EMBRYOLOGY- LECTURE NOTES

DIFFERENT TYPES OF EGGS WITH EXAMPLES

Classification of Egg

On the Basis of the Amount of yolk

Eggs are grouped into three types on the basis of the amount of yolk present in them.

1. Alecithal Egg: When the egg contains no yolk, it is called alecithal egg.
Eg. The eggs of eutherian mammals

2. Microlecithal Egg: When the egg contain. Small or negligible amount of yolk it is said to be microlecithal. Romer and Balinsky named these eggs as oligolecithal eggs Eg'. Amphioxus, Tunicates

3.Mesolecithal egg: In amphibian, Dipnoi and Petromyzon the amount of yolk present is moderate and is not high Hence these eggs are also named as mesolecithal eggs

4. Macrolecithal or Megalecithal or Polylecithal Egg
When the egg contains large amount of yolk it is said to be macrolecithal or megalecithal egg. It is also called Polylecithal egg Eg. Reptiles, Birds, Prototheria (Monotremata) Egg laying mammals.

On the Basis of the distribution of yolk

a. Isolecithal or Homolecithal Egg:ln isolecithal eggs, the very little amount of yolk present is uniformly distributed throughout the ooplasm (eg.. echinoderms, Amphioxus, mammals). This condition is usually observed in eggs with very little amount of yolk.

b. Telolecithal Egg: In eggs containing moderate or large quantity of yolk, the distribution of yolk is not uniform. lt is concentrated more towards the vegeial pole. Such a type of egg, in which the yolk is concentrated towards one pole, is called telolecithai egg.
Telolecithal eggs may further classified into three types:

i.Slightly Telolecithal Thls type of egg contains only a small quantity of yolk which is distributed unevenly. The vegetal pole has the highest concentration and the animal pole the lower (e.g. eggs of fishes).

ii.Moderately Telolecithal egg
This type of egg contains a moderate quanilty of yolk which is distributed unevenly. Due to high concenteration of yolk in the vegetal hemisphere, the nucleus is shifted more towards the animal hemisphere (eg. amphibian egg).

iii.Extremely Telolecithal Egg
ln this type of egg, due to the heavy deposition of yolk, the entire vegetal hemisphere and a major portion of the animal hemisphere are occupied by yolk. Due to this extremely uneven distribution of yolk, the ooplasm and nucleus are displaced towards the animal pole (eg. reptilian and avian eggs).

3. Centrolecithal Egg
Egg of many arthropods and some coelenterates are described as centrolecithal. They are relatively large and elongate and have a very great amount of yolk. The nucleus lies at the geometric centre of the yolk mass, surrounded by a small amount of cytoplasm. A thin cytoplasmic layer covers the surface of the yolk. Fine strands of cytoplasm extend from the peripheral layer to the zone occupied by the nucleus.

Mosaic and Regulative Eggs
a. Mosaic Egg: ln certain eggs, every portion is predetermined with respect to its potentialities for further development. lf a small portion of such an egg is removed, a defective embryo is formed, This is because removal of a portion results in a permanent loss from the egg. The remaining portion of the egg cannot make compensatory development to make good the lost part. Such an egg, in which the future developmental potentialities are predetermined in the form of a mosaic, is called mosaic or determinate egg (e.g annelids, Molluscs and ascidians).

b.Regulative Egg
ln vertebrates and most of the invertebrates, the developmental potentialities are not predetermined in the eggs. Removal of a small portion of the egg, or even one or two early blastomeres will not affect the normal development. This type of egg in which the future developmental potentialities are not predetermined is known as regulative or indeterminate egg.

On the Basis of Shell

Two of types (a) Cleidoic eggs (b) Non-cleidoic egg

(a) **Cleidoic egg** - These eggs contain a thick and hard outermost shell. This hard shell is permeable for gases. Yolk, Salts and Water is present in large amount in cleidoic eggs. Cleidoic egg is a terrestrial adaptation. Eg: Birds & Reptiles, Prototheria mammal and insects.

(b) **Non cleidoic egg** - Egg membranes are soft in these eggs e.g. All viviparous animals and in oviparous animals which lays eggs in water.

Egg Envelops

All membranes (covering) which are present outside to plasma membrane of oocyte or ovum is known as egg membranes now instead on membrane envelop term is used. Envelope containing oocyte or ovum is called as egg

Egg envelope on the basis of origin are of three types.

(1) Primary egg envelops - These are secreted by egg.e.g. Vitelfine membrane-(Zona pellusida & Zona Reticulate)

(2) Secondary egg envelops - These are secreted by ovary. e.g.- Chorion on insects.

