Embryonic Development in Mammal

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Abstract

"Accepting the shelter of the uterus, it also takes the risk of maternal disease or malnutrition, and of biochemical, immunological and hormonal maladjustment. Even before it strikes its root in the living tissue of the endometrium (lining of the uterus) it has week's journey to make, as long as a submarine takes to pass beneath the polar icecap. Like the U-boat it has to carry most of its supplies with it in its trip down the oviduct and the uterine lumen and to add to its difficulties it is surrounded by a far more variable and chemically active medium than ice cold sea water"

These were the words of George W. Corner while he was explaining the risk and problem of developing embryo in the uterus of mammal. So mammalian embryo while accepting the shelter and protection of mother also accepted risk.

The embryo in mammal develops within a specialized part of the oviducts called uterus or womb. The embryo

establishes an intimate contact with the uterus for getting nourishment from it and the young ones are born alive . So the eutherian mammals are viviparous.

On the basis of embryonic development, mammals are divided into three groups. Oviparous mammal in which most of the embryonic development of the fertilized egg take place outside the body of the mother for example Ornithorhynchus. Viviparous animals in which the eggs are fertilized in the fallopian tube and embryo develop inside the uterus of the mother e.g all eutherian mammals. In viviparous animals the embryo get connected with the uterine tissue and all the physiological exchanges occur between the embryo and mother through this connection called the placenta. In ovoviviparous mammals although the egg develop inside the body of the mother but they do not get the nutrition from the mother's body e.g Echidna.

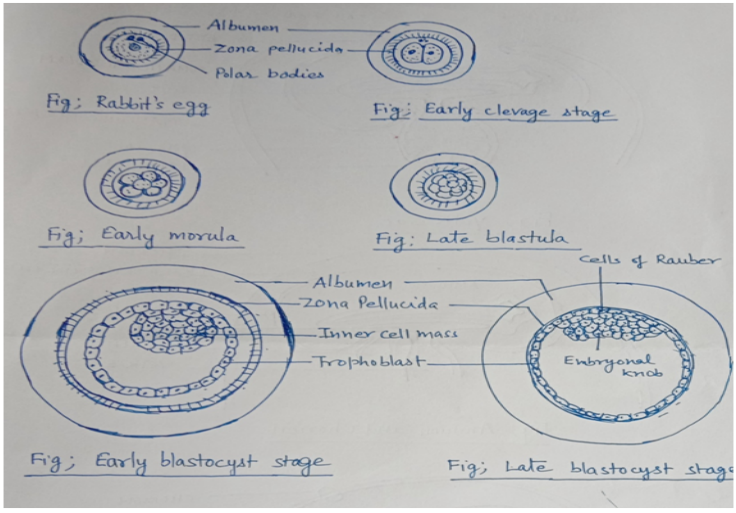
How Evolution of Viviparity Occurred?

Besides mammal, viviparity is also found in some elasmobranchs, teleostean fishes and reptiles. However in these animals the eggs contain sufficient amount of yolk and do not get nutrition from the mother's body. Birds are oviparous which is suited to their aerial mode of life . Viviparity is again resumed in mammals and attained its peak in eutherian mammals.

Mammals are derived from therapsid reptiles. Mostly reptiles are oviparous. Therefore the ancestors of mammals might have oviparity and later on at some stage in their evolution some of the mammals achieved viviparity which is

proved by presence of distinct gradation of embryonic development in different subdivisions of the present day mammals as well as presence of yolk sac in embryonic development of mammal. In prototheria the eggs are polylecithal with large amount of yolk and embryonic development is similar to reptiles. In metatheria embryonic development take place inside the uterus of the mother and the embryo derive nutrition from the mother but they give birth to a poorly developed young ones. Viviparity reached at its apex in eutherian mammals in which egg is microlecithal or alecithal and devoid of yolk completely. So embryo establishes connection with uterine tissue for exchange of materials with the mother and completely developed young ones born.

