

EMBRYOLOGY OF CHICK

The fully formed and freshly laid hen's egg is large. It is 3cm. in diameter and 5cm. in length. It contains enormous amount of yolk. Such egg is called macrolecithal egg. The egg is oval in shape. The ovum contains a nucleus. It is covered by yolk free cytoplasm. It is 3mm. in diameter. It is seen on the animal pole. The entire egg is filled with yolk. This yolk has alternative layers of yellow and white layers. They are arranged concentrically around a flask shaped structure called latebra. Below the blastodisc the neck of latebra expands. This is called nucleus of pander. Yellow yolk got its colour because of carotenoids White yolk layers are thin and yellow yolk layers are thick. Yolk is a liquid. It contains 49% water and 33% phospholipids 18% proteins, vitamins, carbohydrates are present.

The entire ovum is covered by plasma membrane. It is called plasmalemma. It is lipoprotein layer. This is ovum is covered by egg membranes.

Primary membranes: These membranes develop between oocyte and follicle. The primary membranes are secreted by follicle cells. It is called vitelline, membrane is come from two origins. Inner part is produced by ovary. Outer part is from the falopian tube.

Secondary membranes: Oviduct secretes secondary membranes. Above vitelline membrane albumen is present. It is white in colour and it contains water and proteins. The outer layer of albumen is thin. It is called thin albumen. The middle layer of albumen is thick. It is called thick albumen, or dense albumen. The inner most albumen is very thick. It develops into chalazae. The chalazae are called balancers. They keep the ovum in the centre.

Shell membranes: Above the albumen two shell membranes are present. Towards the broad end of egg, in between the shell membranes an air space is present. This air space is formed when egg is laid cooled from 60°C to lesser temperature.

Shell: Above the shell membranes a shell is present, it is porous in nature. It is calcareous. This porous shell is useful for exchange of gases. In a freshly laid hen's egg shell is soft. Very soon it becomes hard.

Laying of the egg: Between 9 A.M. and 3 P.M., the egg is expelled from the cloaca of hen. At the time of laying formation of endoderm is completed. For further development it is to be incubated.

Incubation: When the egg is laid, the development is stopped. For further development it is to be kept at 38°C. This is done by hen by sitting over the egg. This is called incubation. Artificially eggs are incubated in incubators. For the hatching of egg 21 days are required.

In the upper region of oviduct fertilization will takes place. One sperm will penetrate into hens egg and fertilizes with the egg. The fertilized egg will travel through oviduct. It takes nearly 22 hours. Hence the early development of egg will take place in oviduct.

CLEAVAGE

Cleavage is restricted to **blastodisc** and the yolk remains uncleaved. Such cleavage is called **meroblastic or discoidal** cleavage. The central part of blastodisc is whitish and circular. It is surrounded by a darker marginal zone known as the **periblast**, which merges with the underlying white yolk.

I.Cleavage: After five hours of fertilization the first cleavage will appear. It is confined to the centre of blastodisc. It is meridional. It cannot completely divide the blastodisc. Blastomeres are not formed.

II.Cleavage: It takes place at right angles to first cleavage. Even because of second cleavage clear blastomeres are not formed.

III.Cleavage: It is vertical and parallel to the first division. It is in the two sides of first division. As a result of this division eight blastomeres are formed. But they do not show boundaries.

IV.Cleavage: It takes place in such a way that eight central blastomeres and eight peripheral blastomeres (marginal blastomeres) will form. Only at this stage of division definite cells are formed. The central eight cells are completely separated from yolk. After fourth cleavage the cleavages are irregular and a blastoderm is formed.

In all these cleavages, the furrows do not extend right upto the edge of the disc so that the blastomeres in the central area have distinct boundaries and those of the outer area have no outer boundaries but they merge with the unsegmented syncytial periblast.

The marginal syncytial periblast brings the yolk and the growing mass of cells in the blastoderm into nutritive contact. The central cellular area expands by the addition of cells from the periphery. Later the horizontal divisions take place and the central area becomes two or three cell thick. It gets separated from the underlying yolk by a space, the **subgerminal cavity (blastocoel)** which develops either by splitting or separation of the upper layer from the lower layer that retains connection with the yolk mass.

BLASTULA

These cells will undergo further division quickly. Hence above the segmentation cavity mass of cells will be present, in several layers. These cells have complete boundaries. The cells present towards the periphery are not separated from yolk. They are called marginal cells. This region is called **zone of junction**.

