TOPIC: TYPS OF NEURAL INDUCTION

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Primary induction and gray crescent:

The dorsal lip region of the blastopore at the onset of gastrulation can be traced back to the gray-crescent of the undivided fertilized amphibian egg. It was conceived by some developmental biologists that the crescent material of egg cortex initiated gastrulation and has the capacity of neural induction. A.S.G.Curtis (1963) performed a series of experiments of transplanting parts of the cortex of the fertilized egg of the clawed toad, Xenopus is at the beginning of cleavage

In one experiment, the gray-crescent cortex was excised from the fertilized egg and it was observed that the cell division though proceeded undisturbed, the gastrulation failed to take place (Fig. 3A). In another experiment, the gray crescent cortex of uncleaved fertilized egg was excised and transplanted into a ventral position of a second egg, so that the egg receiving the graft had two gray crescents on opposite sides.

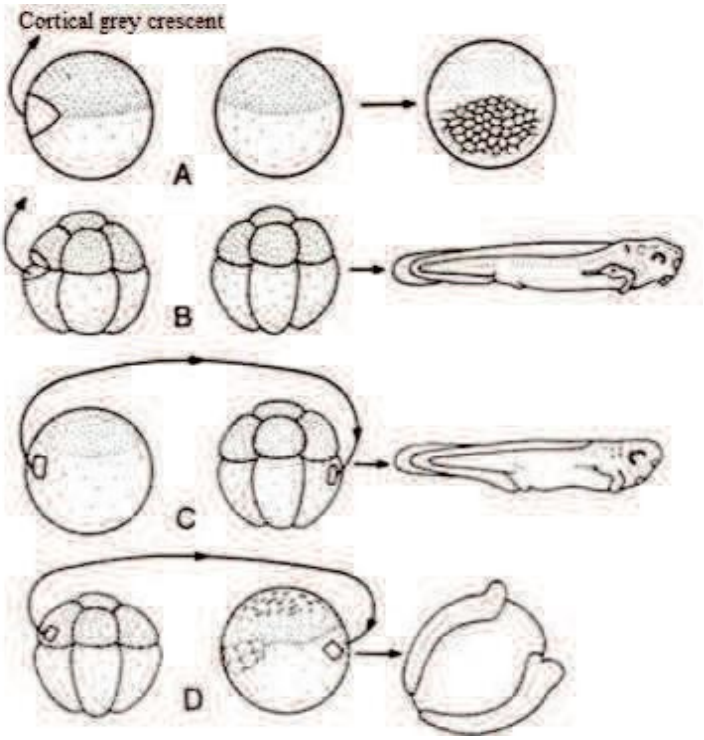

Fig. Experiment of Curtis on Xenopus

As a result, egg cleaved to form a blastula, which underwent two separate gastrulation movements to produce two separate primary nervous systems, notochord and associated somites Similar experiments conducted on the eight-cell stage showed that something had happened during the short – interval represented by the first three cleavages.

Gray crescent cortex of the eight-cell stage still retained its inductive capacity when grafted to younger stages. Removal of the gray crescent at this stage no longer inhibits subsequent gastrulation and normal development, the

missing crescent properties being replaced from adjacent cortical regions.

According to Curtis, a change in cortical organization spreads across the surface of the egg during the second and third cleavages, starting from the gray crescent; when this change is completed, interactions, probably of a biophysical nature, can take place among various parts of the cortex.

Mechanism of neural induction:

Development of the ectoderm overlying the roof of the archenteron into neural tissue suggests a direct action upon the ectodermal cells, either by surface interaction or by chemical mediation.

One of the broad possibilities is surface interaction of the cells at the inductive interface. The contact of the two cellular layers may provide a device whereby the structural pattern or geometry or behaviour of the ectodermal cell membranes is altered directly by the underlying chorda mesodermal cells.

Thus, the spatial configuration of the latter membranes might induce a change in the spatial configuration of the ectodermal cell membranes, this in turn producing in the interior of the cell changes that determine its development into neural plate. A morphological arrangement of this kind

could account for quick and effective transmission of the inductive effect.

