

# **TITLE---FATE MAPS AND GASTRULATION**

**FOR CLASS---BSc Semester 4**

**By K. K. Shukla, Assistant Professor**

**Department of Zoology, JNPG College Lucknow**

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## **FATE MAPS AND GASTRULATION**

A chart showing the fate of each part of an early embryo in a particular blastula is called fate map.

### **CONSTRUCTION OF FATE MAPS**

#### **NATURAL MARKINGS**

In some animals such as Ascidians the cytoplasm of the fertilized egg has natural colour difference in various region and on the basis of this difference different regions of the fertilized egg is constructed .

Example- In Styela, there is four regions.

1-Upper hemisphere of light protoplasm (prospective ectoderm),

2-Yellow crescent posteroventral (prospective mesoderm),

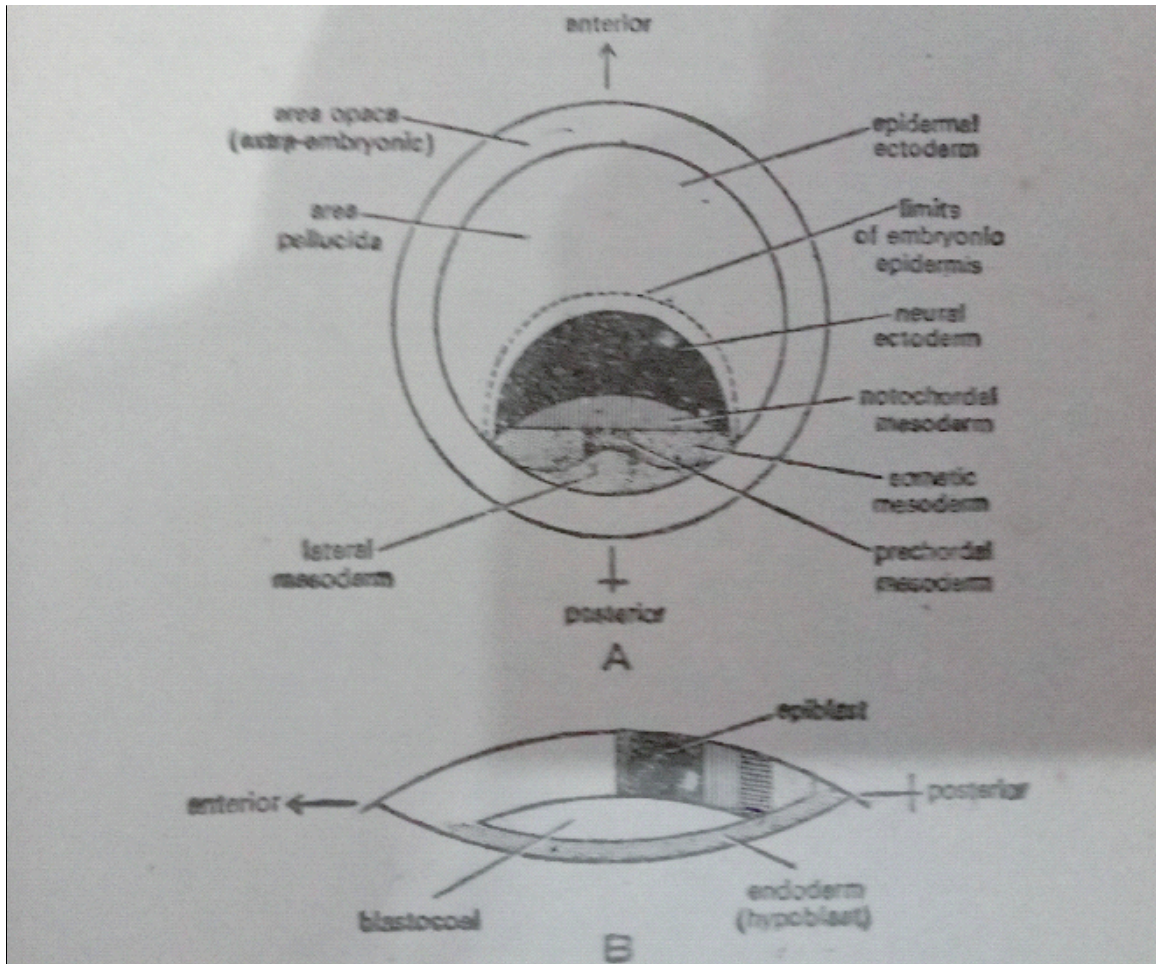
3-Grey crescent of antero-dorsal region and

4-Dark grey yolky substance of vegetative area (prospective endoderm) .

