

cell.

Skree ANIL KUMAR Zoology Part III Pages VI

Topic Q. 19. Write an essay on Fertilization.

Ans. External and Internal Fertilization : In majority of aquatic animals, sperms and ova are released into the water where fertilization takes place. It is called external fertilization. It is the primitive type of fertilization. In amniotes sperms are introduced into the Female's genital tract, where fusion takes place. It is called internal fertilization. It is the advanced type.

Monospermy and Polyspermy : Generally only one spermatozoan enters the egg and fuses with it. Such a fertilization is said to be monospermy. Monospermy is common in majority of animals like co-elenterates, annelids, echinoderms, bony fishes, frogs etc. In other animals normally many sperms enter the egg. Such a fertilization is said to be polyspermy. Even though many sperms enter the egg, only one sperm nucleus fuses with the egg nucleus. Other sperm nuclei degenerate. Polyspermy naturally occurs in animals with heavily yolked eggs. e.g. archnids, some insects, elasmobranches, urodels, reptiles, birds etc. This is known as physiological polyspermy. In other animals polyspermy occurs during abnormal conditions and it is harmful. Such a type of polyspermy is said to be patho polyspermy.

Approximation of Gametes : After the release of the gametes they are brought together. The meeting of the gametes is promoted by the following methods :

1. Chemotaxis.
2. Fertilizin antifertilizin reaction.
3. Production of enormous number of sperms.
4. Random collision.
5. Mechanical juxtaposition of gametes.
6. Synchrony in the production and release of gametes.

1. Chemotaxis : In certain animals sperms are attracted towards the eggs by chemical. This happens in coelenterates, fishes, insects etc. In fishes and insects this chemical is present in the chorion lining the micropyle. When the chorion is removed from the egg, the activity of sperm slows down.

2. Fertilizin and Antifertilizin Reaction : The sperm identifies the egg by the reaction between fertilizin and antifertilizin.

Capacitation : Capacitation is a process where the spermatozoa acquire the capacity to fertilize the eggs. After capacitation, the spermatozoa develop the ability to penetrate the membranes surrounding the egg. The spermatozoa obtain capacitation by the following methods.

1. By remaining in the female's genital tract for some time, the duration of this time is six hours in man and one hour in mouse.

2. In some animals sperms obtain capacitation by passing through epididymis.

3. During capacitation the coating substances on the surface of the sperm are removed. This helps the receptor sites on the sperm to recognize signals coming from the egg.

Sperm Penetration : After making contact with the egg, the sperm has to penetrate the egg membranes to reach the surface of the egg. In some animals such as nemertines, molluscs, echinoderms, insects and fishes, the egg is surrounded by a tough membrane called chorion. This membrane cannot be easily penetrated by the spermatozoa. Hence the eggs are provided with one or more minute openings called micropyles. The spermatozoa enter the eggs only through these openings. In other eggs the penetration may occur at any place.

The mechanism of penetration is chemical. The spermatozoan liberates an enzyme called spermolysin. It is produced by the acrosome of the spermatozoa. It dissolves the egg membrane and makes way for the entry of spermatozoa.

In animals at the time of ovulation, the egg is surrounded by follicle cells. These cells are cemented together by a substance called hyaluronic acid. The mammalian sperm secretes a lytic enzyme called hyaluronidase. The enzyme dissolves the hyaluronic acid, the follicle cells are loosened. This paves the way for the entry of spermatozoa.

Cortical Reaction : As the sperm enters the egg, the egg becomes activated. First of all, changes occur in the cortex of the egg. These changes constitute the cortical reaction. The cortical reaction in the egg of sea-urchin can be summarised as follows:

1. The colour of the egg surface gradually changes from yellow to white. The change starts from the point of attachment of the sperm and gradually spreads over the surface of the egg.

2. The vitelline membrane gets lifted off. This membrane is then called fertilization membrane. The space between it and the surface of the egg is called perivitelline space. It is filled with a fluid.