(3) Tertiary egg envelops - These are secreted by oviduct. e.g.- Jelly coat of frog, Albumin, shell membrane and shell of Hen.

Examples of Eggs

(1) **Egg of Insect**

These are megalecithal polylecithal & centrolecithal eggs.
The cytoplasm of insect egg is limited to periphery only whole central place is filled by yolk.
Two types of egg envelops are present on egg of insects.
Inner - Vitelline membrane - Primary egg membrane.
Outer - Chorion - Secondary egg membrane. Chorion is thick, hard and ornamented.
This ornamentation is taxonomically important in insects.
Egg membrane is absent on a definite place, this place is known as micropyle.
Micropyle is a place to enter for sperms in egg.

(2) **Egg of Frog**

These are Mesolecithal and telolecithal egg.
Two types of egg membranes are present on frog egg.
(i) Inner - Vitelline membrane - Primary egg membrane. It is secreted by egg cell.
(ii) Outer - Jelly coat - Tertiary egg membrane (Secreted by oviduct).

All eggs are layed at a time. These eggs are attached together by jelly coat. This group is called as spawn. Spawn formation in frog occurs after false copulation (amplexus).

Importance of Jelly coat

Air bubbles are present in jelly coat. These provide buyoancy.
Jelly coat protects egg from outer mechanical injury.
The jelly is tasteless hence it prevents the eggs from being eaten by water snails, aquatic insects, fishes and birds.
It prevents infection of bacteria and fungal spores.
The jelly reflects sun-rays, due to melanin it is also protected from UV rays.
The jelly is able to keep the eggs warm.

Like other eggs frog egg also have two poles:

(i) Animal pole - Cytoplasm and nucleus are found in this pole.

(ii) Vegetal pole - It mainly have yolk white yolk is filled in this pole. It is heavy so it is found in lower side.

In animal pole in cytoplasm melanin pigments are also present. Melanin protects the egg from harmful radiation and helps in camouflage.

Sperm enters into egg through animal pole. The entry site of sperm in egg forms anterior part of

embryo. Along with entrance of sperm determines the future polarity. The entrance path of sperm determines the plane of cleavage in egg. First cleavage of egg starts from right angle of the entrance path of sperm. From opposite direction of entry of the sperm, melanin granules move towards the sperm. So a clear region is formed between animal pole and vegetal pole. This clear region is known as "Grey crescent". It produces drosal lip of blastopore in future.

(3) **Egg of Chick**

These are megalecithal or polylecithal, discoidal and cleidoic: Yolk is present in large amount and cytoplasm is found in the form of a disc. This disc is known as **Germinal disc**. Beneath the germinal disc yolk is present. On the basis of colour and content yolk is of 2 types. **Yellow yolk**-It have more phospholipids **White yolk** – It is rich in protein. Phospholipids are in fewer amounts. Both types of yolks are arranged in alternative and concentric layers. Innermost and outermost layer is of white yolk. A stalk like structure of white yolk is present just beneath the germinal disc. This is known as **latebra** and upper part of latebra is known as **Isthmus of pander**. Primary envelop vitelline membrane is found around the egg. Remaining all envelops of chick egg are secreted by oviduct after fertilization. These are tertiary envelops.Egg of chick is filled with liquid albumin which is called as "White of egg". It is produced by Isthumus part of oviduct. Dense albumin on the sides of egg upto shell membrane is coiled chord like structures. These are called as **Chalaza**. It keeps the ovum upward.

Two shell membranes are present just beneath the shell. These are made up of keratin. A air pocket or **air space** is found between shell membranes in broad (wider) part of egg. The outermost part of egg is a shell made up by calcium carbonate [CaCO3). This shell is porous for exchange of gases.

The oviduct of birds is differentiated into three parts

i) Anterior part -- Magnum part—Fertilization of egg occurs in this part. After fertilization this part secretes liquid albumin arround the egg.

(ii) Middle part — Isthmus — Keratin shell membranes are secreted around the egg by this part.

(iii) Posterior part — Nidamental part — This part secretes a shell of CaCO3 around the egg.

(4) **Egg of Eutherian Mammals**

Eggs are alecithal, non-clidoic and microscopic (0.1mm) in metatheria and eutheria.

In prototheria egg are same as hen egg.

Two membranes or egg envelopes are present on egg-

(i) Inner envelop : **Zona pellucida** — Primary egg membrane produced by egg itself. In few mammals zona pellucida is linear and called as zona radiata.

(ii) Outer envelop : **Corona radiata** — formed by follicular cells of ovary. Follicular cells are attached with surface of egg through Hyaluronic acid.

