Welcome to the module for the course Developmental biology ZOC108 for the programme Bachelors of Science, Third year zoology. Myself, Dr K. K. Therisa. The name of the module is Extra-embryonic membranes of Chick development, Structure and functions of the yolk sac from the Unit- Late embryonic Development.

The outline of the presentation. Introduction to the extraembryonic membrane, followed by the development structure and functions of yolk sac.

The learning outcome expected, the students will be able to understand the extraembryonic membranes and its development and also to illustrate and describe the development, structure and functions of yolk sac.

The embryos are covered and protected by a set of membranes called foetal membranes. And this is in case of an amniotic egg. The amniotes are the ones who laid the egg on the land, and they are not dependent on the water body for the embryological development. Therefore, it becomes important that these embryos are covered by a hard shell which will maintain the embryo intact inside and take care from the desiccation on the dry land, but at the same time the embryo requires the other structures which will help it for providing the nutrition for providing the respiratory structures or for exchange of gases for helping to throw out the nitrogenous waste. Which are being developed during the process of embryological development. So, therefore, the set of membranes which are protecting these embryos are the foetal membranes, and these membranes are developed from the tissue lying outside the embryo and therefore they are called as extraembryonic membranes, and the best example is the chick embryo, which we will be talking about in this module.

The main functions of the foetal membrane are to provide the protection, nutrition, respiration, excretion, etc to the embryo. So, all the foetal membranes disappear before or immediately after the hatching because after that all the structures are not required as the young one will be developing all its organs in a normal condition. So, what was the need for extra embryonic membranes in order to move successfully onto the land, the amniotes have developed certain structures and one among that is formation of a cleidoic egg and the extra embryonic membranes. Eggs must have food and means of elimination of metabolic waste when it is outside the body of the mother, so that is been provided with the help of this extraembryonic membranes.

Also, the eggs must have the ways for protection against the desiccation, as this embryo is growing outside the body of the female. The embryo made an extra protection on the dry land so that the embryo doesn't get desiccated. At the same time, the exchange of respiratory gases is very important, and which is also been possible due to this membrane. And the closed environment that is the cleidoic egg must provide.

With additional structures that can solve the above challenges faced by the developing embryo and therefore there is a need of an extraembryonic membranes. The foetal membranes in amniotes, are the Amnion, chorion, yolk sac and Allantois, which I'll be talking about in detail.

Further, the vertebrates are divided into two main groups. Considering the foetal membranes that is either they are called as the anamniota or the amniota. Because of the presence of amnion. Anamniota are those which includes the amphibians and fishes. While Amniota includes the reptiles, birds and mammals. In amniotes, the extraembryonic membranous sacs are composite structures and involved two germ layers. The Amnion and Chorion are composed of the extraembryonic, ectoderm and somatic layer of mesodermal, So this two together the ectoderm and mesoderm, forms Somatopleure. Whereas the yolk sac and Allantois composed of the extraembryonic endoderm and the splanchnic layer of the Mesoderm and these two together forms Splanchnopleure.

Therefore, in amniotes there are two germ layers involved to form this extraembryonic membrane as structures. Therefore, the kinds of extra-embryonic membranes in chick are. The amnion or amniotic sac, which surrounds the embryo and provides a kind of a private aquarium to protect it. The second one is the Serosa or Chorion, which forms the outermost membrane surrounding the rest of the embryonic system. The third one is the yolk sac, filled with the yolk of egg functions as first respiratory organ and as a digestive organ for the embryo and the 4th type is the Allantois is a precocious urinary bladder in origin, but accumulates the embryonic nitrogenous waste.

So, this is a structure that shows all these four kinds of extra embryonic membrane.

So here is the yolk sac, then the amnion, which is surrounding the embryo, the Allantois, which is again an enlargement from the hindgut region of the embryo and the chorion as the 4th membrane, and that is the outermost membrane surrounding the all membranes.