## **ARTIFICIAL MARKING**

### **VITAL STAIN MARKING**

W Vogt 1925 used vital stains for constructing fate map. In amphibians, a small piece of agar or cellophane is stained with vital stain (Nile blue sulphate, Neutral red, Janus green) and pressed against a chosen area of frog blastula. The stain diffuses from agar or cellophane to the blastomeres. By so marking several areas simultaneously and observing continuously movements of cells in gastrulation may be marked.



## CARBON PARTICLE MARKING

Spratt 1946 devised this. In this method, tiny carbon particles applied to the surface of embryo which get attached to the surface of cells and can be used as marker to follow movement of cells and construction of fate map

## RADIOACTIVE LABELLING OF BLASTOMERS

## GASTRULATION

Blastula is single layered structure. By a process of movement of some of the cells of the wall of the blastula it becomes triple layered called gastrula and the process is called gastrulation. In this way cells forming different organs move to their definite position in the developing structure.

Gastrulation is recognised by three events-

1-Formation of primary germ layers

2-Formation of archenteron and

3-Morphogenetic movements

## **MORPHOGENETIC MOVEMENTS IN GASTRULATION**

The movement of blastomeres from one place of embryo to the other place is called morphogenetic movement. During gastrulation two type of morphogenetic movements of blastomeres called epiboly and emboly are found.

### **EPIBOLY**

Micromeres present on dorsal side or in animal

half of blastula divide rapidly and begin to spread out over macromeres covering them from all sides and leaving only a small area called yolk plug.

## **EMBOLY**

The inward migration of prospective chordamesodermal and endodermal blastomeres from external surface of blastula and their extension along the anteroposterior axis of embryo is called emboly . It occurs by following methods--

### **1-Invagination**

Process of insinking or infolding of prospective endodermal cells to form a cavity called archenteron is called invagination. Archenteron opens to outside by blastopore.

On the dorsal side some distance behind the posterior margin of the prospective notochord and along the lower border of earlier grey crescent the macromeres elongates, becomes bottle shaped and move towards the interior of the blastula. Neck of bottle cells remain

attached to the surface of embryo. When these bottle cells are pulled inside an invagination appears at the surface of blastula which gradually increases by continued invagination of endoderm cells and a crescentic groove is formed. This marks the beginning of archenteron.

### **INVOLUTION AND CONVERGENCE**

The micromeres which are present in region of presumptive chorda mesoderm (grey crescent) dorsal to the invaginating endoderm, involute or move inwards along with the invaginating endoderm. These extend along the dorsal wall of invagination and from the dorsal lip of blastopore. Later on intucking of micromeres extending laterally and the lateral lip of blastopore are formed.

The micromeres from the animal half continue to roll inward over the lips of blastopore and are pushed into the blastocoel. As a result archenteron gradually increases in size and blastocoel decreases. Lateral lip blastopore meet in mid ventral line completing the ventral lip. Therefore blastopore in the form of complete

ring is formed. Lip contract reducing it to small aperture shifting it towards posterior side.

## **VENTRAL DIVERGENCE OR ROTATION**

As a result of epiboly the micromeres migrate towards vegetal pole progressively pushing the blastoporal lip towards vegetal pole or post end of embryo. Simultaneously the cells also move outwards and dorsally away from the midventral line which result in rotation of gastrula about a horizontal axis

## **INGRESSION**

It involve invagination or ingression of individual or small group of cells in different parts of inner surface of external layer of blastula to invaginate into blastocoel

## **DELAMINATION**

Separation of a group of cells from other group of cells.

## **INFILTRATION**

Individual cells detach from the inner surface of blastoderm into the blastocoel and arrange

them in a separate layer hypoblast eg birds

As a result of combined effect of all these activity gastrula is formed with an outer ectoderm inner endoderm and middle mesoderm with archenteron as a cavity.

