8. Describe the autonomous specialization of cell differentiation in tunicate embryo.

A.

The single cell zygote develops into an embryo within which several processes occur at the cellular and tissue level to create a multicellular organism. These processes include cell proliferation, differentiation, cellular movement and programmed cell death. Differentiation is the development of specialized cell types which are essential for vital organs, such as the RBCs, brain, heart and skin. It is also known as cell specification by which generic cells change in to specific cells meant to do certain tasks within the body. cell specialization is the most important in the development for embryos.

* Modes of specification :-

There are three general ways a cell can become specified for a particular fate. These are-

1) Autonomous specification.
2) Conditional specification, and
3) Syncytial specification.

* Autonomous specification :-

It is a form of specification in which the developing cell is able to differentiate without receiving external signals. This type of specification results from cell intrinsic properties which arise from a cleavage of a cell with cytoplasmic determinants (ie. Proteins, small regulatory RNAs, and mRNAs).

~~Such~~ Autonomous specification was demonstrated in 1887 by Laurent Chabry (French) working on "tunicate embryos". The main facts are -

(a) it is independent of other cells in embryo.

(b) it is determined by internal cytoplasmic factors/determinants which provide necessary information for specification.

(c) if cleavage patterns are invariant, then cell fates will be invariant.

(d) it gives rise to mosaic development - because embryo appears to be constructed like a tile mosaic of independent self-differentiating parts.

(e) Autonomous specification is characteristics of invertebrates such as Ctenophores, annelids, molluscs, echinoderms and tunicates.

* Autonomous specification in Tunicate embryo :-

Tunicates are marine invertebrate chordates and closest relatives of Vertebrates. The most common tunicates are ascidians. When the 8-celled embryo is separated into it's 4-doublets (the right and left sides being equivalent), mosaic determination is the rule. The animal posterior pair of blastomeres give rise to the ectoderm, and the vegetal posterior pair develops endoderm, mesenchyme and muscle tissue just as expected from its fate map. only one pair of blastomeres (posterior vegetal) in the 8-celled embryo is capable of producing tail muscle tissue. These cell contain the yellow crescent cytoplasm. When this cytoplasm is transferred from the muscle forming blastomere to the ectoderm forming blastomere of an 8-celled tunicate embryo, the ectoderm forming blastomere generate muscle cells as well as it's normal ectodermal progeny (Whittaker, 1982). If a particular blastomere is removed from an embryo early enough, it's developmental that isolated blastomere will produce the same cell. Moreover, the embryo from which that

• cell is taken will lack those cells that would have been produced by the missing blastomere.

* Key Concept: Autonomous Specification.

i) The cytoplasm of animal eggs is heterogenous in composition due to the asymmetric deposition of key regulatory factors termed cytoplasmic determinants.

ii) In general, cytoplasmic determinants are asymmetrically distributed along the primordial axis of the ovum termed the animal - vegetal axis.

iii) Most cytoplasmic determinants provide the necessary information for specifying embryonic cells fates.

iv) When inheritance of cytoplasmic determinants by a cell is sufficient for that cell to undergo it's final differentiation, it is said to undergo ~~differentiation~~ autonomous cell fate specification.

Thus, the fate of the cell depends on factors secreted in to it's cytoplasm during Cleavage.

* DEVELOPMENTAL BIOLOGY:-

One purpose of developmental biology is to understand how a particular cell develops into a final cell type, known as fate determination. Almost all animals undergo a similar sequence of events during very early development which is known as "embryogenesis". Recently scientists discovered that a basic set of the same proteins and mRNAs are involved in embryogenesis. cell differentiation during embryogenesis provides no indications of the mechanisms that drive the specification. The use of molecular techniques, including gene and protein knockdowns, knock outs and over expression allows investigation in to the mechanism of fate determination. Improvements in imaging tools including life confocal microscopy and super resolution microscopy allow visualization of molecular changes in experimentally manipulated cells.

→ PTO.

(2) CONDITIONAL SPECIFICATION

In Contrast to the autonomous specification, this type of specification is a cell-extrinsic process that relies on cues and interactions between cells or from Concentration gradients of morphogenes. Inductive interactions between neighbouring cells is the most common mode of tissue patterning.

In this mechanism, one or two cells from a group of cells with the same developmental potential are exposed to a signal (morphogene) from out side the group. Only the cells exposed to the signal are induced to follow a different developmental pathway, leaving the rest of the equivalence group unchanged. In brief it can be explained as —

- specification dependent conditions (cell interactions)
- more variable
- capacity to regulate, and
- characteristics of Vertebrates (and in some invertebrates)

(3) SYNCYTIAL SPECIFICATION :-

This type of specification is a hybrid of the autonomous and conditional type that occurs in insects. This method involves the action of morphogene gradients within the syncytium. As there are no cell boundaries in the syncytium, these morphogens can influence nuclei in a concentration dependent manner.

- Key points :-
  a) Interactions between regions of cells before cellularization.
  b) Cells have no specific cell fate before cellularisation.
  c) occurs mostly in insects.

— x —