Early Development of Mammal (Rabbit)



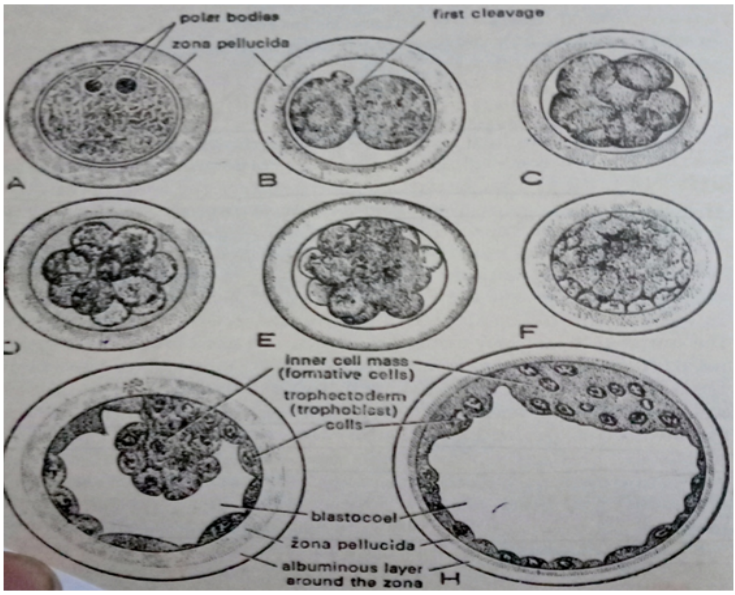
Fig; Diagramatic Representation of Early Developmental

Stages in Rabbit

In Rabbit the egg is 0.1 mm in diameter and released in secondary oocyte stage from the ovary. The egg in mammal is microlecithal with almost no yolk, enclosed in an outer covering of follicle cells called corona radiata and an inner thick membranous covering, secreted by the follicle cells called zona pellucida. The egg is fertilized in upper part of the oviducts called fallopian tube. immediately after fertilization second maturation division occur and the ovum becomes mature. Entire spermatozoa enters the ovum but tail degenerates soon after. The enzyme hyaluronidase present in semen fascilitates the penetration of spermatozoa in the ovum. After fertilization corona radiata disappers and the ovum get surrounded by a thick albumen layer secreted by the oviduct.

Cleavage and Blastulation

Cleavage begins 14 to 15 hours after fertilization. As the cleaving egg passes down the fallopian tube an albuminous coating is deposited around the outer side of the zona pellucida. At about 60 hours after fertilization cleaving egg enters the uterus, increase in size and get connected with uterine wall of the mother through the placenta. This connection is known as implantation.



Fig; Early Stages of Embryonic Development in Rabbit (afte Nelson, 1953)

Cleavage in Rabbit is holoblastic but the synchronization of the mitosis in the blastomeres is lost very early. Consequently the blastomeres formed after cleavage increase in arithmetic manner. In mammals, since cleavage occurs at body temperature it proceeds at slower pace . The first clevage is vertical and two cell stage is formed after 12 hours after fertilization. The second clevage is also vertical but at right angle to the first clevage. After third clevage 8 cell stage is formed. The subsequent clevage divisions are irregular and a ball of cells are formed known as morula at about 55 to 60 hrs after fertilization. The morula (having 32 to 64 blastomeres) contains two type of cells; the epithelial cells