### **GASTRULATION IN ISOLECITHAL EGG (Amphioxus)**

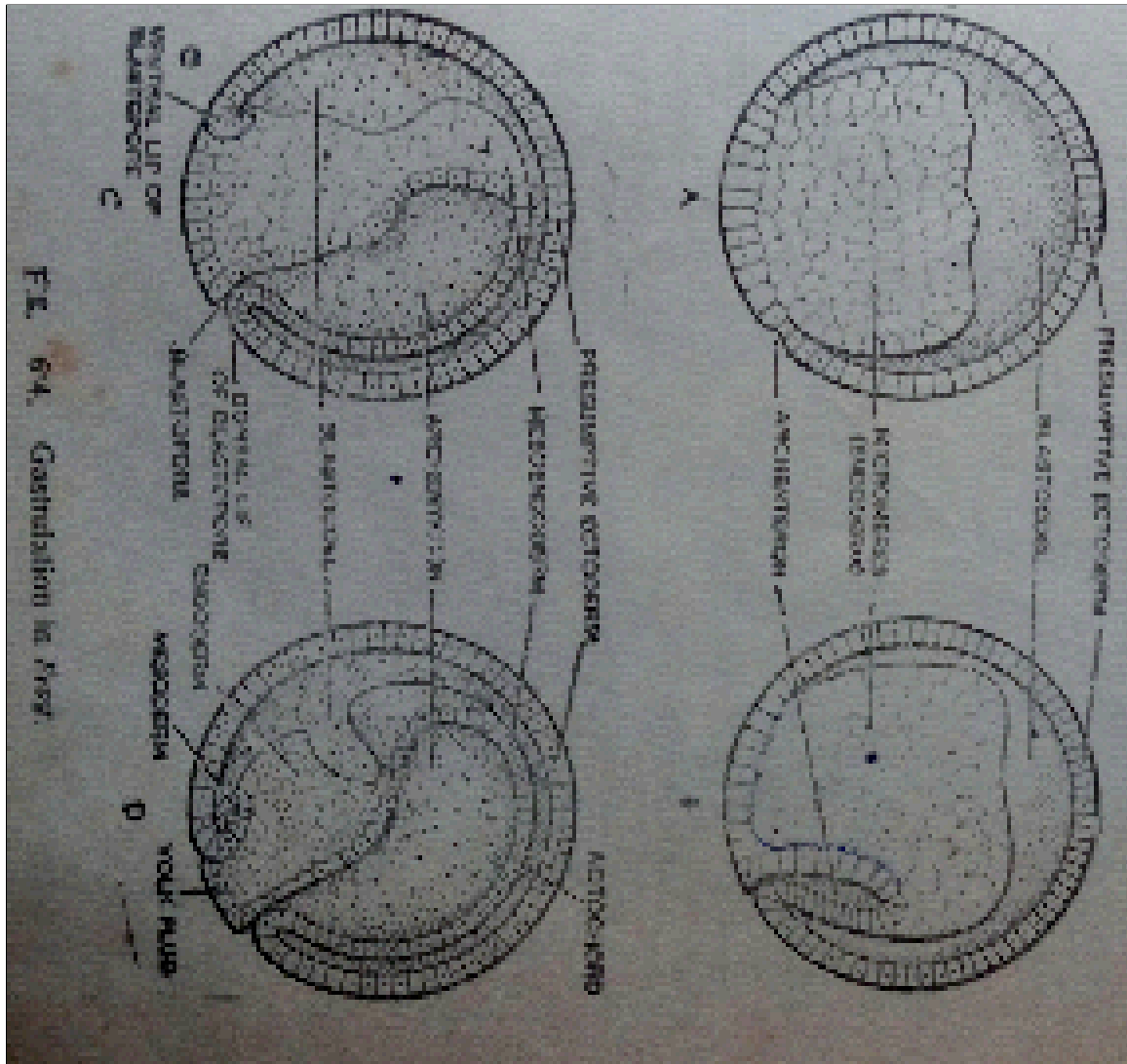
Blastula is coeloblastula. Vegetal pole side becomes flat, gets invaginated, invagination deepens and embryo becomes two layered with ectoderm and endoderm.