3. The cortical granules swell rapidly and explode. The cortical granules release three important components. They are :

(a) Lamellar Folded Bodies : These are dark and dense bodies. On release, they unfold and fuse with the inner surface of the fertilization membrane. Thus the fertilization membrane is strengthened by the lamellar bodies.

(b) Globules : The globular structures fuse together and form a new surface layer just outside the plasma membrane. This layer is called hyaline layer. It helps to keep the blastomers intact during cleavage.

Sperm Nucleus : When the sperm is engulfed by the fertilization cone, it moves towards the female pronucleus. The sperm-nucleus is followed by the centriole, the middle piece and the tail. Soon rotation of the nucleus and centriole occurs. As a result, the centriole comes to occupy in front of the sperm nucleus. The other parts of the spermatozoan get disconnected from the nucleus. They later disintegrate in the egg cytoplasm. The sperm nucleus is now termed as the male pronucleus. As the male pronucleus moves inwards, the path trailing along its path. The path taken by the spot in the periphery of the egg is called penetration path. Inside the egg the direction of movement of the sperm is slightly changes and the nucleus moves towards the female nucleus. This changed path is called copulation path.

Physiological Changes in Fertilization : As the sperm enters the egg, it triggers a number of physiological changes in the egg. They are as follows :

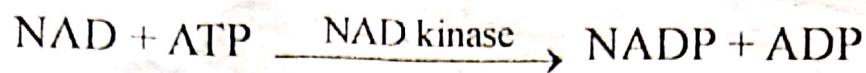
1. Elevation of Fertilization Membrane : The vitelline membrane is lifted off from the surface of the egg. This membrane is now called fertilization membrane. It is strengthened by the deposition of cortical granule materials on its inner surface. A fluid called perivitelline fluid gradually accumulates in the space between the surface of the egg and the fertilization membrane. The fertilized egg freely rotates inside the perivitelline fluid.

2. Explosion of Cortical Granules : When the sperm enters the egg the cortical granules explode and release their contents. The cortical granules synthesize the fertilization membrane, perivitelline fluid and the hyaline layer.

3. The cytoplasmic movement is best illustrated in amphibian eggs. As the sperm penetrates through the cortex of the egg, a trail of dark pigment from the egg's periphery flows in after the sperm. This initial path of the sperm constitutes the penetration path. Then the sperm begins to travel towards its place of meeting with the female pronucleus. This secondary path is the copulation path. On the surface of the egg opposite to the point of spermy, the peripheral area of the egg becomes lighter in colour and assumes a grey appearance. This area is crescentic in shape and is known as the grey crescent.

4. Permeability of Plasma Membrane : The permeability of plasma membrane increases in the case of the molecules of water, ethylene glycol, phosphate.

5. Phosphorylation of coenzymes : At fertilization the coenzyme NAD is phosphorylated into NADH NADPH in the presence of the enzyme NAD kinase.



6. Rate of Oxygen Consumption : The rate of oxygen utilization may increase or decrease or may not change. In frog and toad there is a pronounced drop in respiratory quotient. In seaurchin and lamprey oxygen consumption is increased during fertilization. In teleost fish, fundulus, there is no change in the rate of oxygen consumption.

7. Rate of Protein Synthesis : In the unfertilized egg of seaurchin there is no protein synthesis. During fertilization the rate of protein synthesis increases.

8. Initiation of Mitosis : Fertilization initiates mitosis in the egg resulting in cleavage. Mitosis requires the development of mitotic apparatus. It is produced exclusively by the centriole introduced by the sperm. The introduction of sperm centriole is a must for the egg to form a mitotic spindle. Thus the sperm stimulates the first mitotic division of the fertilized egg, by contributing its centriole to the egg.

9. The Breakdown of Polysaccharide : Immediately after fertilization a rapid breakdown of polysaccharide takes place. There is a corresponding increase in lactic acid.

10. Hexose Phosphate : It increases considerably after fertilization.

11. Dehydrogenases : This enzyme increase after fertilization.

Significance of Fertilization :

1. Fertilization maintains the diploid number of chromosomes in the race.
2. Produces gametic variation.
3. It activate the eggs.