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Topic: Fate maps of Frog and Chick

Fate maps of the Frog and Chick

Fate mapping:

Fate mapping is a method used in developmental biology to study the embryonic origin of various adult tissues and structures. The "fate" of each cell or group of cells is mapped onto the embryo, showing which parts of the embryo will develop into which tissue. When carried out at single-cell resolution, this process is called cell lineage tracing.

Construction of Fate Map:

Fate map of different types of animals have been constructed by the following methods:

i. Observing Living Embryos:

The embryos being transparent and having relatively few daughter cells that remain close to one another, it has been possible to look through the microscope and trace the descendants of a particular cell to the organ they subsequently formed.

ii. Vital Dye Mark:

It was in 1929 that Vogt was able to trace the fate of different areas of amphibian eggs by applying vital dyes. These vital dyes stain the cells without killing them.

iii. Radioactive Labelling and Fluorescent Dyes:

A variation of the dye marking technique is to make one area of the embryo radioactive. A donor embryo is taken and grown in a solution containing radioactive thymidine. This thymidine base is subsequently incorporated into the DNA of the dividing embryo.

A second embryo, acting as the host embryo, is grown under normal conditions. The region of interest is cut off from the host embryo and is replaced by a radioactive graft from the donor embryo. The cells that are radioactive will be the descendants of the cells of the graft, and are distinguished by autoradiography.

iv. Genetic Marking:

Radioactive and vital dye marking have their own drawbacks such as dilution over many cell divisions and the laborious preparation of slides. One permanent way of cell marking is to create mosaic embryos having different genetic constitutions. The best example of such a marking is to graft quail cells inside a chick embryo. By doing so, fine-structure maps of the chick brain and skeletal system can be made.

1. Fate Map of Frog:

The blastula of Xenopus at the 32 cell stage gives no indication as to how the different regions will develop. However, by following the fate of individual cell, or group of cells, the fate map of the blastula can be made. One way of making the fate map is by staining the various parts of the early embryo with a lipophilic dye such as dil and observes where the labelled regions end up.

Another sophisticated way of labelling the blastomeres is by injection of high molecular weight molecules such as rhodamine-labelled dextran, which cannot pass through cell membrane and are, therefore, restricted to the injected cell and its progeny. These cells can be easily detected later, under a UV microsco

The fate map of the Xenopus blastula shows the presence of yolky macromeres at the vegetal pole which gives rise to the endoderm. Depending upon the position of the blastopore, the endodermal area can be divided into the sub-blastoporal and supra-blastoporal endoderm.

The cells toward the animal pole gives rise to the ectoderm, which becomes further subdivided into epidermis and the future nervous tissue. The epidermal ectoderm forms at the ventral side of the animal hemisphere, while the neural ectoderm forms at the dorsal side. The mesoderm forms a belt-like region, known as the marginal zone, around the equator of the blastula.

The mesoderm becomes subdivided along the dorsoventral axis of the blastula. The most dorsal mesoderm gives rise to the Notochord. From this ventrally, the-mesoderm is differentiated by the somites (which gives rise to muscle tissue), lateral plate (which contains heart and kidney mesoderm) and blood islands.