Area Pellucida & Area opaca:

The central cell mass of the blastoderm will be in four to five layers, they are lifted from the yolk. Hence the central part of the blastoderm is free from yolk. This region is transparent.

It is called **area pellicida**, which is destined to become the embryo proper. At the zone of junction the cells are in contact with that region is opaca. That region is called **area opaca** which gives rise to extra-embryonic structure.

The area opaca later becomes differentiated into three more or less distinct zones. The blastomeres produced from the original periblast constitute a **germ wall**. Due to the addition of more and more blastomeres on the periphery, an outer ring called **margin of overgrowth** is formed. The blastomeres of this zone have no well defined boundaries. Inner to the germ wall area and lying in close contact with the yolk are a group of cells without complete cell boundaries. This region is known as **zone junction**.

The blastoderm at this stage contains two types of cells-relatively large yolk-laden blastomeres and small yolk-free blastomeres. Now follows a segregation wherein the yolk rich blastomeres gradually accumulate at the under surface of the blastoderm, leaving the smaller yolk poor blastomeres at the surface. The upper layer is called **epiblast** and the lower layer, the **hypoblast**. A narrow cleft called blastocoels appears between the epiblast and hypoblast. The separation of epiblast from the hypoblast is called **delamination**.

Cleavage results in the conversion of the blastodisc into a disc shaped blastula called **discoblastula** which floats atop the yolk mass.

GASTRULATION IN CHICK

Gastrulation begins within four or five hours after the onset of incubation and it is completed by about 22 hours. Gastrulation in chick embryo can be divided into two phases- 1. Endoderm formation and 2. Primitive streak formation and movement of chordamesodermal elements.

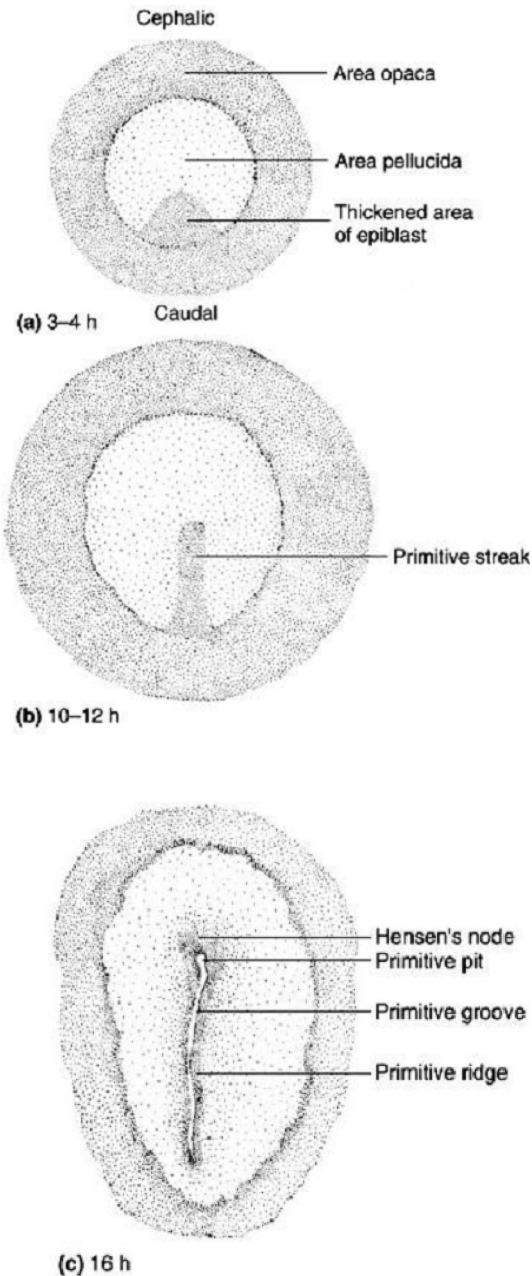
Formation of endoderm: Endoderm of hypoblast develops as a single layer of cells in side of blastocoel. After the formation of endoderm, upper layer is called epiblast. There are different theories to explain the formation of endoderm.

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.

