mass nearly obliterates it. If we imagine the yolk removed from the blastula and the edges of the blastoderm pulled together the chick blastula approaches the form of the blastula in embryos with little yolk.

GASTRULATION IN CHICK

In the chick, the process of gastrulation is prolonged and highly modified than that of frog and Amphioxus. It is already started when the egg of chick is laid and completes well into the second day of incubation. The main characteristic of avian gastrulation is the formation of primitive streak.

The streak is first visible as a thickening of the cell sheet at the central posterior end of the area pellucida. This thickening is caused by the migration of cells from the lateral region of the posterior epiblast towards the centre. As the thickening narrows, it moves anteriorly and constricts to form the definitive primitive streak. This streak elongates 60-75 percent of the length of the area pellucida and marks the anterior posterior axis of the embryo.

As the cells converge to form the primitive streak, a depression forms with in the streak—the primitive groove, through this primitive groove the migrating cells pass into the blastocoel. At the anterior end of the primitive streak is a regional thickening of cells called the primitive knot or Hensen's node.There is a funnel shaped

depression in the centre of the node through which cells can pass into the blastocoel. As soon as the primitive streak is formed, blastoderm cells begin to migrate over the lips of the primitive streak and into the blastocoel

The cells which migrate through the Henson's node pass down into the blastocoel and migrate anteriorly form head mesoderm and notochord, and those cells which pass through the lateral portion of the primitive streak forms the majority of endodermal and mesodermal tissues. The cells entering the inside of the avian embryo form a loosely connected mesenchyme. Moreover, no true archenteron is formed in avian gastrula. As the cells enter the primitive streak, the streak elongates toward the future head region. At the same time, the secondary hypoblastic cells continue to migrate anteriorly from the posterior margin of the blastoderm. The first cells to migrate through the primitive streak are those destined to become the foregut.

Inside the blastocoel, these cells migrate anteriorly and eventually displace the hypoblast cells in the anterior portion of the embryo. The next cells entering the blastocoel through Hensen's node also move anteriorly, but they do not move as far ventrally as the presumptive endodermal cells.

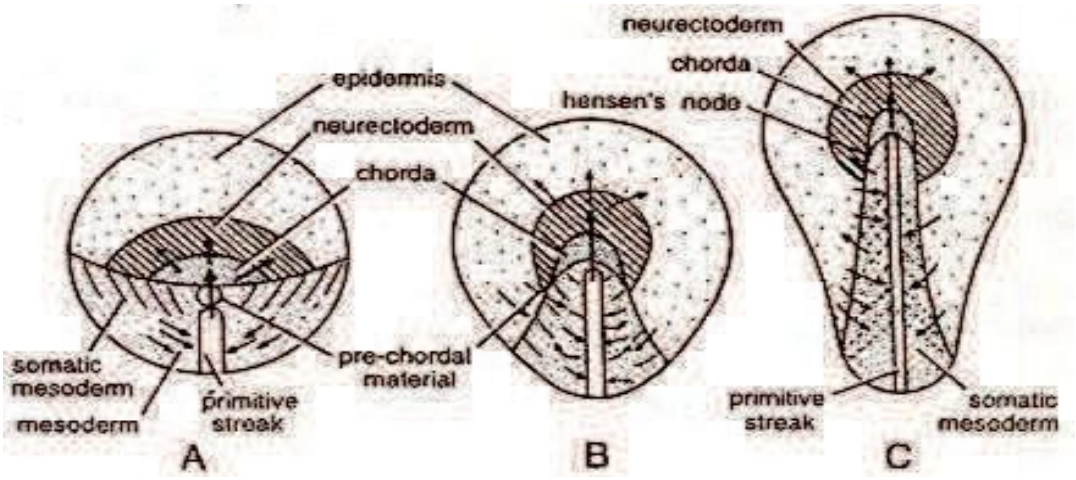


Fig. Formation of the primitive streak and mesoderm during gastrulation in heavily telolecithal egg of chick (dotted arrows indicate movements below the surface)

These cells remain between the endoderm and the epiblast to form the head mesoderm and the chorda mesoderm (notochordal) cells. These early ingressing cells have all moved anteriorly, pushing up the anterior midline region of the epiblast to form the head process.Meanwhile, cells continue migrating inward through the primitive streak. As they enter the blastocoel, these cells separate into two streams. One stream moves deeper and joins the hypoblast along its mid-line, displacing the hypoblast cells to the sides.

These deep-moving cells give rise to all the endodermal organs of the embryo as well as to most of the extra embryonic membranes. The second migrating stream spreads throughout the blastocoel as a loose sheet, roughly mid-way between the hypoblast and the epiblast.

This sheet gives rise to mesodermal portions of the embryo and extra embryonic membranes. By 22 hours of incubation, most of the presumptive endodermal cells are in the interior of the embryo, although presumptive mesodermal cells continue to migrate inward for a longer time.

Now the second phase of gastrulation begins. While the mesodermal ingression continues, the primitive streak starts to regress (disappearance of primitive streak) moving Hensen's node from near the centre of the area pellucida to a more posterior position.

As the node moves further posteriorly, the remaining (posterior) portion of the notochord is laid down. Finally the node regresses to its most posterior position, eventually forming the anal region in true deuterostome fashion. By this time, the epiblast is formed entirely of presumptive ectodermal cells.As a consequence of this two step gastrulation process; avian (and mammalian) embryos exhibit a distinct antero-posterior gradient of developmental maturity. While the posterior portions of the embryo are undergoing gastrulation, cells at the anterior end are already starting to form organs. For the next several days the anterior end of the embryo is seen to be more advanced in its development than the posterior end.

While the presumptive mesodermal and endodermal cells are moving inward, the ectodermal precursors surround the yolk by epiboly. The enclosure of the yolk by the ectoderm takes greater part of 4 days to complete and involves the continuous production of new cellular material at the expense of the yolk and the migration of the- presumptive ectodermal cells along the undersides of the vitelline envelope.

Thus, as avian gastrulation draws to a close, the ectoderm has surrounded the yolk, the endoderm has replaced the hypoblast, and the mesoderm has positioned itself between these two regions. Thus the fully formed chick gastrula consists of these three germ layers-ectoderm, chorda-mesoderm and the endoderm.

Significance of the primitive streak:

The primitive streak with its Hensen's node is analogous to the blastopore and its dorsal lips of amphibian gastrula. The only difference is that the avian blastopore is elongated whereas amphibian blastopore is circular. Some homologies are as follows:

The primitive pit represents the dorsal opening of the blastopore (neurenteric canal).

The primitive node corresponds to the dorsal lip of blastopore (future tail bud). The primitive groove and folds are comparable to the opposed lateral lips of the blastopore. (4) The posterior end of primitive streak may be compared with the ventral region of the blastopore (future anal opening).

The first cells which migrate through the primitive streak are those destined to become foregut. This situation is again similar to amphibians.

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