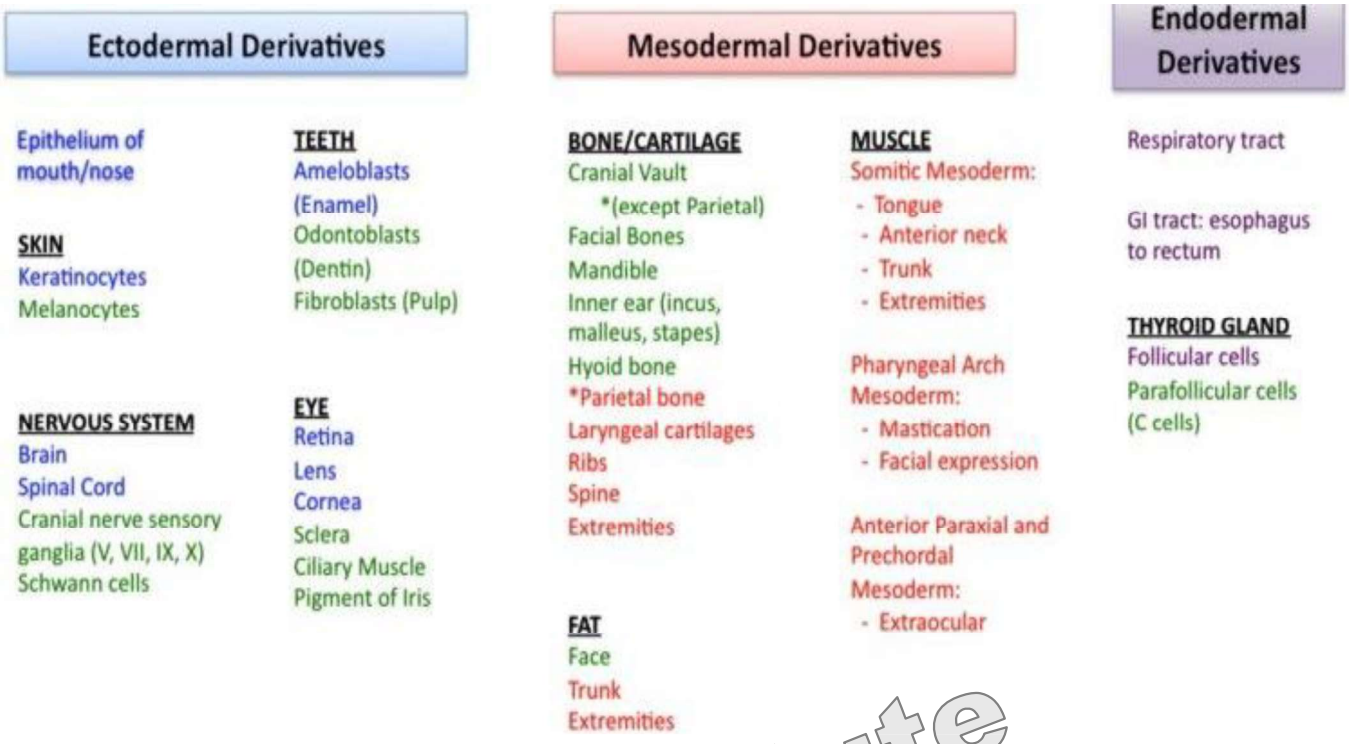


- **Formation of endoderm:** Endoderm of hypoblast develops as a single layer of cells in side of blastocoel. After the formation of endoderm, upper layer is called epiblast. **There are different theories to explain the formation of endoderm.**
- **Infiltration theory** : This was proposed by Peter in 1923. According to this theory some cells in blastoderm which are loaded with yolk will fall into blastocoel. It starts from posterior end of blastoderm. From there the cells migrate forward one behind another and endoderm is formed.
- **Delamination theory** : It was proposed by Spratt in 1946. Blastodenr.[1] is two or three layered thick. The lower layer will separate-fcoijl the upper layer by splitting and the lower layer is called endoderm, upperr layers are called ectoderm. In between ectoderm and endoderm blastocoel is .present.
- **Theory of involution** : In 1909 Peterson Proposed this theory. According to this theory a slit like opening at the posterior side of blastoderm forms. Through this opening the blastoderm cells will role into the primary blastocoel. It forms an endoderm.
- **Theory of invaginaton** : This was proposed by Jockobson in 1938. According to this theory the posterior end of blastoderm will invaginate in blastocoel as a small pocket. This becomes endoderm. In this way endoderm is formed.