Hyaluronidase enzyme is present in Mammalian sperm, which dissolves hyaluronic acid and the corona radiata cells are separated from egg surface. This helps in sperm entery.

Egg cytoplasm have very less or negligible amount of yolk.

On the basis of ovulation mammals are of two types.

(i) **Induced or Reflex Ovulators** — Animals in which ovulation is induced by copulation. eg. All mammals have fixed breeding period. The chances of fertilization increases to 100% in it e.g. Rabbit.

(ii) Spontaneous Ovulators: Ovulation is not depended upon the copulation. Egg passes out in oviduct from ovary after fix period. The chances of fertilization are very low in these animals

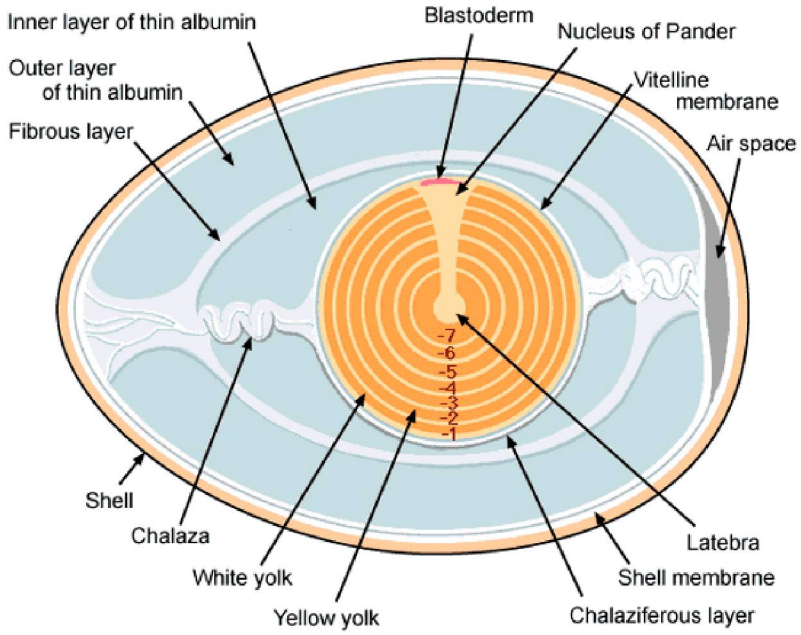
The Structure of a typical Ovum

Ovum is the female gamete. lt stores food required for the entire process of development in the form of yolk. lt has three important functions:

1. lt supplies a haploid set of chromosomes to the future embryo.
2. lt contributes almost all cytoplasm to the zygote.
3. lt supplies food to the developing embryo.

Shape and Size

Typically, the eggs are spherical or ovoid in shape. But in a few animals like insects, the eggs are elongated and cylindrical in nature. Eggs are generally larger than the sperms and average somatic cells. The size of a mature egg depends on the amount of yolk present in it. The smallest known egg is that of mouse (0.07mm); the birds possess larger eggs. Ostrich lays the largest egg having a diameter of about 85 mm. The egg is covered externally by a plasma membrane or plasmalemma. Within the plasma membrane is the granularcytoplasm.



Organisation of Egg Cytoplasm

The cytoplasm of egg cell is known as **ooplasm**. lt is granular and contains in addition to the usual cellular organelles certain other inclusions like yolk, pigments and cortical granules. The peripheral layer of ooplasm is more viscous and gelatinous. lt is known as the egg cortex which is provided with many microvilli and cortical granules. The microvilli are formed by the outpushings of the plasmalemma and they help in transportation of substances from the outside into the ooplasm during the development of egg. The cortical granules are very small spherical bodies varying in diameter from 0.8 µm to 2µm . They are rnembrane bound and are formed from golgi complex. They contain homogeneous and granular mucopolysaccharides. Cortical granules are present in the eggs of sea urchins, frogs, fishes, bivalve molluscs, several annelids and certain mammals.

Yolk: Nutritive substances are stored in the cytoplasm of egg in the form of yolk or deutoplasm. This stored food is utilized by the embryo for its early development. The process of formation of yolk is known as **vitellogenesis.** The yolk is a complex material consisting of proteins, fats, carbohydrates, inorganic salts, vitamins, enzymes, pigments and water. The yolk may be called "protein yolk" when it has more proteins than lipids, or “fatty yolk" when it has more fat contents than the proteins. Most animal eggs contain both kinds of yolk. Since the yolk is heavier, large quantities of yolk, such as those of the frog and chick, the accumulation of yolk in one region is so marked that they are known as telolecithal eggs. In eggs containing lesser amount of yolk, like those of Amphioxus and man, the yolk is distributed more uniformly, hence they are known as isolecithatal or homolecithal.