So let us talk about in brief the development of extraembryonic membrane during the neurulation stage in chick embryo development. The lateral plate mesoderm divides into an outer somatic layer and an inner splanchnic layer, the outer somatic layer is made up of mesodermal at the inner side of the ectoderm and an inner splanchnic layer of mesoderm, lying outer to the endodermal layer and this forms or coelomic space in between this mesodermal layer. So, the splanchnopleure and the somatopleure gradually spreads peripherally over the yolk mass far beyond the area of embryo and as embryo grows.

There are sub cephalic pocket which is formed or the head fold which is formed. The later folds on both side and the caudal fold in near the tail region separate the embryo from the underlying yolk. It lifts up the embryo from the underlying yolk and thus separate the embryonic region from the Extraembryonic region.

So that we can understand using this picture.

This is a picture of an early chick embryo showing the body folds delimiting embryo from the extraembryonic areas. So, this is the embryo. And here is the head fold region or the sub cephalic pocket.
The lateral fold and the caudal fold. This 2-3 together will lift up the embryo a bit up higher from the yolk sac. And below that is the yolk stalk that starts been forming. And this is how the embryo separates, or the embryonic region is separated from the extraembryonic region.

And this is the extraembryonic coelom, Then the ectoderm on outside the embryonic membrane. The albumin outside to the ectoderm. Mesodermal are the layers inner to the ectoderm, as well as outside to the endoderm. Then inside this endoderm is the yolk. And the Extraembryonic somatopleure region is a region together with the Ectoderm and the Mesoderm and this is the region together forms splanchnopleure.

So, development and structure of yolk sac takes place during the neurulation stage in the early development of a chick embryo, where in the gut opens and rest on the yolk mass ventrally. The splanchnopleure closely applied to the yolk, extends peripheral, eventually surrounds the entire yolk and forms the yolk sac.

Further the undercutting folds move toward one another and this establish, floor to the gut and incompletely merge with a small aperture called yolk duct and slowly the yolk duct leads to the yolk stalk and therefore the yolk sac is connected to the digestive tract of the embryo by means of the yolks stalk. But the yolk food reserves are not transmitted to the embryo by this route, because the endodermal lining of the yolk sac has got certain enzymes which are released into the yolk which digest the food material, and this has been absorbed with the help of the blood cells that are surrounding this endodermal lining of the yolk sac and through the blood circulation, it is been reached to the embryo.

So, the endodermal surface of the yolk sac which thrown into the fold are called as the yolk septa that penetrates the yolk mass. The enzymes from these cells digest the yolk ultimately absorbed by the endodermal lining of the yolk sac, and thus the materials absorbed are transported to the embryo using the vitelline vein. A rich blood circulation develops within the mesodermal component of the yolk sac and the vitelline arteries and veins, and this two together is called as the omphalomesenteric blood vessels.

The yolk is completely absorbed during the embryonic life and shortly before hatching. The yolk sac is retracted into the abdominal cavity. So here is the structure of the yolk sac, which is completely being developed during the early stages of development of extraembryonic membrane.

So here is the yolk stalk. Followed by that is the yolk sac, which contains the yolk and here is the membrane. The endodermal lining which forms the folds that is the yolk stalk, yolk septa which is used for the digestion process. Because there are the cells in those endoderm lining which will digest the material in this vicinity, in this region, which is absorbed with the help of the blood vessels and finally through the omphalomesenteric circulation it is reached to the embryo.

So this is the late embryonic developmental stage, showing the yolk sac with the yolk stalk, the yolks, egg with the yolk sac septa. So finally the function of the yolk sac is to provide the nutrition to the embryo. The inner lining digest the food that is the yolk and the digested food is carried by the vitelline vein to the growing embryo.

Therefore, we can see that the yolk sac is like an extra embryonic intestine that digest and absorb the food. Also, it helps in the exchange of gases that takes place through the vascularised wall of the yolk sac.

These are the references which was used to prepare this module. Thank you.