The endoderm surrounds the cavity called archenteron which open outside through blastopore. The blastopore region forms posterior end of embryo.

The endoderm becomes thick at dorsal end and gets cut off to form notochord. Dorsolateral wall of archenteron pushed out to form enterocoelic pouch. Later this pouch cut off to form mesoderm enclosing coelome. In Amphioxus coelome is enterocoelic in origin.



## GASTRULATION IN MESOLECITHAL EGG



Mesolecithal egg is found in frog so gastrulation in frog may be taken as example.

Gastrulation in frog is accomplished by three morphogenetic movements epiboly, emboly and involution.

### EPIBOLY

Micromeres present on dorsal side or in animal half of blastula divide rapidly and begin to spread out over macromeres covering them from all sides and leaving only a small area called yolk plug.

### **Invagination or emboly**

On the dorsal side some distance behind the posterior margin of the prospective notochord and along the lower border of earlier grey crescent the macromeres elongates, becomes bottle shaped and move towards the interior of the blastula. Neck of bottle cells remain attached to the surface of embryo. When these bottle cells are pulled inside an invagination appears at the surface of blastula which gradually increases by continued invagination of endoderm cells and a crecentric groove is formed. This marks the beginning of archenteron. Its opening on surface of embryo is called blastopore.

### **INVOLUTION OF CHORDAMESODERMAL CELLS**

The micromeres which are present in region of

presumptive chorda mesoderm (grey crescent) dorsal to the invaginating endoderm, involute or move inwards along with the invaginating endoderm. These extend along the dorsal wall of invagination and from the dorsal lip of blastopore. Later on intucking of micromeres extending laterally and the lateral lip of blastopore are formed.

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## **VENTRAL DIVERGENCE OR ROTATION**

