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2. PRE FERTILIZATION ... of gametes, Acro... Reaction

I. Introduction

1. Fertilisation is a complex process involving fusion of male and female gametes by the fusion of their cytoplasm followed by the fusion of their nuclei.

2. Manner Harold :→ (1964) defenies fertilization as the entire process beginning with the approach to the egg and ending with the fusion of egg and Sperm pronuclei.

3. The elements that unite during fertilization are single cells and by their union a rejuvenated individual is formed.

II. MECHANISM OF FERTILIZATION :→

The process of fertilization completes in following five stages :-

A. Encounter of Spermatozoa and ova.

B. Capacitation and contact

C. Acrosome reaction and penetration

D. Activation of ovum

E. Migration of pronuclei and Amphimixis.

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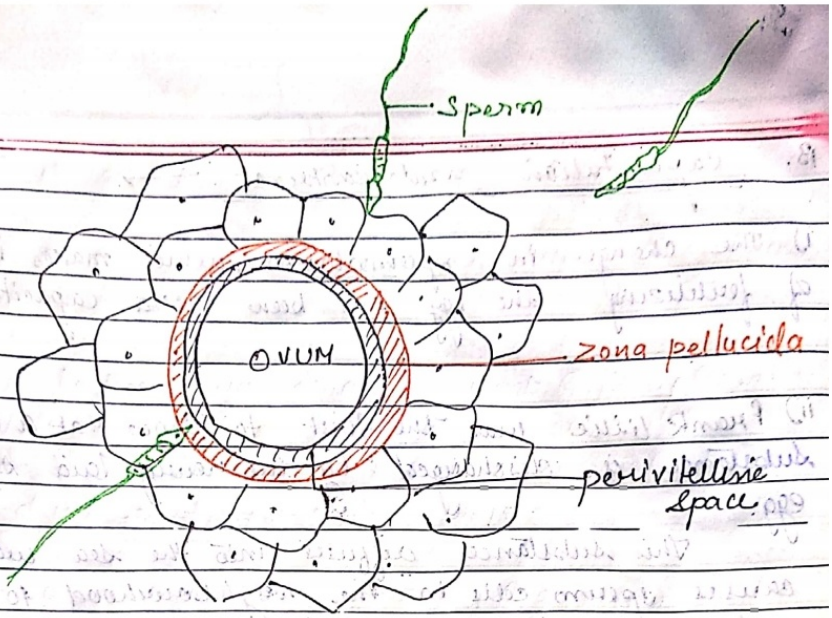

ovum surrounded by few sperms

A. Encounter of Spermatozoa and ova:

i) Previously it was thought that sperms are attracted towards the ripe eggs by chemotaxis

ii) The primary needs for the encounter of spermatozoa and ova are fluid medium for the act of fertilization and delivery of large quantities of spermatozoa close to the number of ripe eggs at the right time.

According to the place and nature of fluid following two types of fertilization do :→

1. External fertilisation
2. Internal fertilisation

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B. Capacitation and Contract :→

i) The change in Spermatozoa, which makes it capable of fertilizing the egg has been called capacitation.

ii) Frank Lillie was the first to show that a chemical substance is discharged by the newly laid sea urchin egg.

This substance diffuses into the sea water and causes sperm cells in the neighbourhood to become more active and attracted to the cell.

This condition is called as chemotaxis

J. Agglutination :→

a. In most of the animals, it has been observed that the ripen egg lying on the surface of the water of the same species,

the Spermatozoa adhere to the surface of the egg by its lateral side and even to each other.

b. This reaction is seen within few seconds and.

c. The Spermatozoa are seen to clump together, head to head or less commonly tail to tail.

This adhesion of Spermatozoa results in their clumping or agglutination.

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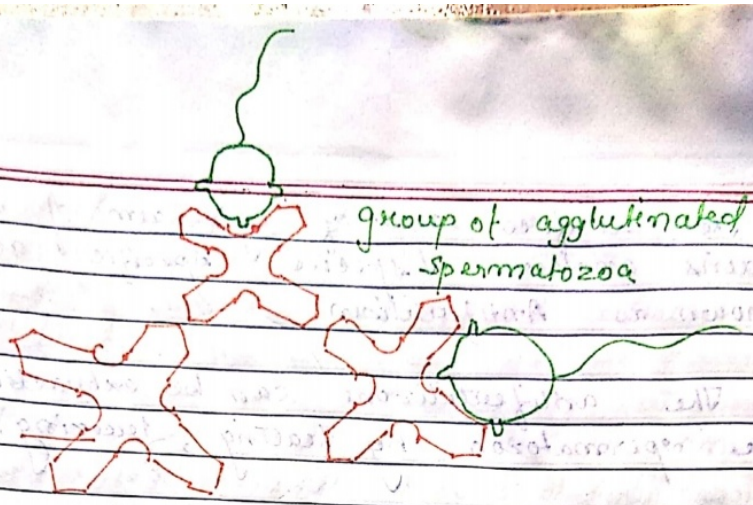


