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What is fate map? Fate map in typical cordate blastula

The fate of a cell describes what it will become in the course of normal development. The fate of a particular cell can be discovered by labelling that cell and observing what structures it becomes a part of. When the fate of all cells of an embryo has been discovered, we can build a **fate map**, which is a diagram of that organism at an early stage of development that indicates the fate of each cell or region at a later stage of development. A fate map tells us which parts of the egg or early embryo contributes to specific tissues or structures at some later, advanced stage of development.

Some animals may have a very strict fate map, in which particular parts of the egg or cleavage stage blastomeres always contribute to particular parts of the larva or adult. Examples include the nematode *C. elegans*, or the urochordate tunicates (sea squirts). Or some animals do not have a very predictable fate map (such as mammals), or other animals have fate maps.

Construction of Fate Map

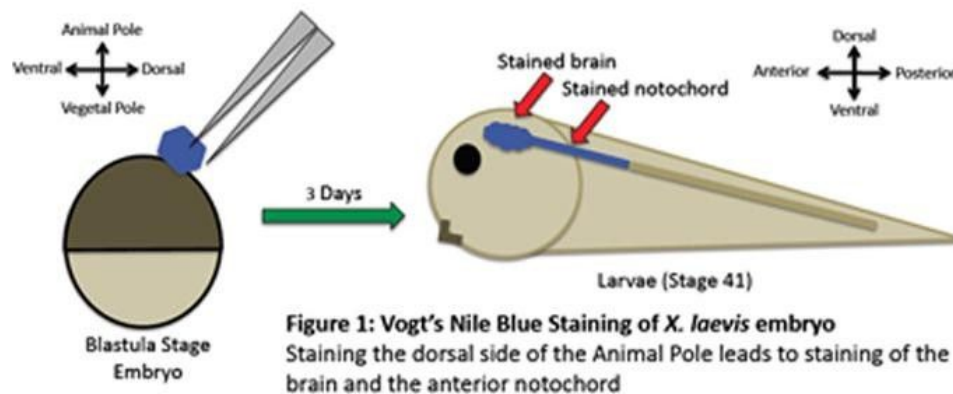
Various techniques have been devised for the construction of fate map. Of these tracing the course of natural colours and artificial markings are most important. In practice one makes some sort of "mark" on, or inside, the egg or embryo, with any number of agents: charcoal, dye, soot (old fashioned ways), or modern agents, like fluorescent molecules (rhodamine- conjugated dextran) or proteins like green fluorescent protein (GFP), or enzymes encoded by injected genes or mRNAs. Whichever way you choose, the principal is the same: Make your mark at some time "0" and score where the mark is at a later time(s) "x". It is also important to be able to orient your marks on an embryo with respect to some asymmetric feature, such as a pigment difference or a unique structure.

Natural markings

The cytoplasm of certain eggs such as those of ascidians has natural pigments. Thus in eggs of *Styela* four coloured centres have been recognized, an upper hemisphere of light protoplasm, an yellow crescent postero-ventrally, a grey crescent antero-dorsally and a vegetal area of dark grey yolky substance. The fate of these areas can be followed very easily. It has been revealed that the upper clear cytoplasm contains the material for epidermal ectoderm. The grey crescent area differentiates into the prospective neurectoderm and notochord. The yellow crescent becomes the prospective mesoderm and the dark grey yolky area forms prospective endoderm.

Artificial markings: there are three methods to mark or label the early blastomeres by which their fate can be traced out. They are:

Vital staining: Early embryologists used "vital dyes" (which would stain but not harm the cells) to follow movements of individual cells or groups of cells. The tissues to which the cells contribute would thus be labeled and visible in the adult organism. The first person to develop and use this technique to study cell fate was embryologist Walter Vogt in 1929. Vogt used small chips of agar impregnated with a vital dye, (such as Nile Blue or Nile Red) which he placed on a particular cell or population of cells in *Xenopus* embryos until the dye absorbed into the yolk platelets within the desired cells. Once the cells were effectively labeled, the agar chip could be removed and the embryo was allowed to develop normally. With this method, Vogt was able to distinguish movements of particular cell populations and the ultimate organ or tissue into which they integrated. Vital stains are mild blue, sulphate, neutral fed, Jenus green etc.



Carbon particle marking: this technique was introduced by Spratt (1946) to demonstrate the process involved in primitive streak formation in chick. This consists of applying tiny particles of carbon over the surface of blastomeres. They stick to the cell surface and enable to follow the movements of the cells and to determine the fate of these blastomeres.

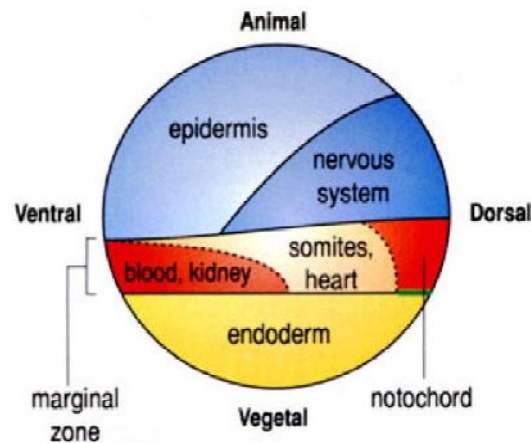
Radioactive isotope labeling: The radioactive isotope such as C^{14} and P are used to label the early blastomeres. By carefully following the course of these radioactive isotopes the fate of blastomeres can be determined.

Fate map of typical chordate blastula

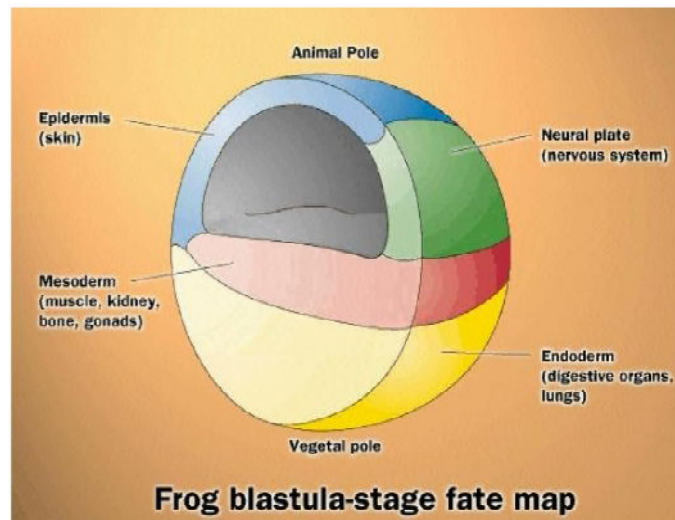
The following presumptive areas are discernible in chordate blastula.

1. There is a broad ectodermal area in the animal hemisphere which forms the epidermal layer of the skin. This is known as **epidermal ectoderm**.

2. A relatively smaller ectodermal area lies below the epidermal ectoderm. This area is known as **neurectodem** since it contributes to the formation of neural tube and nervous system.
3. A crescentic area below the neurectodem is designated as **notochordal area** which gives rise to the notochord of the embryo.
4. On either side of the notochordal area are two lateral areas. These constitute the prospective **mesoderm**.
5. Most of the yolky vegetal hemisphere blastomeres collectively form the prospective **endoderm**.
6. At the caudal margin of the notochordal area is a small strip of blastomeres called **prechordal plate** region. This region mainly gives rise to some of the head mesoderm.



Fate Map of Frog



Frog blastula-stage fate map