

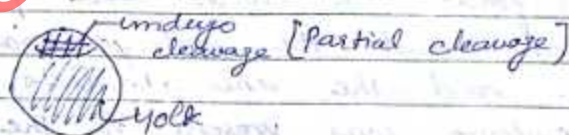
- Development
 - Ontogeny: Development of ^m embryo
 - Phylogeny: Evolutionary development

Approaches to study development :-

- ① Anatomical approach
- ② Genetic approach
- ③ Experimental approach

- Anatomical
 - Comparative
 - Evolutionary
 - Teratology [study abt birth defects]
 - Mathematical modelling

- Comparative - Aristotle (4th century BC) father of comparative embryology.
 - Give the concept of oviparous, viviparous, ovoviviparous.
 - He saw a no. of eggs and said egg can undergo holoblastic [when cell completely divided into two] cleavage and meroblastic cleavage.



Meroblastic cleavage [Birds]

→ Also studied the functions of placenta and umbilical cord.

⇒ William Harvey in the year 1651

- All animals arise from eggs - He said this
- He also said / ~~the~~ or give the function of amniotic fluid → amniotic fluid acts shock absorber.

⇒ Marcello Malpighi

- He gave the first microscopic account of chick development.

EPIGENESIS AND PREFORMATION ?-

- Aristotle Harvey said development is de novo
- Epigenesis is supported by Aristotle Harvey. They said embryos are formed de novo.
Preformation was proposed by Marcello Malpighi. He said that the organs of the adult were present in miniature form in eggs and sometimes sperm. When the embryo begins to develop, these parts grow or unfold. The Ovisists were people who believed that the embryo was formed in the egg and the animalculists believe that the embryo was present in the spermatozoa. However, the discovery of parthenogenetic development in insects gave support to the Ovisists.

Epigenesis is revived by ^{Kasper} ~~Fodor~~ ^{Frederick} ~~Fodor~~ ^{Wolff} who observed the formation of chick embryo and noticed no pre-formed structure in the egg only granule substance were present. He concluded that the eggs contain material from which material is built. Also epigenesis gained strength with the development of improved microscope, better staining technique and the German universities.

- Christian Pander → He discovered the germ layers. He saw the tissue interactions.
- Heinrich Rathke → He saw the development of frog, Salamander, Fish, birds and mammals. He concluded there are similarities in development in all Vertebrates.
- Karl Ernst von Baer → Von Baer's laws
 - First law :- General features appear earlier in development. (Motochord)
 - Second law :- The less general characters appear from the more general characters.
 - Third law :- Embryo of a given species instead of passing to the adult stages of lower animal, departs more from them.
 - Fourth law :- Earlier embryo of higher animal is never like a lower animal. It only resembles its embryo.

Biogenetic Law :

Biogenetic Law Muller-Haeckel

Muller propounded the law and supported it based on the development of crustaceans [Arthropods]. Haeckel (1866) named it the biogenetic law. It is basically the Baer's law re-interpreted in the light of evolutionary theory.

Evolutionary theory - It states ontogeny recapitulates phylogeny, i.e. ontogenic development presents the various features of animal organisation in the same sequence in which they develop phylogenetically.

Biogenetic law states that ontogeny is a shortened and modified recapitulation of phylogeny. While phylogeny takes years, ontogeny is a matter of days and weeks. Also many stages are omitted in ontogeny.

Fate maps

6/Jan

Fate maps are the map that trace larval or adult structure onto the region of embryo from which it arose. It forms the bases of experimental embryology. They can be generated in several ways:

- ① By observing living embryos.

In some invertebrates the embryos are transparent and have few cells. In this we can observe and trace the descendants of particular cells into organs they generate. Edwin G. Conklin took eggs of tunicate Styela partita, a sea ^{Squid} ~~Squid~~ and followed the fate of each cell. This was possible bcoz in Styela different cells contain different pigment. Eg muscle-forming cell had yellow pigment. The exp. was confirmed by cell-removal experiment. It was seen that removal of these yellow cell resulted in absence of tailed muscles.

(2) Vital dye staining : (Those stain live cells) Vogt in 1929, dyed particular cells with vital dyes. For this he prepared agar on slide and mixed it with the dye. The ends of the dyed agar were placed on the frog embryo. After the dye stained the cells, agar chips were removed the cells movement could be observed.

(3) Radioactive movement labelling and fluorescent dye :

For this the donor embryo is grown in radioactive medium. The region of interest is cut from the host embryo and replaced by radioactive graft of the donor then sections are cut for the microscopy. The descants of interest are radioactive. The problem with vital dye and radioactive dye is that with each division it becomes diluted and difficult to detect.

Fluorescent dyes like fluorescent conjugated dextran can be used to stain cell and the embryo can be observed under UV.

(4) Genetic marking :-

Mosaic embryos can be created. Best e.g is the construction of chimeric embryos consisting of graft of Quail cells inside chick embryo [both have similar early embryonic devel.] Quail cells have diff. nucleus c. heterochromatin and also these are cell specific antigens that are quail specific. Quail cells are substituted for chick cells while embryo is still inside the egg and the chick that hatches will have quail cells at particular sites.

- Fate maps are instrumental in demonstrating the extensive cell migration during development.
- Mary Burt in 1940 showed that melanocytes of chick originate in the neural crest. Crest Using the same technique, Ris (1941) demonstrated that while external pigment cells in chicken originate from neural crest, the retinal pigment cells are formed in the retina itself. By using radioactive marking, Weston in 1963 demonstrated that neural crest cells give rise to melanocytes, peripheral neurons and adrenal medulla.