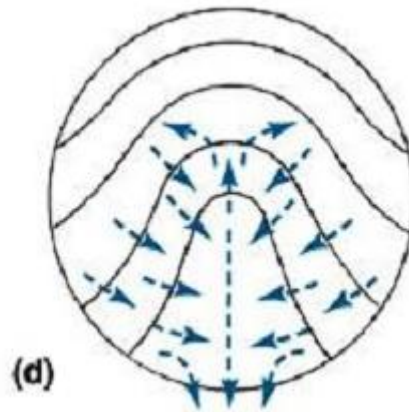
Delamination theory: It was proposed by Spratt in 1946. Blastoderm is two or three layered thick. The lower layer will separate from the upper layer by splitting and the lower layer is called endoderm, upper layers are called ectoderm. In between ectoderm and endoderm blastocoel is present.

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 roll into the primary blastocoel. It forms an endoderm.

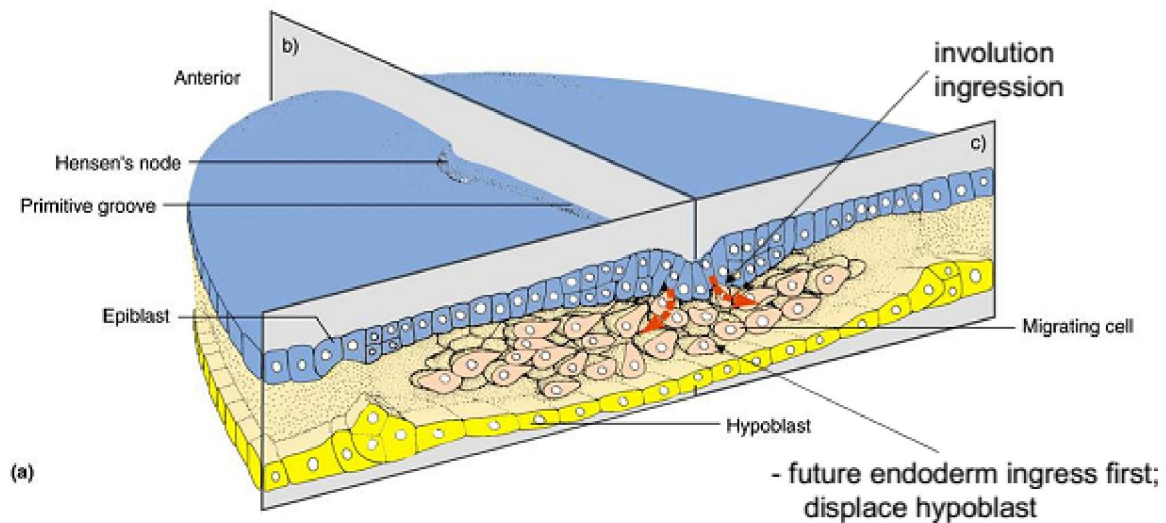
Theory of invagination: This was proposed by Jockobson in 1938. According to this theory the posterior end of blastoderm will invaginate in blastocoel as a small pocket. This becomes endoderm. In this way endoderm is formed.

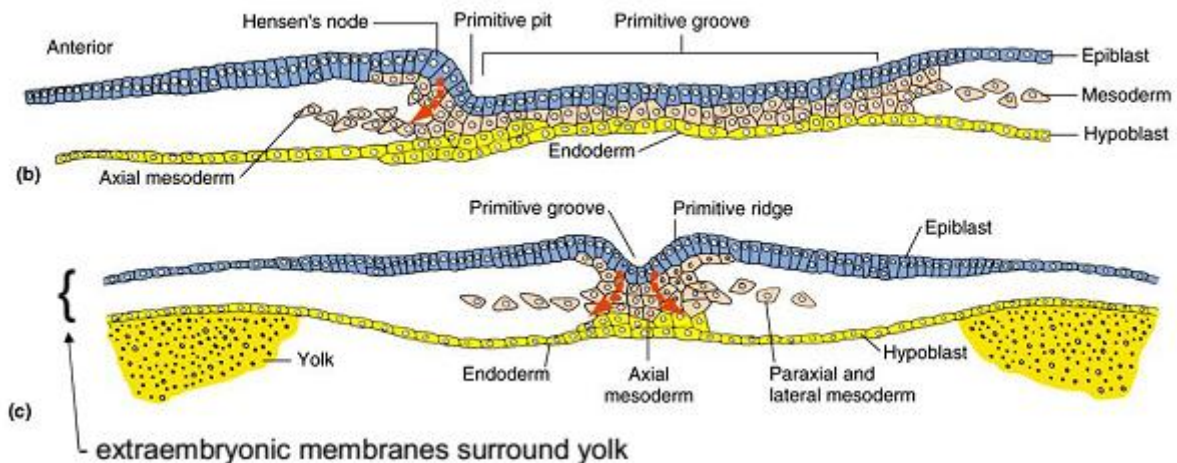


**Elongation of primitive streak and formation of primitive groove & primitive pit
anterior end of primitive ridges are thickened = Hensen's node**