Cell differentiation

a) is the process by which embryonic cells become different from one another (distinct identifies and functions).
b) involves the emergence of cell types such as muscle, nerve, skin and fat cells.
c) is the achievement of a stable terminal state (not just transitory differences).
d) involves a change in gene expression to produce "luxury" proteins.
e) is characterized by the profile of proteins present in that cell.
Microarray analysis can be utilized to study differences in gene expression.
The earliest stage of cell differentiation is cell determination where the cells becomes committed to a subset of cell fates.

►**How cells differentiate:**

The specialized properties of different cell types are conferred by the proteins they contain. The process of differentiation must therefore involve the synthesis of different sets of proteins in different cells. Exceptionally, this may be achieved by DNA rearrangement, as in the differentiation of antibody-producing blood cells. However, most cells contain the same DNA, and different sets of proteins are made by the selective expression or activation of particular gene products. The synthesis of a functional proteins is dependent on a series of steps including transcription, RNA processing, protein synthesis and posts-translational protein modification. Any or all of these stages can be regulated, so differentiation usually begins with the activation of a particular regulator molecule, such as a transcription factor

►**Lateral inhibition and the community effect**

Lateral inhibition is the inhibition of a particular developmental process in one cell by signals from an adjacent cell. Lateral inhibition can be used as a special form of induction, which involves an initially equivalent field of cells, yet results in the differentiation of individual cells in a regularly spaced pattern

► **Competence**

Competence is a property of the cell responding to induction. A cell is described as competent if it can respond to the inductive signal by undergoing all the appropriate molecular changes that allow it to follow the 'induced' develop-mental pathway. In the absence of induction, the cell eventually becomes deter-mined to an alternative pathway, and this coincides with its loss of competence to respond to induction. In the case of endocrine or paracrine signaling, competence depends on the synthesis of all the components of the signal transduction pathway that link the inductive signal to its target, such as a transcription factor, in the responding cell. If any of these components is lost, e.g. the cell surface receptor, the signal transduction apparatus, or the downstream target transcription factor itself, the cell loses competence. In the case of juxtracrine signaling, a cell may also lose competence simply by breaking contact with the inducing cell. This may reflect the movement of cells away from each other, or the disassembly of gap junctions.

► **Instructive and permissive Induction**

These two categories of induction reflect the choices available to the responding cell. Instructive induction occurs where the responding cell has a choice of fates and will follow one pathway in response to induction but an alternative pathway in the absence of induction.

Permissive induction occurs where the responding cell is already committed to a certain develop-mental fate, and simply requires the inducing signal to continue down that developmental pathway. An example is muscle development, where myoblasts continue to proliferate until growth factors are withdrawn, when they differentiate into myotubes and eventually muscle fibers

► **Instructive and permissive induction can be distinguished by grafting experiments**. For example, in mammals, the cardiogenic mesenchyme (future heart) is required to induce hepatocyte development in the presumptive liver-forming region of the foregut. The signals could be instructing the foregut to form hepatocytes instead of other cell types or could be permitting the differentiation of hepatocyte cells that have already been specified by other mechanisms. If the cardiogenic mesenchyme is grafted under the hindgut, no hepatocytes are induced. The inductive signals from the cardiogenic mesenchyme are therefore permissive rather than instructive.

► **Cytoplasmic determinants**

A cell can divide to produce two daughters committed to different fates in the absence of any external influences. Stem cells provide an excellent example of this process. Each division of a stem cell produces one daughter cell committed to differentiate, and a replacement stern cell. This stereotyped division program can occur in isolation, indicating that the mechanism of differentiation is entirely intrinsic. One way in which this could be achieved is through the asymmetric distribution of cytoplasmic determinants (molecules in the cytoplasm that can help to determine cell fate). If a mother cell contains a cytoplasmic determinant that is localized to one pole as the cell undergoes division, that determinant will be inherited by only one of the daughters.

MOSAIC AND REGULATIVE DEVELOPMENT

►Definitions of mosaic and regulative development

Cytoplasmic determinants and inductive signals can both be used to control cell fates. If development was controlled entirely by cytoplasmic determinants, the fate of every cell would depend on its lineage, while its position in the embryo would be irrelevant. This is the definition of mosaic development.