Agglutination of Sperm

2- Fertilizin — Antifertilizin Reaction :→

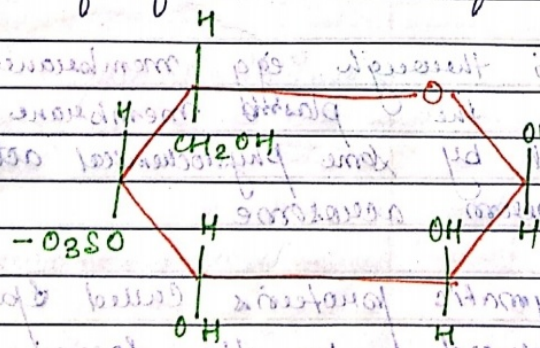
a. Frank Lillie, observed that fertilizin and antifertilizin occur in the egg and sperm respectively

b. The main source of fertilizin is the egg itself and it is located in the plasma membrane

c. The fertilizin is a gel formed of glycoprotein or mucopolysaccharide.

Each species possesses its specific type of fertilizin

d. Molecule of fertilizins are quite large.



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e. The surface layer of cytoplasm of spermatozoa contains another species specific acid protein known as Antifertilizin.

f. The antifertilizins can be extracted from the spermatozoa by heating, freezing.

g. During capacitation and contact stage of fertilization when spermatozoa and eggs of same species come in physical contact of each other, a chemical lock established between the antifertilizin molecules of spermatozoa and fertilizin molecules of egg.

Function of fertilizin & Antifertilizin

→ take out the number of spermatozoa around the egg, so that the chances of two or more spermatozoa fusing with the egg at the same time is diminished.

III. ACROSOMAL REACTION AND PENETRATION OF SPERM

1. When a spermatozoon is attached to surface of the egg, it becomes motionless.

2. Its penetration through egg membrane and also through the plasma membrane of the egg is achieved by some physiochemical activity of the sperm acrosome.

3. Certain enzymatic proteins called sperm lysins are produced by the sperm Acrosome.

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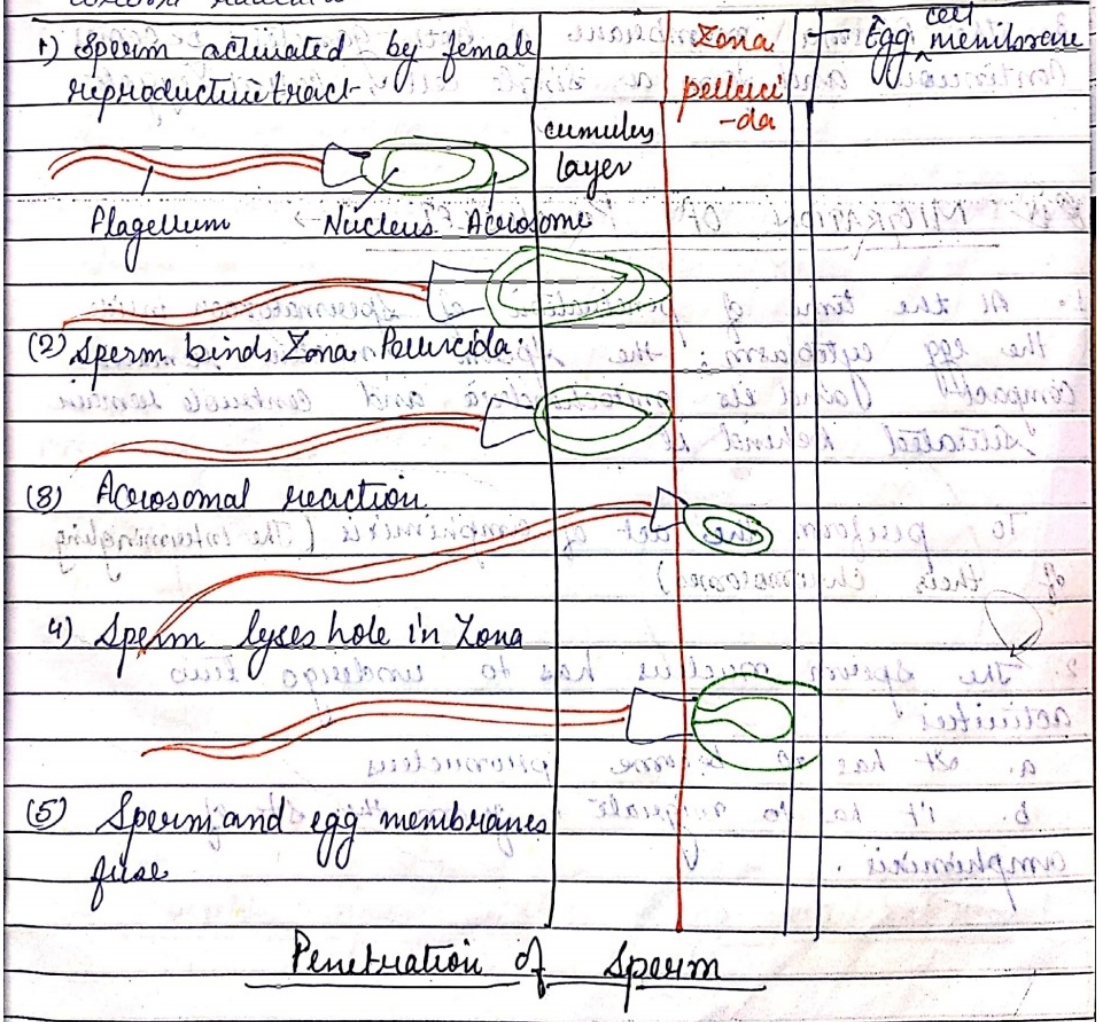
4. In mammals, when the eggs are released from the ovary, they are commonly covered in a layer of follicular cells called corona radiata.