**Major gastrulation events occur at the primitive pit & primitive groove
functional equivalent of amphibian blastopore**





The second step in gastrulation is the **formation of primitive streak**. At the posterior region of area pellucida in the mid dorsal line primitive streak will appear as a thickened area. It starts eight hours after incubation. The thickening is because convergence of cells of blastoderm towards the centre. Usually in the early stages the primitive streak is short and broad. It gradually extends to the middle of blastoderm. At eighteen to nineteen hours of incubation, primitive streak is well developed. It is called definite primitive streak. Along the middle line of primitive streak a narrow furrow is developed called **Primitive groove**. The edges of groove are thick. They are called **primitive folds**. At the anterior end of groove a mass of closely packed cells will be present. It is called "**hensen's node**" or **primitive knob**. In the centre of this node a pit is present. It is called **primitive pit**. It represents the vestige of neurenteric canal. The primitive streak elongates along with this, area pellucida will also elongates. As the primitive streaks growing the cells from this region will involute into space between epiblast and hypoblast. This process is called immigration. The immigrated cells will become prechordal plate, notochord, and mesoderm.

The mesoderm is formed as two layers. In front of the primitive streak an area without mesoderm is present. It is called **proamnion**. At this place head will develop. After 48 hours of incubation the proamnion is also occupied by mesoderm. The mesoderm is divided into dorsal and intermediate and lateral mesoderms.

The notochordal cells arrange themselves to form a cylindrical, rod called notochordal process. It will begin at hensen's node and it slowly grows. Because of its growth the primitive streak is slowly reduced. By the end of gastrulation the primitive streak is reduced and incorporate into tail bud.

The dorsal mesoderm is located on either side of notochord. It is divided into segments. They are called **somites**. The first pair of somites will form after 21 hours of incubation.

Afterwards, for every one hour one pair of somite will add. The 24 hours old embryo contains four pairs of somites.

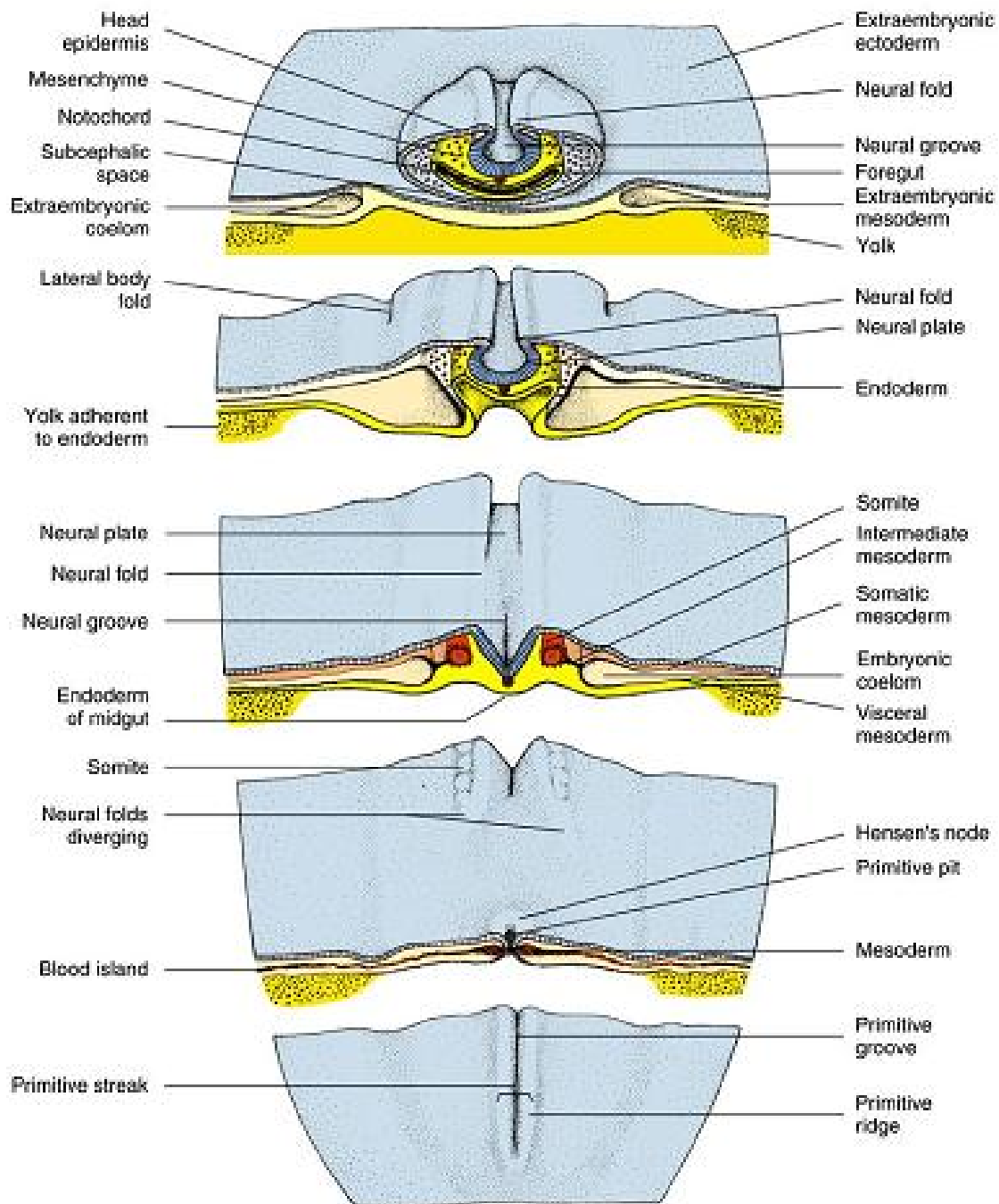
The intermediate mesoderm connects the dorsal mesoderm with lateral mesoderm as a stalk. Afterwards it undergoes segmentation and give kidneys.