Conversely, if development was controlled entirely by inductive interactions, the fate of every cell would depend on its position in the embryo and its lineage would be irrelevant. This is the definition of regulative development. The development of most organisms involves a combination of these mechanisms. The two mechanisms are discussed in more detail below, and their key features are compared.

► **Regulative Development**

In regulative development, the fate of every cell is governed entirely by its interactions with other cells. Cell fate depends on position in the embryo and is independent of lineage. The potency of each cell is therefore much greater than its fate. During regulative development, each cell is said to undergo conditional specification, i.e. conditional on the presence of other cells. Therefore, if removed from the embryo, a given cell will not fulfil its normal fate because it lacks the necessary interactions. Furthermore, the remainder of the embryo can regulate to replace missing parts, because the appropriate inductive interactions have yet to take place, and other cells can be respecified to fill in the missing pattern. The fate map of a regulative embryo is not the same as a specification map, since cells in isolation will not develop in the same way as those in the embryo.

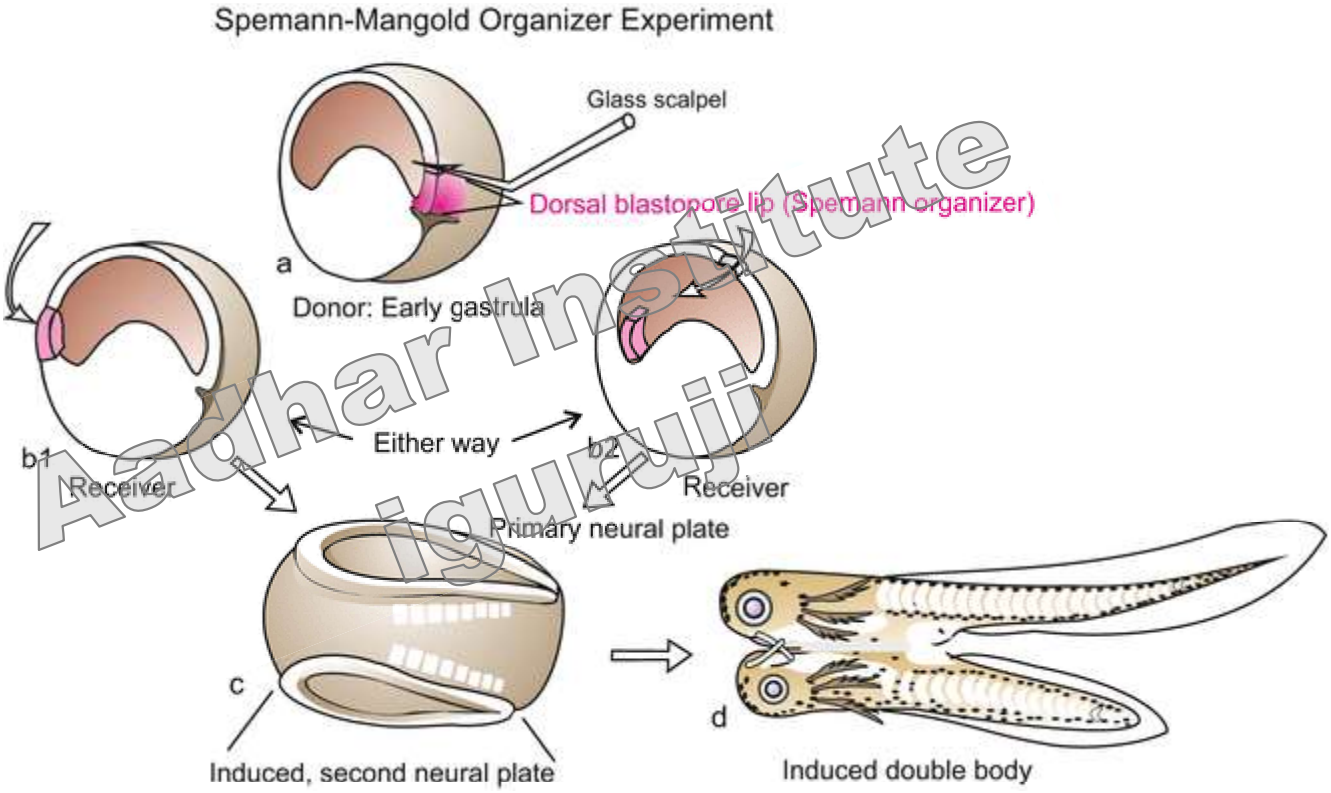
► **Maternal and zygotic genes**

Cytoplasmic determinants often feature in early animal development, where maternal gene products are localized in the egg to help pattern the early embryo. In such cases, early development becomes dependent on the maternal genome, while the paternal genome plays no part. This leads to an interesting class of mutants called maternal effect mutants, whose phenotypes are manifest in the embryos of mutant females, but not in the mutant females themselves. Furthermore, if the mutation is recessive and the female is homozygous for the mutation, embryonic development cannot be rescued by mating to a wild type male

TOPIC:Embryonic Induction

In amphibian embryos, the dorsal ectodermal cells in a mid-longitudinal region differentiate to form a neural plate, only when the chorda-mesoderm is below it. **Chorda-mesoderm is the layer formed by invagination cells from the region of the dorsal blastoporal lip, which form the roof of archenteron.**

- **Mangold (1927) selected a small part of dorsal blastoporal lip from an early gastrula of Triturus cristatus and grafted it at a place near the lateral lip of the blastopore of the host gastrula of T. taeniatus.**
- The graft cells grew in number and spread inside the host gastrula to form an additional chorda-mesoderm at this place. This chorda-mesoderm, subsequently induced the ectoderm of the host gastrula to form an additional neural tube.



The graft cells themselves formed an additional notochord. As the host gastrula developed further, it grew into a double embryo joined together.

- One of the embryos was the regular one, while the second was the induced one. The latter did not develop a complete head.