These cells are held together by an adhesive cementing substance called hyaluronic acid.

5. The sperm's acrosome produces an enzyme hyaluronidase, which secretes to dissolve the adhesive substance and disperses the cells of corona radiata.



Penetration of Sperm

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(iii) ACTIVATION OF OVUM. :→

1. Activation of ovum is that aspect of fertilization by which an egg released from its inactive stage and begins to develop.

2. As soon as the apex of acrosomal tubule of a spermatozoon touches the surface of egg plasma membrane fusion of both membrane over this limited area of contact takes place and a single continuous mosaic membrane is formed.

3. The plasma membrane of both gametes becomes continuous and form a single cell, called Zygote

(iv) MIGRATION OF PRONUCLEI :→

1. At the time of penetration of spermatozoon inside the egg cytoplasm; the sperm nucleus remains compact and its mitochondria and centriole remain situated behind it

To perform the act of amphimixis (The intermingling of their chromosomes)

2. The sperm nucleus has to undergo two activities

a. It has to become pronucleus

b. It has to migrate from the site of amphimixis.

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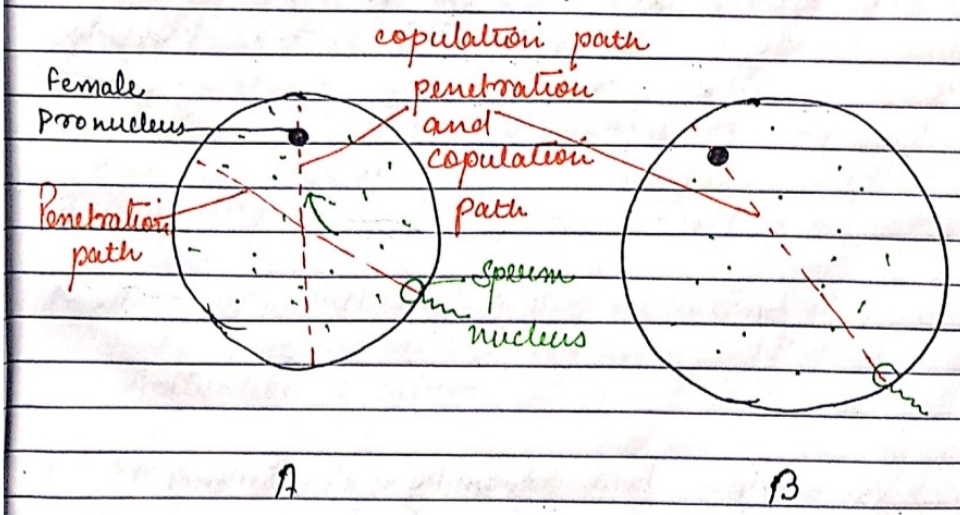
5. As the sperm nucleus moves inwards from the site of fertilization cone, it soon rotates through an angle of 180°C.

4. The sperm nucleus starts swelling and its chromatin, which is very closely packed and is called as pronucleus.

5. The movement of the sperm appears to be directed and some investigators feel that it is due to a chemotaxic effect of chemicals liberated by the female pronucleus.

6. During this movement towards the female pronucleus, the sperm may have to deviate from its penetration path.

If it does, the new pathway taken is referred to as copulation path.



Possible sperm paths during fertilization

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SIGNIFICANCE OF FERTILIZATION :-

1. The fertilization ensures the usual specific diploidy of the organisms, by the fusion of the male and female pronuclei.
2. It introduces genetic variations in the species.
3. It activates the egg to start cleavage.