The lateral mesoderm extends on periphery of embryo, it is divisible into extra embryonic and embryonic mesoderms. This lateral mesoderm will split into two layers. The upper layer is called **somatic mesoderm** and inner layer is called **splanchnic mesoderm**. Ectoderm and somatic mesoderm will be called **somatopleure**. The splanchnic layer and endoderm will be called **splanchnopleure**. In between the two layers of mesoderm the space is called **coelome**.

Thus at the end of gastrulation specific organ forming areas started to develop.

24 HRS. CHICK EMBRYO

1. At 24 hrs. incubation period the chick embryo is oval in shape.
2. The primitive streak is fully formed and the process of gastrulation is completed
3. The Notochord extends from the from the hensens node as head process into the mesoderm-free area anteriorly.
4. The head fold and fore-gut develop in the embryo.
5. The mesoderm differentiates into somites, intermediate and lateral plate mesoderm.
6. In the 24 hrs chick embryo four pairs of somites are differentiated from the mesoderm.
7. The coelom begins to develop in the lateral plate mesoderm.
8. The blood islands appear in the area opaca. Pericardial region and primordial of heart are established.
9. The area opaca further modifies into the area vasculosa and area vitellina.
10. The neurectoderm gives rise to the neural folds and neural groove. The fusion of neural folds begins from the mid-region.



33 HRS CHICK EMBRYO

1. Lengthening of foregut and subcephalic pocket.
2. Formation of neural tube and sinus rhomboidalis.
3. The primary division of encephalon into prosencephalon, mesencephalon and rhombencephalon.
4. Formation of neural crest cells on either side of the neural tube.
5. Development of the infundibulum as a median ventral outgrowth from the floor of prosencephalon.
6. Formation of 13 pairs of somites.
7. Development of heart as tubular structure lying in the midventral region to the foregut.
8. Formation of extraembryonic blood vessels in the area vasculosa.
9. Formation of intraembryonic blood vessels.
10. Disappearance of primitive streak.