- This experiment clearly showed that the dorsal blastoporal lip of the blastula had the ability to induce the formation of the neural plate in the ectoderm of the host. **This phenomenon is called neural induction**..
- This influence of one structure in the formation of another structure is called embryonic induction.
- In fact, the entire development of an organism is due to a series of inductions.

- The structure, which induces the formation of another structure, is called the inductor or organizer. The chemical substance that is emitted by an inductor is called an evacuator.
- The tissue on which an evacuator or inductor acts is called the responsive tissue.

Historical Background of Embryonic Induction:

For the discovery of neural induction, the German embryologist, Hans Spemann and his student, Hilde Mangold (1924) worked a lot and for his work Spemann received Nobel Prize in 1935.

These two scientists performed certain heteroblastic transplantations between two species of newt, i.e., Triturus cristatus and Triturus taeniatus and reported that the dorsal lip of their early gastrula has the capacity of induction and organization of presumptive neural ectoderm to form a neural tube and also the capacity of evocation and organization of ectoderm, mesoderm and endoderm to form a complete secondary embryo.

- They called the dorsal lip of the blastopore the primary organizer since it was first in the sequence of inductions and as it had the capacity to organize the development of a second embryo.

Later on, the primary organizer was reported to exist in many animals, e.g. in frogs (Daloq and Pasteels, 1937); in cyclostomes (Yamada, 1938); in bony fishes (Oppenheimer, 1936); in birds (Waddington, 1933) and in rabbit (Waddington, 1934).

In 1960 and 1963 Curtis investigated and reported that the organizer of gastrula of Xenopus laevis can be distinguished in the cortex of gray crescent of a fertilized egg.

Types of embryonic induction:

Lovtrup (1974) classified different types of embryonic induction into two basic categories- endogenous and exogenous inductions.

1. Endogenous induction:

- Certain embryonic cells gradually assume new diversification pattern through the inductors that are produced by them endogenously.
- **Due to these inductors, these cells undergo either self-transformation or self-differentiation.** Examples of such induction were reported in Mesenchymal cells of ventral pole of Echinoid and in small sized, yolk-laden cells of dorsal lip of amphibian blastopore.

2. Exogenous induction:

- When some external agent or a cell or a tissue is introduced into an embryo, they exert their influence by a process of diversification pattern upon neighbouring cells through contact induction. This phenomenon is called exogenous induction.
- It may be **homotypic or heterotypic** depending on the fact that whether the inductor provokes the formation of same or different kind of tissues respectively.
- **In homotypic induction**, a differentiated cell produces an inductor. The inductor not only serves to maintain the state of the cell proper, but also induces adjacent cells to differentiate according to it, after crossing the cell boundaries. **Best example of the heterotypic exogenous**