

Gr-2 - Embryology (vi) Fertilization

Fertilization

Introduction → Fertilization of the egg is the first step in the process of embryogenesis. In fertilization, there are two coordinated phenomena. First by self propulsion from its flagellum, the sperm reaches the egg surface and after membrane fusion becomes incorporated into the cytoplasm of egg. Second, two haploid nuclei of male and female gametes fusion is a process called amphimixis or syngamy and a diploid nucleus containing zygote results which soon starts the first division by establishing the first cleavage spindle by the centrioles donated mostly by the sperm. Another most interesting point about fertilization is that it is species specific i.e. in the sense that the sperm from one species cannot fertilize the egg of another species. And this maintains the stability of a species.

Basic Requirements of Fertilization -

In most animals the act of fertilization requires following fundamental requirements for its completion -

1. In most animals, fertilization requires a fluid medium, which may be seawater in marine forms, freshwater in freshwater forms or some body fluid in viviparous animals.
2. The life span of gametes are limited. The female gametes, egg also has a short life span similar to male gametes or sperms. So, they need to be fertilized within their life span.
3. To increase the probability of fertilization, the no. of sperms must exceed the no. of eggs.

Mechanism of Fertilization -

The process of fertilization completes in following stages -

1. Encounter of Spermatozoa & Ova →

A major problem in sexual reproduction is how to bring together the spermatozoa and ova. It is important that ripe eggs and sperms be brought together in vicinity so that sperms

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may reach the surface of ovum. According to place and nature of fluid media, following two kind of fertilizations have been reported —

A External Fertilization B Internal Fertilization.

A External Fertilization — when the fertilization occurs in the aquatic medium outside the bodies of male and female of parents, it is called External Fertilization. The aquatic medium for the external fertilization may be either sea-water or freshwater.

B Internal Fertilization — In terrestrial forms, particularly, when eggs are completely enclosed in impermeable envelopes before being laid or when they are retained within the maternal body throughout development as in higher animals like mammals.

2 Approach of the Spermatozoa to the Egg →

This is possible by either of these two methods —

A Chemotaxis → It is the ability of the sperm or pollen to detect the difference in concentration of some specific substance released into the water by the egg and to move from lower to one of

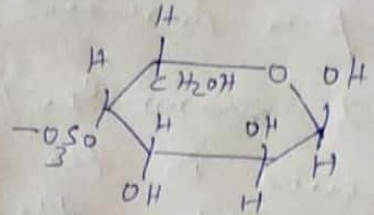
greater concentrations of the substance. This kind of chemotaxis has been detected in coelenterates and fishes. [Pg-4]

B Fertilizin - Antifertilizin interactions -

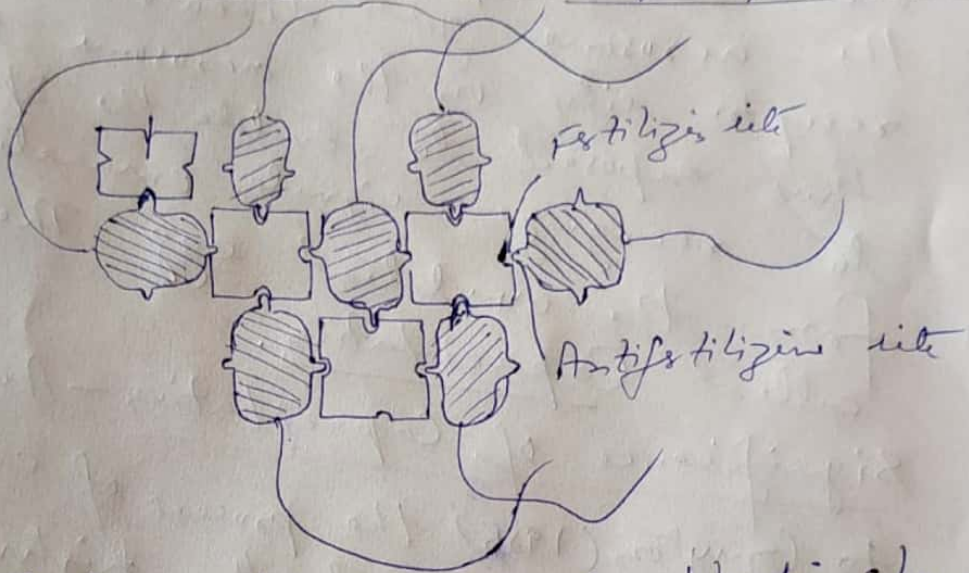
In 1914, F.R. Lillie, proposed their theory of physiology of fertilization. He observed that egg water agglutinates the sperms and activated their motility. The reaction was specific since some sperms from related species were unaffected. This factor called fertilizin, secret present in egg jelly and membrane. For agglutination by sperms for these fertilizins, they have receptor sites on their surface. These receptor sites or antifertilizins interact with fertilizin molecules. The antifertilizins can be extracted from the spermatozoa by heating, freezing or acidifying the water.

Regarding the mode of interaction of fertilizin and antifertilizin, Belinsky (1981) has proposed lock and key type interaction. Chemically, a fertilizin is a glycoprotein or mucopolysaccharide, containing a variety of amino acids and as a polysaccharide it includes sialic acid and

one or more monosaccharides such as glucose, fructose or galactose.



Chemical structure of monosaccharide of fertilizers estrified by Sulphuric Acid



Mode of binding of Sea Urchin spermatozoa by particles of Fertilizer

(Balinsky, 1970)

Each molecule of fertilizer has more than one active group so that one fertilizer particle may attach two or more spermatozoa. In contrast to it, antifertilizer an acid protein with fairly a small molecule (mol. wt. 10,000 letters).

Sperm motility → Factor release of Nat. active release of acid and as increase of intracellular pH.

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This causes increased metabolism and motility. Thus great motility of male gamete depends upon increased metabolism.

2. Capacitation → In mammals, it usually occurs in the fallopian tube of female, when the coating substances of sperm and the acrosome get dissolved. The receptor sites on the acrosome are thus exposed to enable the sperm to recognize signals emanating from the ovulated egg. This is called Capacitation.

Significance of Capacitation - According to Crayton (1986) the process of capacitation of human beings and other higher mammals holds the importance that the acrosome of human sperm contains extremely powerful hydrolytic and proteolytic enzymes that could literally destroy the male genital tract, if they rupture pre-maturely. But seminal fluid with excess of cholesterol protects it. But in further course, they lose extra cholesterol to become capacitated. In this way, they prepare themselves for further acrosome reaction. →

E. Acrosome Reaction: [Control ----]