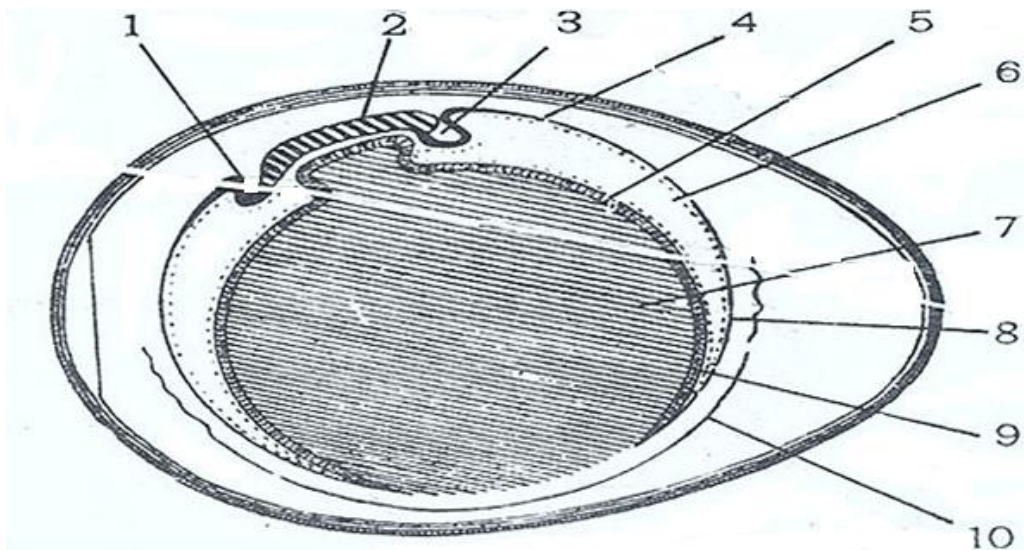
48 HRS. CHICK EMBRYO

1. Appearance of cranial flexure and torsion.
2. Formation of eleven neuromeres, 3 neuromeres in prosencephalon, 2 in mesencephalon and 6 in rhombencephalon
3. Formation of secondary constrictions in the brain.
4. Completion of vitelline (extraembryonic) circulatory system.
5. Development of intra embryonic blood vessels.
6. Formation of two pairs of aortic arches.
7. Twisting of the heart and formation of chambers in it.
8. Commencement of blood circulation.
9. Formation of optic cup and lens vesicle.
10. Formation of visceral cleft.
11. Development of auditory vesicle.
12. Differentiation of 28 somites
13. Development of extra embryonic membranes
14. Formation of pronephros.

FOETAL MEMBRANES OF CHICK

In the development of every vertebrate certain tissues do not directly enter into the formation of the embryo proper. These tissues rather help in the care and maintenance of the embryo. Collectively these parts are referred to as extra-embryonic membranes. In chick a well developed system of extra-embryonic membranes are formed.

In the development of chick these membranes will develop from original blastoderm, the central part of blastoderm will give embryo proper, the marginal blastoderm will give extra embryonic membranes. Amnion and chorion will develop from somatopleure, yolk sac and allantois, will develop from splanchnopleure.



1. Tail fold 2. Embryo 3. Head fold 4. Extra embryonic somatopleure 5. Extra embryonic splanchnopleure 6. Extra embryonic coelom 7. Yolk 8. Ectoderm 9. Endoderm 10. Vitelline membrane

Amnion & Chorion:

In the development of embryo amnion and chorion are closely associated, Amnion is bag like covering over the embryo, it separates the embryo from internal environment, Amnion is developed from somatopleuric amniotic folds. These folds are head fold, lateral folds and tail folds.

a) At about 30 hours of incubation, in front of the head of embryo a head fold is developed, it is called amniotic head fold.

b) At about third day of incubation amniotic tail fold is developed. It grows opposite to head fold.

c) Meanwhile lateral folds will develop, they grow dorso-medially.

d) After some time head fold, lateral folds, and tail fold will fuse near posterior end of the embryo.

e) At 72 of incubation they are still not fused. They show an opening called amniotic umblicus, afterwards they unite.

f) The amniotic folds consist of two limbs, an outer and an inner, both consisting of ectoderm and a thin layer of somatic mesoderm. In the outer limb, the ectoderm is external and mesoderm is internal, while the inner limb contains an inner ectoderm and an outer mesoderm. The outer limb constitutes the chorion and the inner limb becomes the amnion.

g) As the amniotic folds grow centripetally, they fuse to form continuous membranes which constitute two sacs around the embryo. At the end of 4th day, the embryo is completely enclosed in a cavity called amniotic cavity bounded by amnion. The space between the amnion and chorion is called the sero-amniotic cavity or exocoel.

Functions of chorion:-

The extra embryonic coelome is filled with a fluid. It gives protection to the developing embryo.