arranged in the outer layer of flat epithelial cells called trophoblast which is a nourishing layer and a central mass of spherical cells (formative cells) called the inner cell mass which form the embryo proper and called as formative cells. A vacuoles appear on one side of inner cell mass and cells of trophoblasts join to form a fluid filled cavity which occupy the lower half of the morula called the blastocoel. The fluid is absorbed from the uterine cavity through zona pellucida and placed in blastocoels so that blastocoels increases in size and formative tissue is displaced towards one end of the embryo . The trophoblast get separated form inner cell mass at most of the place except at one end which becomes the embryonic pole. Embryo at this stage is known as blastocyct. At this time zona pellucida disappears, trophoblast cells of blastocyst get connected with the endometrium of uterine wall and embryo is implanted with uterine wall. The point at which trophoblasts remain attached with the inner cell mass is called as cells of Rauber and the embryo at this stage is called as blastocyct. The fully developed blastula of rabbit is disc shaped and known as discoblastula. The later consists of an outer epiblast and inner hypoblast. Blastocyst stage is found exclusively in mammals. The trophoblasts cells opposite to the embryonal knob form small finger like villi which penetrate into the crypts of the uterine wall and the blastocysts get implanted with the uterine wall of the mother.

Gastrulation

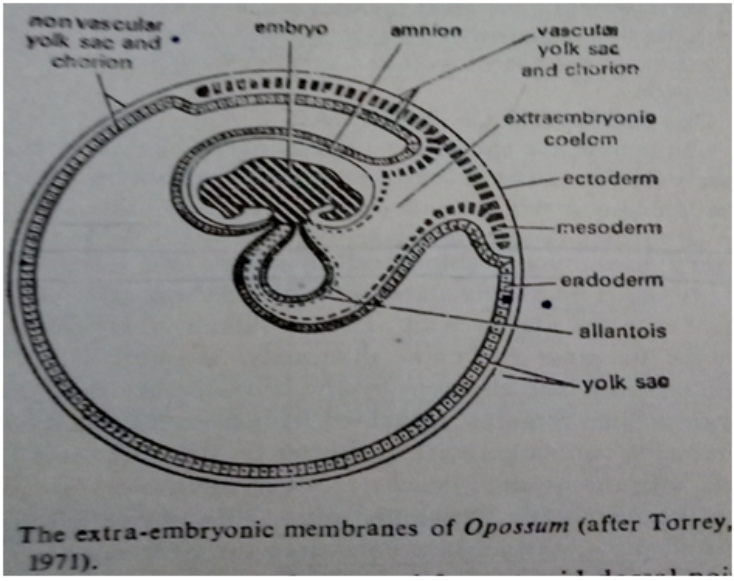
After some times the cells from lower surface of the embryonal knob proliferates and migrate into subgerminal

cavity immediately below the knob and form embryonic endoderm or hypoblast. The embryonal knob forms the embryonic ectoderm or the epiblasts. The blastocysts is now two layered with a fluid filled yolk sac in between two layers. Now the embryonal knob flattens to form embryonal disc and cells of Rauber, zona radiata and albumen layer disintegrate. Now mesodermal cells proliferate get accumulated in the centre of the embryonal knob to form primitive streak. Due to the movement of the mesodermal cells of the primitive streak on both the sides, an opaque pear shaped embryonal area appears in the center of the embryonal knob, which is broad infront and narrow at posterior end . At the posterior end this is marked by an opaque line called primitive streak. The anterior end of the primitive streak swell to form primitive node or Hensen's node. All these changes occur due to active proliferation and movement of the cells. A groove or channel appear in the center of the primitive streak due to active migration of the cells. These migrated cells get accumulated in between the ectoderm and endoderm. Some cells also migrate forward from upper and lower part of the primitive knot and differentiate into neural plate and notochordal process respectively.

Development of Extra Embryonic Membranes In Rabbit

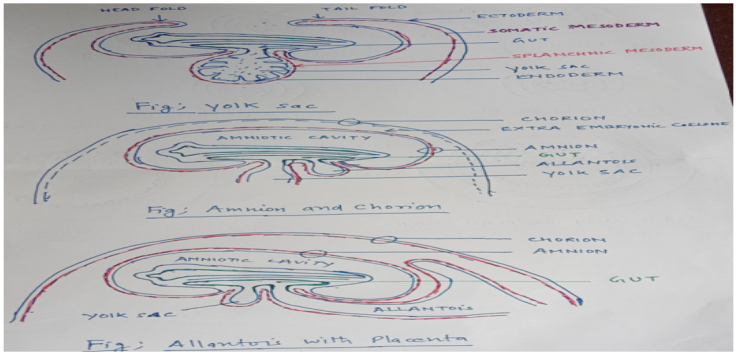
The foetal membranes in Rabbit are amnion, chorion , allantois and yolk sac. Amnion and chorion develop simultaneously from the somatopleure (trophoblasts and somatic mesoderm). Soon after the appearance of the primitive streak, a fold of ectoderm arises from the rim of

