

Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Third Year)

Subject: Zoology

Course Code: ZOC 108

Course Title: Developmental biology

Unit: Transplantation, Embryonic induction, Concept of Primary organizer and Competence.

Module Name: Embryonic induction: types

Module No: 19

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Notes

Embryonic Induction

During the embryogenesis of the multicellular organisms, different kinds of interactions between the different types of embryonic tissues at one or other embryonic stages have been observed by many embryologists. One kind of such a tissue-interaction called inductive interaction or embryonic induction has been reported to be a wide spread developmental phenomenon in many invertebrates, prevertebrate chordates and vertebrate chordates.

Amphibians are the most extensively studied vertebrates for investigations into embryonic induction.

The embryonic induction is a morphogenetic effect by which one embryonic tissue transmits a chemical stimulus that influences another embryonic part to produce a structure that otherwise would not come into existence.

Induction is a process whereby one cell or group of cells can influence the developmental fate of another, and is a common strategy to control differentiation and pattern formation in development. Two identical cells can

follow different fates if one is exposed to an external signal (often produced by a different cell) while the other is not.

The inductive signal can be a protein or another molecule (secreted by the inducing cell) that interacts with a receptor on the surface of the responding cell (although some inductive signals pass the cell membrane and interact with cytosolic receptors). The signal initiates a signal transduction cascade that influence the activity of transcription factors and/or other proteins eventually altering the pattern of gene expression. Responding cells may show a single stereotyped response to the inductive signal, or a graded response dependent on its concentration, in which case it is called a morphogen*.

The response to inductive signals depends on the ability of the cell to receive the signal and react in an appropriate manner. This ability is called **competence**. The loss of competence (e.g. loss of cell surface receptors, signal transduction apparatus, or downstream target transcription factors) is one mechanism by which cells become irreversibly committed to a given developmental pathway. In other words, the cell is no longer able to respond to the inductive signals.

The embryonic tissue which exerts such an inductive influence is called an inductor and the chemical substance that is emitted by an inductor is called an evocator. The tissue on which a evocator of inductor acts is known as the responsive tissue.

The embryonic induction is a mechanism of determination through which a control of the pattern of the protein synthesis is imposed on a responsive tissue and new kinds of cells with new behaviours are created. it occurs especially in organs assembled as a composite from different sources and is useful in bringing about orderly development and the correct timing and fitting together of parts.

Types of Embryonic inductions.

1. Endogenous induction

Certain embryonic cells gradually assume new diversification pattern through the inductors that are produced by them endogenously. Due to these endogenous inductors, these cells undergo either self-transformation or self-

differentiation. Such endogenous induction has been reported in mesenchymal cells of ventral pole of Echinoidea and in small sized, yolk laden cells of dorsal lip of amphibian blastopore. It is found to depend on several factors such as unequal divisions, small cells, yolk laden cells and sub-lethal cytolysis, etc.

2. Exogenous induction

When some external influence or a cell or a tissue is introduced into an embryo, they exert their influence by process of diversification pattern upon neighbouring cells through contact induction. This phenomenon is called exogenous induction. An exogenous induction may be homotypic or heterotypic depending on the fact that whether the inductor provokes the formation of its own kind of tissue or it provokes the formation of different kind of tissues, respectively. In case of homotypic exogenous induction, diversified cell produces the inductor which serves to maintain the proper state in the cell and which differentiates other adjacent cells according to it after crossing the cell boundaries Ex. Formation of a secondary embryonic axis by an implanted presumptive notochord in amphibians.

3. Instructive interaction

In instructive interaction, a signal from the inducing cell is necessary for initiating new gene expression in the responding cell. Without the inducing cell, the responding cell would not be capable of differentiating in that particular way. For example, when the optic vesicle is experimentally placed under a new region of the head ectoderm and causes that region of the ectoderm to form a lens, that is an instructive interaction.

Instructive induction occurs where the responding cell has a choice of fates and will follow one developmental pathway following induction, and an alternative pathway in absence of the inductive signals. In example, in the early *Xenopus* embryo, ectoderm will form the neural plate in presence of inductive signals from the notochord, but epidermis in the absence of induction.

4. Permissive interaction.

Here, the responding tissue contains all the potentials that are to be expressed, and needs only an environment that allows the expression of these traits.[‡] For instance, many tissues need a solid substrate containing fibronectin

or laminin in order to develop. The fibronectin or laminin does not alter the type of cell that is to be produced, but only enables what has been determined to be expressed.

Permissive induction occurs where the responding cell is already committed to a certain fate, and requires the inducing signal to proceed in the developmental pathway.