This coelome gives space, for developing allantois.

Chorion combines with allantois and acts as a respiratory organ.

Functions of Amnion:-

Amnion is a sac like structure around embryo. It contains amniotic fluid. It will protect embryo from mechanical shocks and desiccations.

It protects the embryo when the egg is laid. It gives artificial aquatic environment for growth of embryo.

Yolk sac:

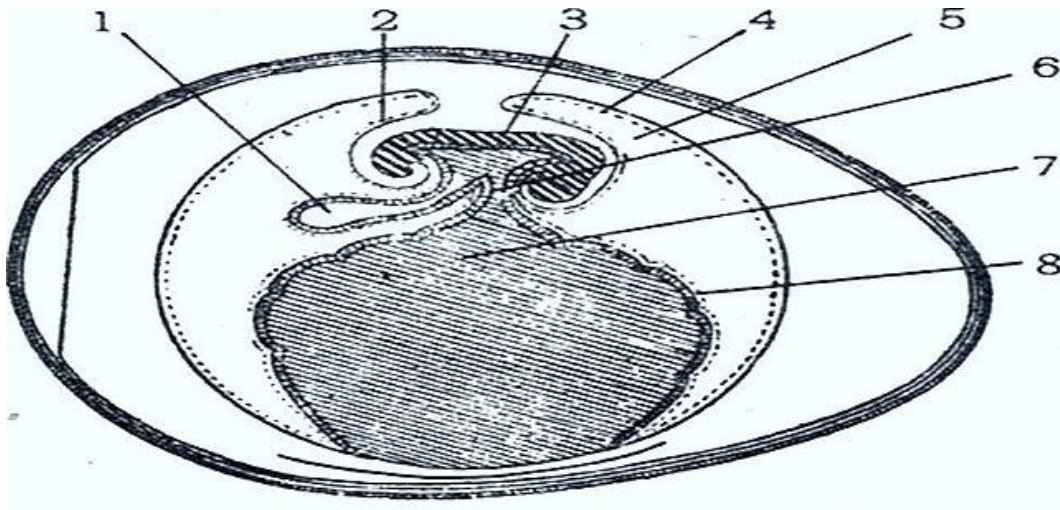
At 16 hours of incubation, yolk sac makes its appearance. It develops from splanchnopleure. Splanchnopleure contains endoderm and mesoderm layers. The Splanchnopleure instead of forming a close gut, it will grow over yolk, and becomes yolk sac. The primitive gut is present above the yolk. This yolk region is in contact with midgut. Finally the yolk sac is communicated with midgut through an opening. The yolk sac is connected to the mid-gut by a narrow stalk called yolk stalk or umbilical stalk. The narrow canal within the yolk stalk is termed as the yolk duct.

Functions of Yolk sac:

It digests the yolk, and the digested food will be circulated through blood to the developing embryo. Hence yolk sac is considered as a nutritive organ of the embryo. It also performs respiration during the early stage of development.

Allantois:

In chick it develops from the ventral part of caudal end of the hindgut. It develops at third day of incubation. About the 3rd day of incubation, a region of the floor of the hind gut begins to buldge out as a diverticulum which gives rise to allantois. It consists of an inner endoderm and an outer splanchnic layer of mesoderm. Allantois remains posterior to yolk sac and expands very rapidly penetrating into the extraembryonic coelom. The distal end of allantois enlarges into an allantoic vesicle and the proximal part becomes the allantoic stalk. Unlike amnion and chorion, the allantois arises within the body of the embryo. The mesoderm of the chorion and mesoderm of allantois will unite. It forms chorio-allantoic membrane. As the embryo is growing the allantoic and yolk stalk are brought together. Their mesodermal layers will unite. It is called umbilical stalk. It is covered by somatic umblicus.



Early stage in the development of extra-embryonic membrane in chick

**1.Allantois 2. Prospective amnion 3. Embryo 4.Amniotic folds 5. Prospective chorion
6. Yolk stalk 7. Yolk 8. Yolk sac**

Functions of Allantois :

Allantois is richly vascularised. Hence it works as respiratory organ.

It stores nitrogenous waste material of the embryo.

In later development the allantoic circulation will absorb calcium from the shell. This calcium is used in construction of bones in young ones.

Allantois absorbs calcium from shell. Hence the shell becomes thin. It helps in rupturing the shell during hatching.