Evolutionary Embryology

Based on the Muller's interpretation of Baer's law Charles Darwin suggested that embryonic resemblances show genetic connectiveness of different animals.

Based on larval forms, Barnacles were placed in Arthropods and tunicate larvae in chordates. bcoz they have notochord and pharyngeal pouches. Also Darwin noted that embryonic organisms make structures in appropriate for their adult form but they show their relatedness to other animals.

Homology : Homology structure which are similar as they are derived from common ancestral structure. E.g. forelimb of human and wing of bird, Gill cartilage of fish, Reptalian Jaw and mammalian middle ear.

Analogous : They are similar as they perform the similar function. e.g. wings of insect and wings of birds.

Teratology

medical Embryology and teratology

• Defect $\left\{ \begin{array}{l} \text{Genetic - (defect in genes)} \\ \text{Teratology} \end{array} \right.$

Some birth defects are due to mutant genes or chromosomes. Others are produced by environmental factors, abnormalities caused by genetic events are called as malformation and those in the study of embryological defect caused by environ. [chemicals, radiations] are known as ~~toxa~~ teratology.

Integration of malformation with the knowledge of genes responsible for the development has helped us identify steps in development.

Mathematical modelling and Development :-

Pattern formation and growth are two areas in which mathematical modelling has helped.

Unicellular to multicellular - 2 Principle -

- (1) Staying together
- (2) Differentiation

Evolution of multicellular organism :-

Orderly division of cells and subsequent differentiation e.g. Volvoxians mostly they are group of cells resembling unicellular Chlamydomonas. The group of cell come from flat-plate of cells (4-16 cells) e.g. Gonium. In Pandorina, the 16 cells form a sphere. Thus in this, we see the orderly cell division followed by arrangement in a predictable manner, Process basically resembles the cleavage. In 2 genera of Volvoxian, another imp principle is seen, i.e. differentiation of cell type. In Pandorina and Volvox there is differentiation of reproductive cell and somatic cell.

In planaria, only anterior cells perform somatic function and posterior cells take place in reproduction.

In Volvox, reproductive cells never develop flagella and do not help in motility or any other somatic function.

Differentiation and morphogenesis :

↳ movement of cell during gastrulation

- It can be seen in unicellular org. Ectocarpus discoidium.

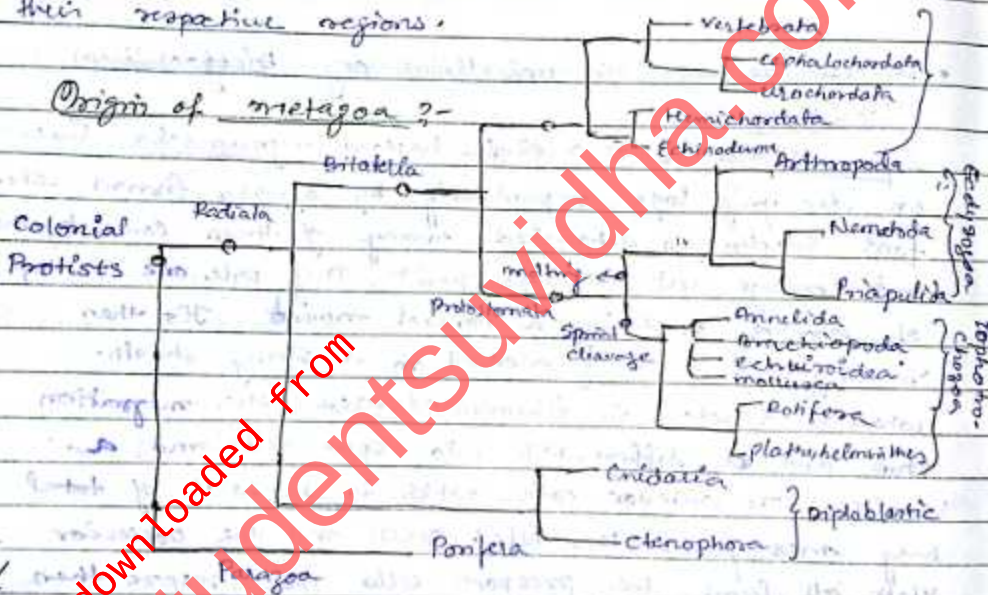
Life cycle :- It is a single haploid organism. It lives on decaying logs, reproducing by binary fission. When food supply is exhausted, many of them come together and congregate at a single point. They pile one on top of another, producing a conical mound. It's then moving as a slug, encased in a slimy sheath. When it reaches a illuminated area, the migration stop and it differentiates into spore cells and a stalk. The stalk cells, which is 55-20% of total body mass, form the stalk and the posterior 45% cells form the prespore cells. The prespore then becomes the new spore cells, disperse and again become new organisms. In this we see cell differentiation and also cell morphogenesis to form complex organism.

How this aggregation takes place :- aggregation takes place due to "chemotaxis". Cyclic AMP is released by the cells. The neighbouring cells move towards the cyclic AMP pulse and also return release more cyclic AMP.

How adhesion takes place :- Adhesion takes place with the help of adhesion molecules. The initial cell-cell adhesion is initiated by 24 kDa glycoproteins (gp24). The second adhesion molecule is of 80 kDa (gp80). This helps in stabilization of adhesion. There is a third adhesion molecule gp150 (150 kDa).

If this protein is absent due to gene mutation, then the prespore and postspore fail to sort out into their respective regions.

Origin of metazoa :-



- Amniote egg -
- (1) Presence of Amnion also known as
 - (2) " yolk sac
 - (3) " chorion (Gas exchange)
 - (4) " allantois (helps in excretion)