Pigment granules are present in the cytoplasm of eggs of many species. The granules may be brown, black, red, yellow, green or- grey in colour. As the pigment granules are not common to all eggs, they do not play any significant role in development.

Polarity

The constituents of egg are not uniformly distributed throughout the cytoplasm. These are distributed in such a way that two poles distinct can be identified in the egg. These pores are known as animal pole and vegetal pore. The cytoplasm is concentrated in the upper portion or animal hemisphere and the yolk material is concentrated in the lower portion or vegetal hemisphere. A plane passing through these two poles constitute the polar axis. The nucleus is always located in the polar axis, more or less towards the animal pole. The yolk shows a gradation from the animal pole towards the vegetal pole. There is also a metabolic gradation along the polar axis. Metabolic processes are highest at the animal pole and progressively diminish towards the vegetal pole.

Egg Membranes

The eggs are well protected by egg membranes. The membranes are produced either by the egg itself or by the follicle cells of the ovary or by the genital ducts (oviduct) of the female, mother. Accordingly, the egg membranes are classified into three types. They are:

1. **Primary membranes 2. Secondary membranes and 3. Tertiary membrane**.

I. Primary membranes: The membranes secreted by egg cytoplasm (ooplasm) constitute the primary membrane. They are closely attached to the surface of the egg. The primary membranes are named differently in the different animals. They are

a. Plasma Membrane

It is the membrane covering the egg immediately It over it. is found in all the eggs in structure, It resembles the plasma membrane of a cell.

b.Vitelline Membrane: it is closely attached to the plasma membrane of egg. Commonly found in Egg of Amphioxus. molluscs. Echinoderms, amphibians birds etc It is very thin and and transparent. It is formed of mucopolysacharide and fibrous protein. The space formed between it and the plasma membrane is called perivitelline space filled with a fluid called perivitelline fluid.

c. Chorion: It is found in the eggs of lower chordates like fishes (styela)It is a product of surface ooplasm

d.Zona Radiata

The egg of the shark Scyllium canicula, has two primary membranes produced by the surface ooplasm. The outer membrane is the vitetlline membrane and the inner membrane has a radiating appearance and hence called zona radiata The eggs of teleost fishes are also covered by zona radiata.

e.Zona Pellucida

All mammalian eggs are surrounded by a membrane called zona pellucida is also named as zone radiata. It is so named because it gives a striated appearance under the microscope. The striations are due to the presence of microvilli and macrovilli (desmosomes) in this zone. The microvilli are produced by the surface of the egg and microvilli are produced by follicle cells. They protrude into the zona pellucida.

II. Secondary Membranes

The secondary membranes are produced by the follicle cells (cells found around the developing oocytes) of the ovary. These membranes are usually tough and impermeable. The secondary membranes are as follows:

a. Chorion

This is a common outer covering in the eggs of insects, ascidians and cyclostomes (Myxine).It is found outside the vitelline membrane. As the chorion is tough and impermeable. It is provided with one or more openings called micropyles through which the sperms enter the egg.

b. Corona Radiata It is found in mammalian eggs. This membrane is formed of a layer of follicle cells. The cells are radially arranged around the zona pellucida

III.Tertiary Membranes

The tertiary membranes are produced by the oviduct.

a. White Albumen

It is found in the egg of hen. It is found outside the vitelline membrane. It is formed of three layers-inner less dense albumen, a middle dense albumen and an outer less dense albumen. The albumen is formed of water and protein

b. Shell Membrane: The shell membrane is formed around the albumen in the egg of hen. It is a double membrane. The two membranes adhere closely and are separated by an air space ar the blunt end of the egg. This membrane is formed of keratin-

c. Shell: The shell is the outer covering of land animals eggs. It is formed of calcium carbonate. It is white or brown in colour. It contains as many as 7000 minute pores. These pores are 0.04 to 0.05 mm in diameter. They are filled with a proteinous substance called collagen.

d. Jelly Coat: The amphibian eggs are surrounded by a gelatinous covering called jelly coat

e. Mermaid's Purse: It is the egg case of some cartilaginous fishes. It is a protective hard shell secreted by the shell glands present in the oviduct. The shape of the purse varies from group to group. Generally, it is rectangular in shape. The corners of the shell are drawn out into four long twisted elastic filaments which serve to attach the eggs to sea weeds. In dog-fish Chiloscyllium, development is completed within this purse.