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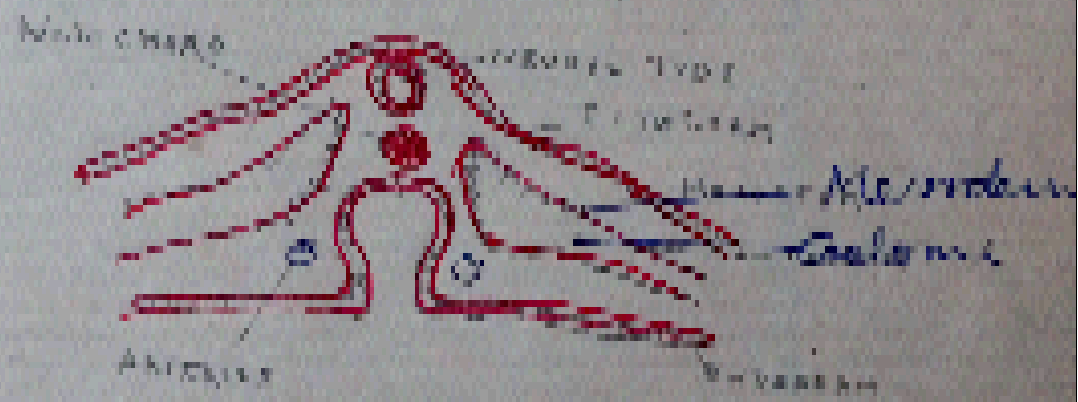
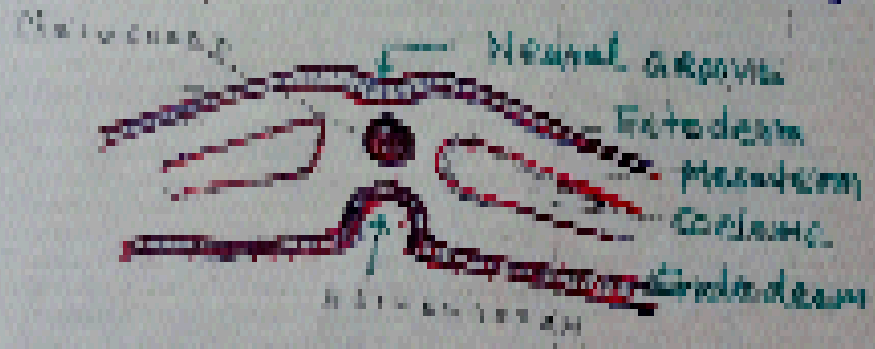
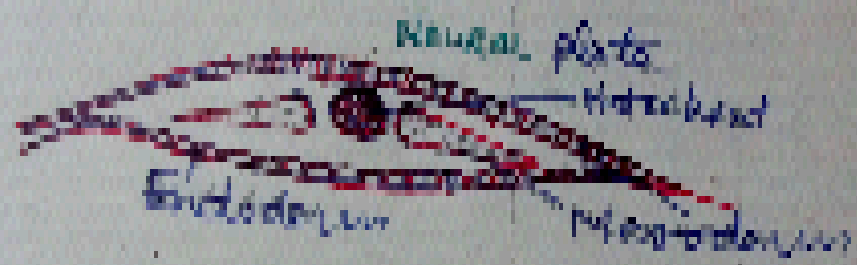
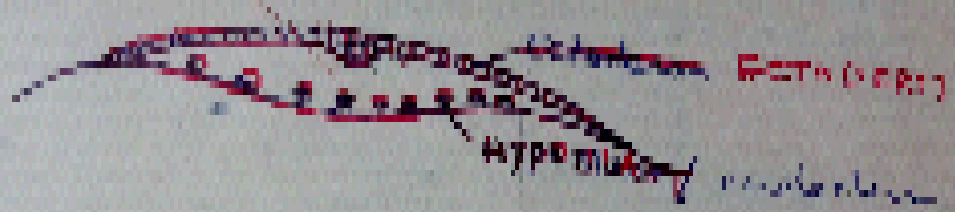
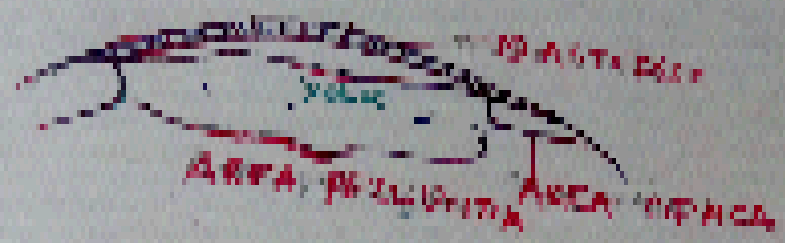
line which result in rotation of gastrula about a horizontal axis

## **CONVERGENCE**

It involve migration and accumulation of cells towards particular side or area.

As a result of combined effect of all these activity gastrula is formed with an outer ectoderm inner endoderm amd middle mesoderm.

## **GASTRULATION IN MACROLECITHAL EGG**



BIRD EGG - GASTRULATION

In chick egg is macrolecithal and cleavage is meroblastic. Cleavage results in disc like structure at animal pole called embryonic plate. Below this there is segmentation cavity or blastocoel.

Blastoderm is slightly lifted from yolk in the center. So central part appears translucent called area pellucida and periferal part is opaque called area opaca.

In chick gastrulation is marked by formation of hypoblast or endoderm which involve follwing processes-

1-Convergent streaming and embolic morphogenetic movement of chordamesodermal and endodermal cells.

2-Involution of chordamesodermal cells

3-Spreading and

4-Elongation of primitive streak

As a consequent of above processes two layered blastula with epiblast and hypoblast layer is modified into three layered gastrula.The

original blastoderm form epiblast and hypoblast is formed above yolk and the space between yolk and hypoblast is archenteron. The next step is formation of primitive streak. In posterior part of area pellucida primitive streak appear in form of thick line due to convergence of cells there. At the anterior end of primitive streak there is a groove called primitive groove. In front of this groove there is a knot called primitive knot or Hensen's node. In the middle of primitive streak a groove starts appearing because of convergence of cells there to immigrate into blastocoel. Below the primitive streak the cells starts getting converted into notochordal cells. Simultaneously sheet of cells cut off on either side as mesoderm somites. The pairs of mesoderm somites indicate the age of embryo. The somites starts forming by about 20 hours of development. So number of somites plus 20 give the approximate age of embryo. The mesoderm somites split apart to form coelome and the later is schizocoelic in origin.

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