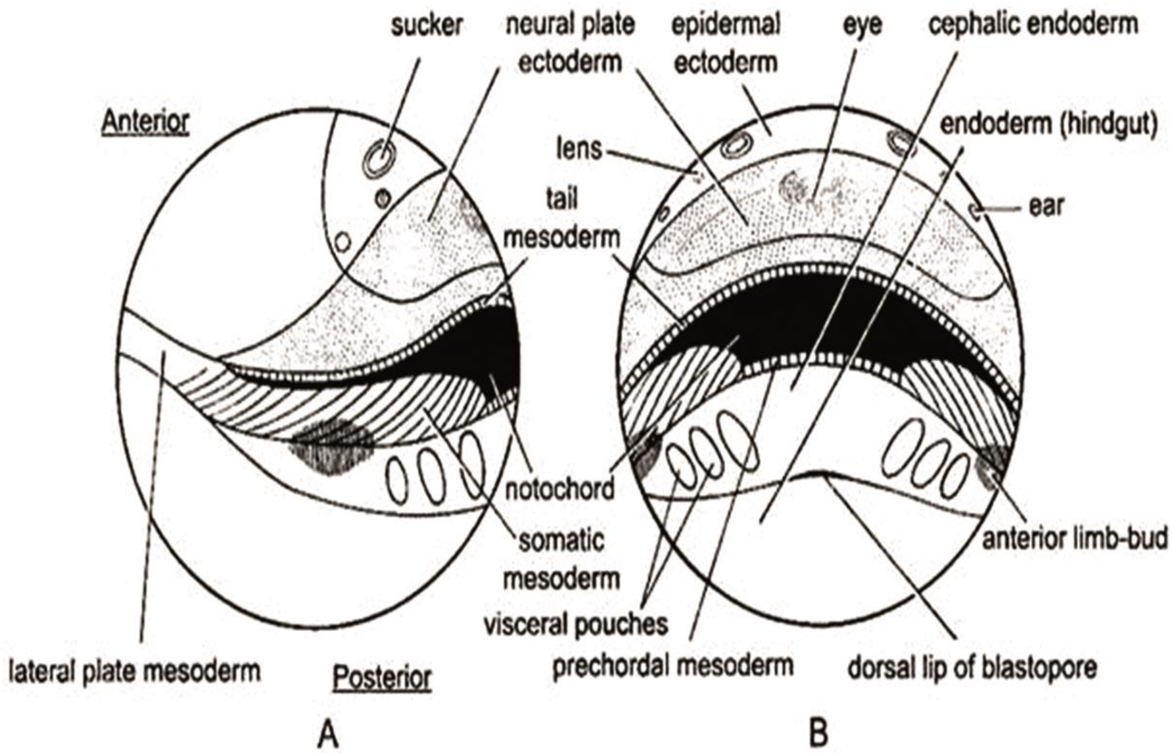

Fig. Frog. Fate maps of blastula. A–Ventral view from the lateral side; B–Viewed from the dorsal side.

ii. Fate Map of Chick:

Before going through the fate map of chick one should go through the formation of area pellucida and area opaca, and also through the format ion of hypoblast and epiblast. From the study of the above formations, it becomes clear that the hypoblast does not contribute any cells to the formation of the embryo proper; rather they contribute to the formation of a portion of the external membranes.

Recent studies with cell adhesion molecules (CAMs), it has become possible to construct the fate map of chick epiblast. All the three germ layers of the embryo proper are formed by the epiblastic cells. The epiblast also forms a considerable amount of extra-embryonic (mesoderm) membrane.

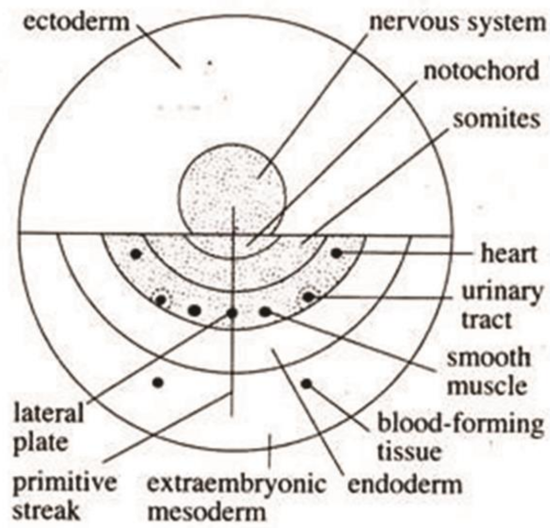

Fig. Fate map of chick embryo.

The fate map of chick reveals that the cells of the epiblast are organised around the notochord and nervous system. The neural ectoderm is present as a knob-like structure facing towards the anterior side. The cells at the anterior part of the epiblast form the ectoderm, while the cells at the posterior side gives rise to mesoderm (body proper), endoderm and extra-embryonic mesoderm.

Usefulness of Fate Map:

The fate map of organisms is helpful in tracing the morphogenetic movements of the cells and the ultimate positions they take up. However, they tell us nothing about the tissue developmental potentialities during morphogenesis.