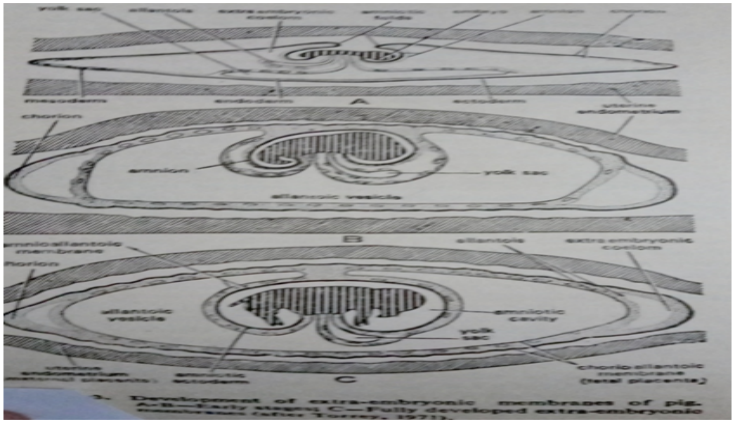
flattened embryonal disc both from anterior and posterior ends. The folds arising from the anterior end is called head fold and the folds arising from the posterior end is called tail fold. In mammals, Tail folds appears first. soon somatic layer of mesoderm and coelome invade them. The tail fold is comparatively longer and grow more rapidly than the head fold. Both the folds raised upwards, grow in size in the opposite direction and approach each other slightly towards the head end. Later on the two fold fuse together and the point of fusion is known as seroamniotic connection. After some times the connection disappears and the two folds become continuous forming an outer chorionic membrane and inner amniotic membrane . The space between the chorion and amnion is known as extra embryonic coelome. The chorion consists of an outer ectoderm and inner somatic mesoderm while amnion consists of outer somatic mesoderm and inner ectoderm. The chorion spreads out on the surface of the blastocysts and is produced into finger like processes called as trophoblastic villi. The later burrow into the uterine wall and form the placenta.



Fig; Extra embryonic membranes of Opossum

Before the establishment of the sero amniotic connection, the endoderm from the posterior part of the embryo is thrown out into the extra embryonic coelom in form of sac known as allantoic sac. The allantoic sac has outer splanchnic mesoderm and inner endoderm. The allantoic sac increase in size, extend in to the extra embryonic coelome and then fuse with amnion and chorion. With the chorion it forms allanto-chorion which consists of outer ectoderm, somatic mesoderm, splanchnic mesoderm and endoderm. The allanto-chorion play important role in embryonic respiration, excretion, nutrition by developing into placenta.





Fig; Development of extra embryonic membranes in Pig.

Although mammalian egg contains no yolk but still small yolk sac is present which is clear indication that the ancestors of mammals were oviparous. Yolk sac develops from the posterior part of the embryo from the splanchnopleure (splanchnic mesoderm and endoderm) . The yolk sac in mammal is no longer nutritive in function, rather it becomes a haemopoetic organ of embryo.

The embryo in mammals during development derive

nourishment by following four methods.

1. Morula comes in contact with uterus and absorb nourishment from uterus.
2. The trophoblastic villi of blastocysts directly absorb nourishment from the uterine wall .
3. Chorionic villi absorbs nourishment from uterus
4. Lastly the allantochorion placenta is formed by association between the foetal and maternal tissue and the embryo get its nourishment from the mother through placenta.

After completion of the gestation period the fully formed young ones born and the process is known as parturition.

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