Another broad possibility is a chemical mediation of the inductive effect. Therefore, a chemical substance or substances produced and released by inducing chorda mesoderm cells at the archenteron -ectoderm interface may act upon or enter the ectodermal cells to initiate cellular activities leading to neural development. A great deal of evidence favours the idea of an exchange of material between cells and also suggests that a diffusible substance may act as effective inductive stimulus.

Chemical basis of neural induction:

The results of numerous studies to elucidate the mechanism of induction and to identify the chemical substance or substances presumed to be involved have not yielded good results. It was found that many different tissues, embryonic or adult, from a great variety of different species, were capable of inducing nervous tissue in amphibian embryos. Moreover, some foreign tissues were found to be much more potent inductors after they had been killed by heat or alcohol treatment.

This fact remains against the concept of a universally present ‘masked organizer’s, released in the primary inductor region. Few inorganic agents as iodine and kaolin, local injury,

exposure to saline solutions of excessively high or low pH, cause neural differentiation in ectoderm. These findings establish the early grand concept of master-chemical embryonic organizer of Holtfreter's sublethal cytolysis. It has the concept of reversible cell injury liberating neural inductor.

Different chemical substances of either gray crescent or dorsal lip or chord mesoderm are separated by different biochemical methods to find out the molecule which causes the neural induction and then the inductive capacity of each molecule was tested separately. Few experiments show that inducing substance is a protein.

Exhaustive attempts were made by different embryologists to understand the real mechanism of neural induction. Some theories have been put forward to understand the mechanism of neural induction, out of which the most important are as follows:

Protein denaturation theory of neural induction:

According to Ranzi (1963) neural induction and notochord formation are related to protein denaturation. Site of notochord formation is amphibian gray crescent, which is a center of high metabolic activity. Such centers of greater metabolic activity correspond to sites of protein denaturation.

Gradient theory of neural induction:

Toivonen (1968) and Yamada (1961) stated that two chemically distinct factors are involved in the action of the primary inductor. Out of these two factors, one is neutralizing agent and the other is mesodermalizing agent. These experiments were conducted with denatured bone marrow and liver as the inductors.

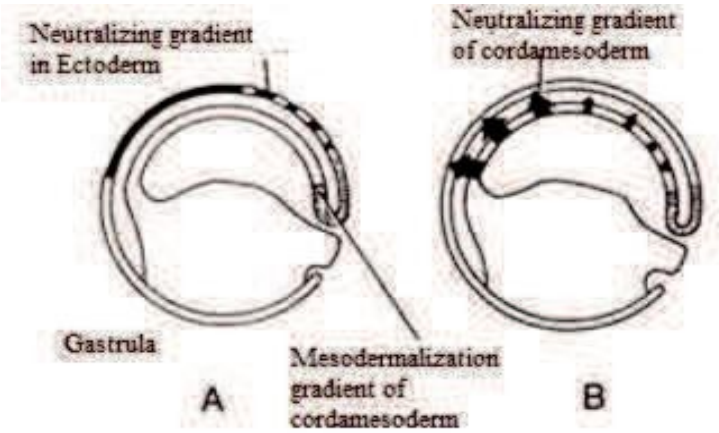

Fig. (A) The neutralizing gradient in ectoderm over lying in the mesodermalization gradient of chordamesoderm, (B) Neutralizing gradient of chordamesoderm

Regional specificity of the embryonic axis arises from the interaction between two gradients: neutralizing principle has its highest concentration in the dorsal side of the embryo and diminishes laterally, while the mesodermalizing principle is

present as an antero-posterior gradient with its peak in the posterior region.

Anteriorly the neutralizing principle acts alone to induce forebrain structures, more posterior the mesodermalizing principle acts along with the neutralizing one to induce mid-brain and hind-brain structures, while even more posteriorly the high concentration level of the mesoderm gradient produces spino-caudal structures (Fig).

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